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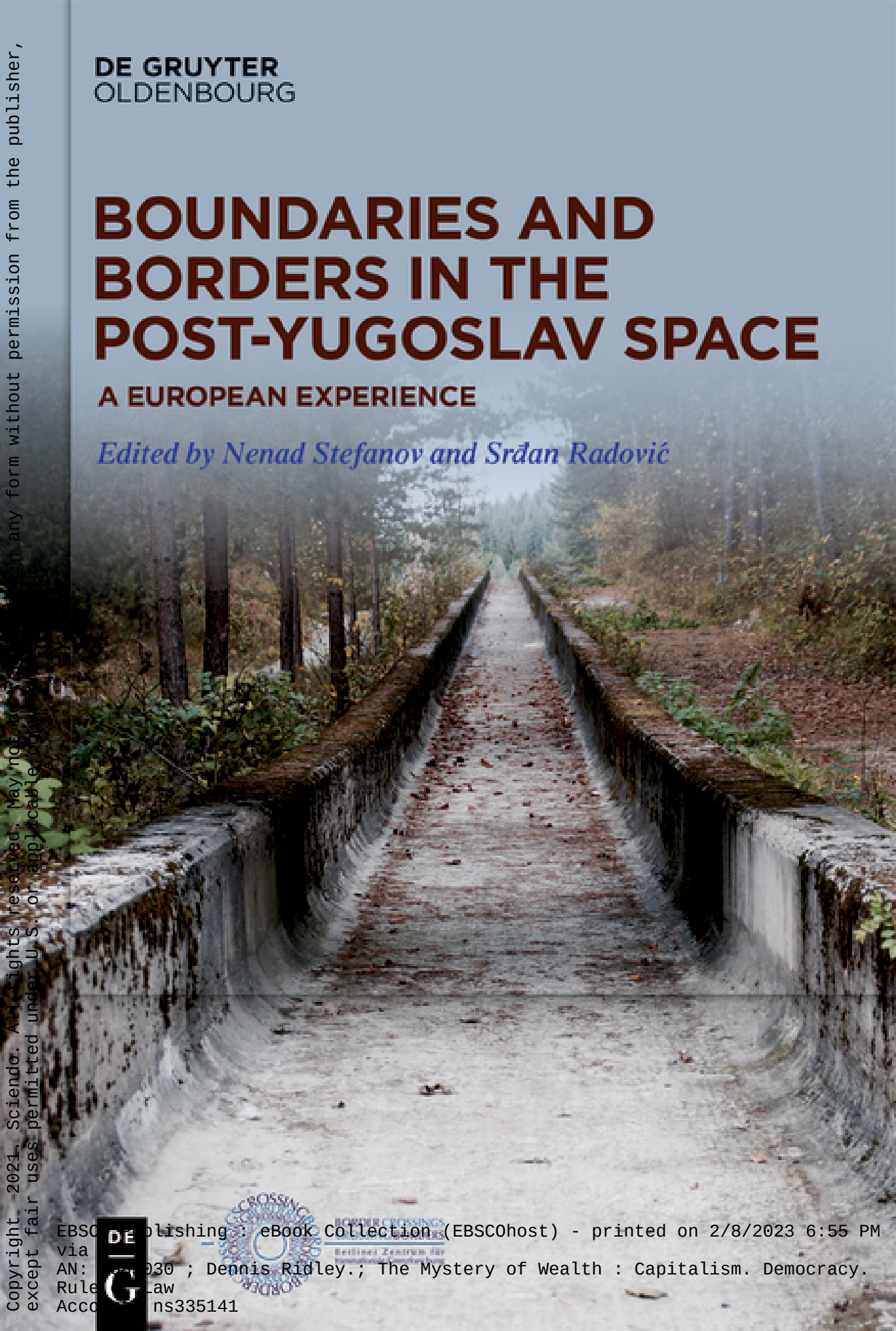
BOUNDARIES AND BORDERS IN THE POST-YUGOSLAV SPACE

A EUROPEAN EXPERIENCE

Edited by Nenad Stefanov and Srđan Radović



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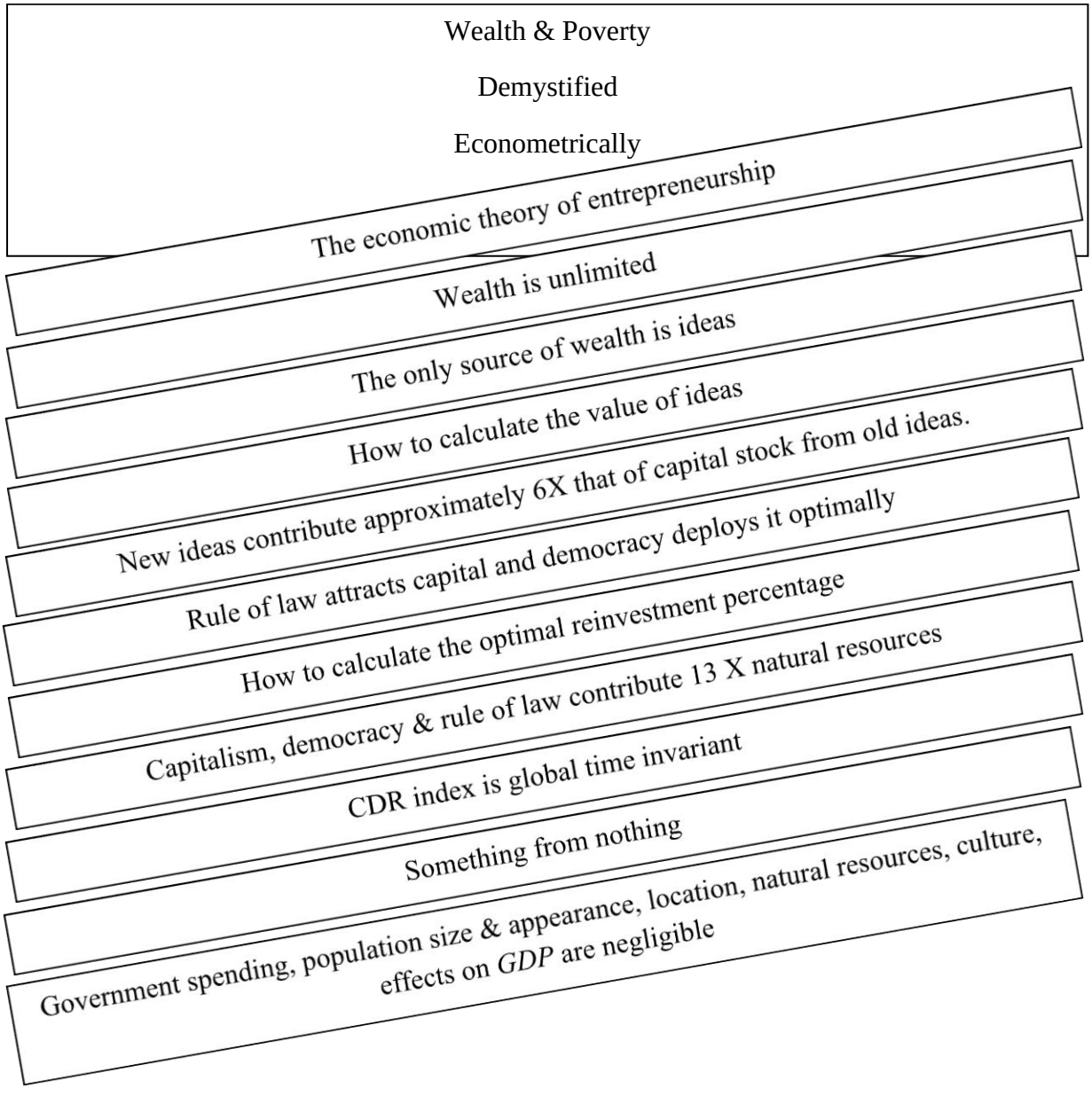
Wealth

explained by

Capitalism Democracy Rule of law

General theory of economics

CDR supply side scientific growth law unveiled
from confusion to clarity



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About the Author

Dr. Dennis Ridley studied Electrical Engineering at Middlesex University in England and the University of the West Indies, where he received the Master of Science degree in Computer Methods in Electrical Power Systems Analysis. He received his PhD degree in Engineering Management from Clemson University, USA. He has the distinction of a US patent, publication in the Journal of the Royal Statistical Society, US State Department Fulbright Senior Specialist at Kharkov University in Ukraine and Harvard Business School certificate in The Art & Craft of Discussion leadership.

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He is widely published in the fields of electrical, industrial & biomedical engineering, economics, finance, management science, operations research, time series analysis, statistics, supply chain management and entrepreneurship. His professional societies have included the Institute for Operations Research and Management Science, the International Institute of Forecasters, the Institute of Business Forecasting, the American Statistical Association, and the Production & Operations Management Society.

He is the father of the computer-powered wire(less) ultra-intelligent real-time monitor, antithetic time series analysis, the moving window-spectral method, the CDR economic growth index, the professorial evaluation metric, live case study pedagogy, Andrew Ridley and Jon Ridley.

Dr. Ridley has served as an accreditation visitation team member in service to the University of the District of Columbia, Seton Hall University, State University of New York and Rutgers University.

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PREFACE

The purpose of this book is to demystify the causes of wealth and poverty like never before done. It is the seminal comprehensive presentation of the CDR index. The CDR index is a mathematical model that shows how capitalism (C), democracy (D) and rule of law (R) jointly with natural resources and geography explain almost all economic growth. As it turns out, capitalism, democracy, and rule of law are intangible policy variables that are at the disposal of all countries and explain almost all gross domestic production of tangible products and services. There is also a minor contribution from non-policy variables such as natural resources and geography. These are all that countries require at their disposal and choice in order to enjoy their desired standard of living. The CDR economic growth model is a new paradigm.

The book will serve the needs of individuals who wish to gain a basic understanding of national wealth and the macro-economic growth and decision making that is responsible for wealth. The reader may start with a preliminary review of the information at CDRindex.blogspot.com and here in Chapter 1. The blog is intended for anybody, especially persons with a high school education and beyond. The introduction proceeds to explain wealth in general terms. It contains a summary of conclusions that flow from the basic CDR fact that the source of all wealth is human ideas of imagination and creativity. It contains many conclusions that are counterintuitive and different from commonly held beliefs. Chapters 2 and beyond are intended for college and university students, and professionals. It is anticipated that through the study of entrepreneurship, students might gain a sense of ownership and purpose that places higher value in their own education. They might also become more supportive of the minority of students who choose entrepreneurship for a career and will likely pioneer future wealth building for society as a whole. Chapters 2 explains the relationship of CDR and wealth to entrepreneurship. Chapter 2 focuses on entrepreneurship in the United States of America (USA). Chapters 3 and 4 explain the mind as source of wealth and its ramifications for welfare transfer payments. Chapters 5-12 drill down to develop the economic theory of entrepreneurship. The final (on economic theory) Chapter 13 addresses the implementation of the CDR model to improve the economies of all countries including wealthy countries. But low income countries can benefit the most. A seminal model is presented for political and economic transition from low CDR, low wealth countries to high CDR, high wealth countries. The transition involves game theoretic strategies for the replacement of pernicious corrupt dictatorship with nation building CDR. Chapter 14 considers what can be done with CDR to increase the wealth of formerly communist countries. Chapters 15a-15c contain pedagogical proposals for revising introductory economics, engineering and mathematics courses to better develop science, technology, engineering and mathematics (STEM), and entrepreneurial concepts and creative thinking in higher education.

Chapter appendices that include supporting information for a chapter are placed at the end of the chapter. Global appendices that support multiple chapters are placed at the end of the book and are named with double letters. Appendix AA contains a nomenclature of economic terminology that is developed specifically to explain the CDR growth model and how it works. Appendix BB contains the regression results and chart that depicts the source and mechanism of wealth. Appendix CC contains a question and answer review that compares traditional economic growth models with the new CDR economic growth model.

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CHAPTER 1

Introduction: Context, Perspective and History of Economic Growth

Capitalism-Democracy-Rule of Law (CDR) theory of economic growth

The true source of wealth is entrepreneurial capital. Capital comprises intangible exogenous human entrepreneurial capital ideas of imagination and creativity, and capital stock of knowledge (skills and memory), and tangible endogenous machinery, recordings, computers, etc. Capitalism is a method of organizing capital for the purpose of profitable investment. Rule of law is an intangible exogenous catalyst that creates stability for attracting capital. Democracy is an intangible exogenous catalyst that creates new pathways for the optimal deployment of capital. Total capital is converted into production of capital stock, goods and services, which after consumption, depreciation and obsolescence, contributes to wealth. Since capital stock is subject to continuing depreciation and obsolescence, entrepreneurship must be the true source of new wealth creation. The CDR index is a weighted average of capitalism (C), democracy (D) and rule of law (R) that jointly with natural resources and geography explain almost all economic growth. High CDR countries are where ideas go to fly. Low CDR countries are where ideas go to die.

Organization

This book is a compilation of papers written by a collection of authors, collectively referred to in the text as “we” or “our” when stating in pertinent part, partial research findings and conclusions. The contributing authors and the related published paper are identified at the beginning of each chapter. The primary author is solely responsible for the creation of the book and any errors and omissions. The book discusses capitalism (*C*), democracy (*D*), and rule of law (*R*) - (CDR) and their role as the main drivers of global economic success. Chapters 1-6 are concerned with the fundaments of CDR. Chapters 2, 14 and 15 are guides to CDR education and how to teach it. These 8 chapters are kept qualitative for the reader who is not fond of mathematics and is satisfied with verbal arguments in support of the CDR theory. In the study of physical sciences like physics and engineering, experiments can be controlled and repeated at will. In growth economics considered here, the study is of data that are recorded from experiments that cannot be repeated. It is never obvious what and when changes in which variables occurred, and how they are related. The task of chapters 7-13 is to sort these out, and that requires some specialized quantitative analysis. Think of them as a bonus. They provide mathematical proof, and demonstrations based on econometric modeling and statistical analysis. While statistical analysis by simple regression is accessible to undergraduate sophomores, CDR is a multivariate model and therefore requires multiple regression analysis. Furthermore, *C* is a mixture of *exogenous* and *endogenous* components and therefore requires econometric analysis; two stage least squares and instrumental variables. But, Hakuna Matata (no worries), as all presentations are accompanied by copious verbal qualitative explanations. Of particular interest are the seminal presentations of how to calculate the value of ideas (chapter 9), how to calculate the value of endogenous growth, and proof that it is a fallacy of composition to think that we can simply jump from microeconomic production function conceptions to an understanding of aggregate production by society as a whole (chapter 11). Chapter 13 discusses how countries can increase

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their CDR. The analysis there is based on game theory in general and Nash Equilibrium in particular.

Each chapter is self-contained, completely covering its designated learning milestone. But collectively they can be the reference book for a university course in entrepreneurship. They can also be used as a textbook dedicated to modern economic growth theory in general and the new CDR paradigm in particular. Like all good methodologies in economics that improve the wealth of nations, CDR can be applied to improve the personal wealth of individuals.

There may be instances where the reader is surprised by a finding that is inconsonant with their own personal beliefs and observations. The reason for this could be that the reader's information is anecdotal. Bear in mind that the data analyzed in this book are aggregate country macro-economic averages and the conclusions reached are about macro-economic averages. Actual outcomes are distributed around their average and may not *by themselves* provide reliable information about the whole population from which the data are summarized. One must take into account their distributional properties and statistics such as mean (location), variance (spread), asymmetry (skewness) and kurtosis (peakedness or flatness). Also, when certain concluding statements are made about the partial (or marginal) impact of a particular variable of interest, they are always based on the assumption of *ceteris paribus* where all other variables are held constant.

The Mission

Several researchers (Friedman and Friedman, 1980, Friedman, 2002, Gwartney, Holcombe and Lawson, 1999, Gwartney and Lawson 2003, Heritage Foundation, 1995-2016, Sowell, 2015, Rand, 1961, Homburg, 2015) have identified *C*, *D* and *R* as impacting gross domestic product (GDP). But they do not identify these variables as exclusive and unique policy variables. They have not eliminated what are assumed to be numerous other possible factors. This book presents a new macro-economic model that accounts for standard of living as a function of *C*, *D* and *R*. The model is a weighted average of *C*, *D* and *R*. When natural resources and geography are included, the model explains approximately 90% of standard of living. We assume that the remaining 10% is attributable to intrinsic error in the data. The data are based on all countries in the world and for all years for which there are data. This extraordinary ability to explain standard of living far exceeds that of any extant model. *C*, *D* and *R* are policy variables that can be implemented by a country. Natural resources (*N*) and geography as measured by the absolute value of latitude (*L*) are not policy variables under the control of a country. *N* and *L* cannot be chosen. Therefore, the model is referred to simply as the CDR model. By raising their CDR, countries can raise their standard of living. Even if certain limiting human characteristics, or *N* or *L* were obstacles in some nations, CDR is salutary to economic development in terms of making the best of what is possible.

C, *D* and *R* are complex variables with many elements. For the moment suffice it to say that *C* is the degree to which capital is organized, measured by total market capitalization. *D* is the degree to which democracy is implemented. *R* is the degree to which corruption is reduced. The way in which these variables are constituted, combine and interact, are explained later in this introductory chapter and in great detail in chapter 7. Numerous implications of CDR are expanded on throughout the book.

The CDR model is estimated by the regression of GDP adjusted for purchasing power parity (G) on *C*, *D*, *R*. All variables are standardized to range from 0 to 1 for easy interpretation. The model obtained for the computation of standard of living is $\hat{g} = 1.53C + 0.14D + 0.23R -$

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$1.21C{\cdot}D{\cdot}R + 0.38N$. The high coefficient of multiple determination (R^2_{adj}) and the results obtained being the same for all the years for which data are available, demonstrate that the model is global and time invariant. This and the constant mean and variance randomness of the residuals from the regression indicate that there are no other systematic policy variables that are responsible for explaining GDP. Computations that demonstrate and prove the validity of the CDR model are given in chapter 7. All the data required to permit replication of all CDR results presented, are provided in Appendix BB. Collectively, these stake a dispositive claim for finally placing growth economics on a sound scientific footing. A CDR scientific growth law. The mission of this work is to assist in the fight against poverty, raise standard of living and wealth, and promote middle class societies everywhere in the world.

Wealth and poverty

About ten percent of the people in the world are rich and getting richer (Pew Research Center, 2015). Even when they do not know why they continue to do what appears to work. In 2014 when the research for this book commenced, ninety percent of the people in the world were impecunious, living on two to three U.S. dollars per day. The only thing standing between them and wealth is a corrupt dictator. It is high time for entrepreneurial education - capitalism, democracy and rule of law - to raise the human condition so that all people can enjoy a desirable standard of living. This book is a call to action, not to opine poverty. “The arc of the moral universe is long, but it bends toward justice.”

Capitalism is often associated with rapacious intentions of the one percent capitalists and their willful exploitation of the ninety nine percent common men. This rent seeker ad hominem trope places successful entrepreneurs in its crosshairs, but it has done nothing to raise the lot of the poor. If entrepreneurship is to be beneficial it is important to eradicate this wrongheaded way of thinking. Recall Adam Smith “Every individual is continually exerting himself to find out the most advantageous employment for whatever capital he can command. It is his own advantage, indeed, and not that of the society that he has in view. But, the study of his own advantage naturally, or rather necessarily, leads him to prefer that employment which is most advantageous to society… He intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. By pursuing his own interest, he frequently promotes that of the society more effectually than when he really intends to promote it.” A capitalist is one who attempts to maximize one’s earnings in return for one’s efforts. Therefore, every rational person is a capitalist. Capitalism is a method of organizing capital for the purpose of profitable investment. All countries possess capital, if only its people, but capital contribution to wealth is minimal unless it is organized by capitalism. An example of capitalism is the capital market, the ultimate such market being Wall Street, in the United States of America (USA). This is no time to fool. In today’s internet of communications and worldwide travel networks, capital can and will flee as quickly as it arrived at the slightest hint of corrupt dictatorship. At the time of this writing, the foot traffic of human capital fleeing South America, particularly Venezuela, has not gone unnoticed.

Investment by the one percent creates new products and services that benefit the ninety nine percent on a massive scale. That is why the poor in the USA experience a living standard that is far better than that of the preindustrial revolution members of any royal family none of whom had indoor plumbing. The one percent entrepreneurs who pursue wealth soon discover the toil from experimentation, design and development, disappointment, joy of discovery, and the

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meaning of risk taking. Then, assuming positive proof of concept, they devote their leisure time to searching for ways to manufacture their product at a cost that makes it affordable to the ninety nine percent. The benefits of labor-saving devices, leisure time, health, and better standard of living in general accrue to common men. In reality, entrepreneurs are a gift to humanity. Anything done to impede their activities can only destroy capital and threaten a return to poverty.

Now that we have some insight into the cause of wealth, let us pause to consider the cause of poverty. For millennia, prior to the industrial revolution, with few exceptions, the normal state of existence of historic mankind was poverty. This was the case even though man was surrounded by natural resources. The way to maximize poverty was then and still is now, to do nothing. The next best way is not to innovate, but to live from day to day, hunting and gathering, barely eking out an existence, not knowing where the next meal is coming from. If the lifting up of the human condition was not due to capitalism, then what was it due to? Was it socialism? Socialism is a method of state owned and controlled production and redistribution of wealth. But, just as commonly held property (no property rights) cannot serve as fungible collateral-based capital for wealth generation, commonly held ideas (no patent rights) cannot be extracted from human capital for wealth generation (there are no incentives). When the source of government revenue is taxes, government spending cannot increase gross domestic product (GDP) without reducing the GDP contribution from the taxpayer (see also Ricardo, 1817,1821). The net change may be zero. And, when there is no wealth, what is obtained from the redistribution of poverty? Is it not poverty?

While we are on the subject of government spending, we added it to the CDR regression model and found that it had absolutely no effect on GDP. This is because the effect of government spending is completely offset by the corresponding taxes that were removed from private hands. This implicitly denies the commonly held belief in a government spending multiplier effect. In Keynesian economic theory, the multiplier effect is the effect of exogenous spending on endogenous growth. But, government money comes from taxes, taxes come from sources such as salaries, profits, etc. that are endogenous outcomes from the economic system. Therefore, government spending is endogenous to which no multiplier effect applies.

Entrepreneurship stops the poverty cycle

Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. At a time when the American government has promised to renew the fight against poverty, high technology productivity not only accelerated, it went global. This has led to a loss of high paying manufacturing US jobs, and massive profits for large corporations. One solution is for Americans to purchase stocks in the corporations and receive dividends. Since small businesses collectively create more jobs than the large corporations, another solution is entrepreneurship.

This book discusses factors that affect entrepreneurial mindset, economic success and poverty reduction. In particular, the case of extreme paucity of entrepreneurship in family background, that has led to confusion about the factors governing economic success and perpetual avoidance of entrepreneurship. One cannot deny the very low frequency of minority owned businesses. Formerly oppressed American communities typically have almost no examples of family entrepreneurs. They cannot imagine the inner workings of business. They are not part of any meaningful conversation on business planning or day to day business operations. They see a restaurant as a place to eat, not a place where business is being conducted. It may seem strange that a person can work and earn at one place of business, make purchases at

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another, and yet, not be able to decode the inner workings of either business. But it is no stranger than illiterate persons living amongst those who read newspapers every day, seeing signs all around them, yet themselves never having learned to read. After the oppressive forces are lifted, there is little ability to compete in business.

Wealth derives from ownership of the means of production. Technology as a means of production is an intellectual outcome. Factories may produce goods, but ideas produce factories. Therefore, wealth creation is an indirect product of the imagination of the mind and study by the mind. This is distinctly different from the mere transfer of wealth through invasion, colonization, enslavement and theft. When the members of a deprived community own no means of production, they are almost void of wealth. Furthermore, their poor economic condition is persistent. Any transfer of wealth through welfare systems is soon returned to its owner via consumption, plus labor value added, minus unproductive government agency employee payments. And, the wealth gap increases. The days are long, but the decades are short, and no progress has been made. More time will not cure this.

Progress is possible through extensive introspection, and academic and experiential entrepreneurship education. Teaching entrepreneurship is about encouraging students to dream big, then showing them how to act on those dreams. A realistic program will benefit from incubators, angel investors, and future venture capital. It must produce entrepreneurially minded graduates, consultants, and entrepreneurs. Encouragement and economic development amongst the formerly oppressed that are now underrepresented in business is a good investment that the mainstream should welcome. Because, if anywhere, somebody makes a product at a lower price with the same quality or better quality at the same price, the total economic pie must increase, and poverty must decline for all to benefit.

Entrepreneurship creates jobs

Changes in US business and economic structure have led to high productivity by machinery and underemployment of people. One way to overcome this is through an increase in entrepreneurship. The purpose of CDR theory is to counter a debilitating mindset of self-doubt, an insurmountable obstacle that can stymie all other efforts to raise the level of entrepreneurship (see also Dweck, 2019).

First, recognize that the limited liability company is the greatest invention so far in economic history because it has impacted the lives of more people than any other. A tour de force. It is the instrument of capitalism. Before this invention (about the turn of the 19th century and the industrial revolution), apart from feudal lords, beneficiaries of the 17th century Amsterdam stock exchange, the Dutch and English East India Companies, and certain skilled artisans, all people were poor. Capitalism is the mechanism for capital formation. It needs democracy and the rule of law to grow and flourish. Capitalism has created vast wealth. To illustrate this, consider a measure, CDR, that combines the degrees of *C*, *D* and *R* practiced in a country. Health and wealth increase with CDR. This relationship should be a critical component of entrepreneurial education which if not understood, can impede all other efforts to increase entrepreneurship. Despite evidence to the contrary, it is easy to mistakenly think that economic development is attributable to natural resources, not CDR. It turns out that CDR is about thirteen times more important than natural resources. If anything, the true natural resource is human ideas of what to do with what would otherwise be mere natural deposits.

For the most part, USA, Western Europe and oil free Japan are prominent world economic leaders. However, Botswana, Poland, Chile and Equatorial Guinea were able to break quickly

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away from their geographic neighbors by adopting CDR policies. Bermuda and Cayman Islands are greater long-standing beneficiaries of CDR than their Caribbean neighbors. China's low CDR has kept its GDP low. Its recent growth rate though impressive, started from a very low base. Russia is awash in oil. But a mere accusation that they entered Ukraine illegally has caused their post-communist economic growth to collapse. While USA shares the top position with some European countries, were it not for a liberal immigration policy, US GDP would be even greater, earlier. This is due purely to the need for time to assimilate. Furthermore, immigrants accomplish phenomenal economic gains for themselves and for the USA as they travel from low CDR territories to high CDR countries like the USA. They might have possessed great human capital while they were in the old country, but their capital was not realized until they were able to function in the USA.

Micro intrapreneurship

As economic growth succeeds there is one vexing problem that invariably occurs. It is what to do about workers who have been made indigent due to displacement by technology. The great contradiction is that many of these workers who helped to build efficient production systems, in which they were previously employed, become redundant. At a very minimum, as is inevitable in any dynamic economy, temporary structural unemployment looms large. Should they have listened to the luddites? Retraining will alleviate some structural unemployment and develop new sources of human capital. Not wanting to be defined by its poor, rich nations have adopted minimum wage laws and welfare systems. The economic law of demand stipulates that when the price of labor rises the quantity demanded falls, ceteris paribus. For that reason, minimum wage laws create unemployment amongst the least qualified persons. Welfare must then take care of the unemployed. To quote Milton Friedman, a former famous economist, "Welfare programs involve some people spending other people's money for objectives that are determined by still a third group of people. Nobody spends somebody else's money as carefully as he spends his own. Nobody has the same dedication to achieving somebody else's objectives that he displays when he pursues his own." From the point of view of CDR theory, self-efficacy is destroyed. James Murray Spangler (1848-1915) was an American inventor, salesman and janitor who invented the first commercially successful portable electric vacuum cleaner that revolutionized household carpet cleaning. Were he not a janitor, he might never have noticed the possibilities. Had he been rendered an unemployed janitor due to minimum wage laws, he might never have made his discovery. The unemployed cannot contribute to human capital stock and are therefore reduced to dead capital.

Chapter 4 contains a seminal presentation referred to there as micro intrapreneurship. It is the CDR based alternative that preserves human capital and promotes further economic growth. In this proposal, government stipulates what it considers to be a living wage. It supplements all wages in the amount of the difference between the living wage and the wage that an employer is willing to pay. Unemployment for anybody wishing to work will end instantly. The part of the wage the employer pays saves the government money that it would have incurred in welfare transfer payments. And, it is temporary until the worker is retrained or acquires relevant experience. There is also the contribution of the workers' human capital to the national pool in their neck of the woods. The net result is a higher average standard of living for society.

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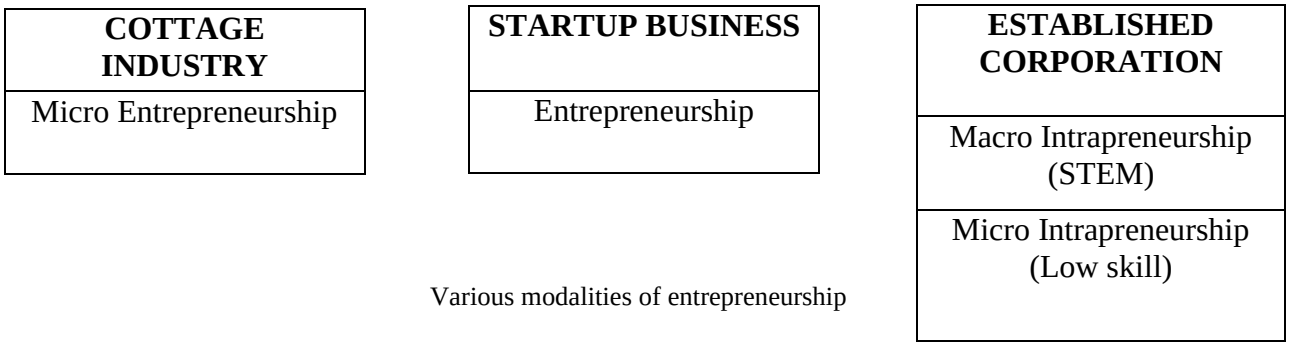
Macro intrapreneurship

In passing we also mention those professional STEM employees who contribute ideas of creativity and imagination. They are entrepreneurs in heart and spirit. But these intraprenuers prefer to utilize the resources (people, equipment, money, etc.) of the large corporation in which they are employed. They are also attracted to the many opportunities there such as finding likeminded camaraderie and existing viable projects in need of their expertise.

Micro entrepreneurship

In passing we also mention microloans because of their relationship to human capital. Microloans to individual businesspersons are examples of support for cottage industry micro entrepreneurship. Microloans attract people with business ideas of their own, and pride in those ideas. In underdeveloped countries, these loans have a stellar rate of repayment with interest. This observation is consistent with the CDR model in which wealth comes from ideas and the bearers of the ideas need a suitable environment to bring them to fruition. Many great ideas have humble origins.



Various modalities of entrepreneurship

Entrepreneurship curricula

It seems clear from the preceding that entrepreneurship must play a significant role in wealth building. Chapter 2 explains the relationship between wealth and entrepreneurship. It also explains how to plan a general management American university entrepreneurship curriculum that is necessary to create an entrepreneurial community that in turn is necessary to improve the functioning of entrepreneurs and entrepreneurship in society. Chapter 14 is an English translation of our Russian paper that explains how to plan an entrepreneurship curriculum in a country that is formerly communist and where entrepreneurship is an altogether new concept. The country example used is Russia. Russia was selected because it is emblematic of communism. And, while it has the greatest abundance of natural resources, it is relatively poor, a direct result of a long history absent of entrepreneurship. Chapters 15a-15c contain a pedagogical suite of proposals for revising introductory economics, engineering and mathematics courses. They include sample syllabi designed to better develop science, technology, engineering and mathematics (STEM), and entrepreneurial concepts and creative thinking in higher education. In passing we mention that one must learn the difference between entrepreneurship and business management, and how

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to transition from entrepreneurial creative innovation and entrepreneurial implementation to startup business management activities such as selling, phone answering, order acquisition, order processing, order fulfilment, payroll, services, and income tax returns, etc.

Capitalism democracy and rule of law

This book studies the impact of CDR on the standard of living of nations represented by per capita real gross domestic product, GDP, adjusted for purchasing power parity (*G*). This is indeed a very important relationship that needs to be studied from different perspectives. We argue that one of the major channels of the impact of the CDR factors on *G* is through entrepreneurship. The data on *G*, policy variables *C, D, R,* and non-policy variable natural resources (*N*) are collected from open sources such as the IMF, the World Bank and Transparency International. Capitalism is based on total capitalization of the financial markets of publicly traded stocks. It represents the present value of all future income from investments in the production of goods and services that comprise GDP. Democracy and rule of law are based on country ranking. These data are then transformed into indices that take on values from 0 to 1 for ease of interpretation. These data are then used to construct cross sectional regressions for all 79 countries in the world for which data are available for the year 2014. The remaining countries are small, have small populations less than one million, and are therefore insignificant. The regressions are repeated for all other years for which data are available with remarkably very similar results. From the regressions, we discover that all three policy variables (C, D, R) have a positive and significant impact on *G*. There is a C•D•R interaction effect that has a negative and significant impact. And, *N* has a positive and significant impact. Afterwards, a CDR index is formed by using the estimated coefficients from the regression as weights.

The CDR model is parsimonious. It is this parsimony that demonstrates the power of only three policy variables as regressors to determine economic growth. It is true that democracy and rule of law are complicated concepts. And, there are numerous component factors that make up these variables. But such subcomponents are highly correlated with the actual regressors used in the model. Therefore, for the purpose of statistical analysis, it does not matter that these subcomponents are excluded. There is no need to include them in a regression model for explaining *G*. Furthermore, to include such sub components would only serve to reduce the degrees of freedom and reduce the statistical significance of democracy and rule of law. In any case, most, if not all the components are not available for all countries.

Chapter 7 contains all calculations and results, informative graphs of *G* versus *C, D, R,* and *N*. There, we discuss the importance of capitalism, democracy and rule of law compared to the presence or absence of natural resources. One surprising result is that the interaction effect is negative. At the beginning of the research it was considered that the three policy variables would contribute positively to *G* and that their interaction might result in a positive bonus. What we learned is that democracy is necessary for the deployment of capital. And, without democracy people tend to lose their enthusiasm for contributing their best. But, unless all parties are in perfect agreement, democracy can also slow down the decision-making process resulting in a less than optimal process thereby subtracting from maximum *G*. Another surprising result is that the impact of natural resources is only six percent. We knew from casual observation that countries flush in oil are typically poor and many rich countries have no natural resources. But six percent is a jaw dropping discovery. It turns out that contrary to commonly held beliefs, there is no scarce resource impediment to economic growth. Human ideas of imagination and creativity will

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create all that are needed. And, the only real shortage in poor countries is capitalism, democracy and rule of law. Another surprising result is that latitude (*L*), the variable used to measure the effect of geography has an even smaller impact equal to four percent. One demonstration of this is the disparate economies of North and South Korea. These two countries were formerly one, of common geography and culture. Now, they are separated only by CDR, GDP and the 38th parallel. It is obvious that a population that is located in a geographic region where a wide variety of foods cannot be grown will suffer through no fault of their own. But, now that we know what Adam Smith had to say, it is equally obvious that trading will solve the problem associated with geography. In today's worldwide travel and communications, trading could not be easier. In any case, we also suggest that countries can raise their CDR index and standard of living to the degree of economic development that is salutary to that country, given their geographic disposition. That is, they can make the best of their circumstances while enjoying the climate of their choice.

Last but not least, the greatest and most welcome surprise is that wealth can be explained for the most part by capitalism, democracy and rule of law, and almost entirely (approximately ninety percent) when natural resources and latitude are included. The implication of such a high coefficient of multiple determination is that the conversion of *C* to *G* is the same in all countries in the world. It is determined by the laws of natural science. What is commonly thought to be differences in productivity is actually the differences in the amount of *C* that countries can attract for conversion to *G*. It is now clear that the true and only source of wealth is human capital ideas of imagination and creativity. Money is a method of accounting for wealth, but it is not the source. Since ideas are in unlimited abundance, then potential wealth is unlimited.


Human capital ideas of imagination and creativity are the only source of wealth.

Adults possess human capital, but the more successful they are the less likely they are to contribute more capital if it means taking risks. They are more settled in their ways and less entrepreneurial. They tend to sit on their laurels so to speak. Each child brings its own wealth into the world, and some, due to their very uniqueness. What they appear to do most is take risks. Uniqueness means that they add to diversity. It is now well known that diversity makes for better decision making in problem solving. The wisdom of crowds exceeds that of the smartest individual amongst them. Any pregnancy that ends without a birth reduces what would have been greater diversity and its accompanying wealth. It behooves us to make proper arrangements to welcome the child, teach it the current state of knowledge capital, and help it to contribute its own capital. No child is a liability and every child is an asset. Any suggestion that a child is a liability is counterfactual. New ideas are the natural born enemies of the way things are. Only change can usher in new wealth. "Sometimes it is the people who no one imagines anything of

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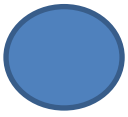
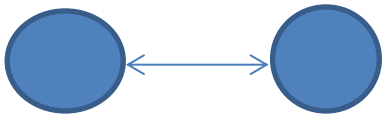
who do the things that no one can imagine." There is trace entrepreneurship in everybody. If wealth were fixed, children would contribute to the impoverishment of everybody else. The massive wealth creation by high CDR countries where population has grown dispels any suggestion of impoverishment. The inescapable conclusion is that countries must raise their CDR index if they are to raise their standard of living.

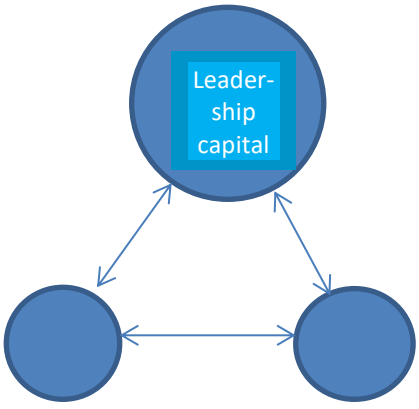
Democracy creates additional pathways for the optimal deployment of capital but genius is not impressed by democracy, for democracy can only dilute it. Genius is impressed by rule of law that protects its property rights in the form of patents. Still, lest we underestimate the potential for democratic pathways, and the attendant power of idea generation for finding an optimal solution to any problem, consider the following examples of one through six person teams acting democratically. We see that the number of pathways increases exponentially. For *n* persons the number of pathways increases according to the square of *n*, calculated from $n(n\text{-}1) = n^2\text{-}n$. For a mere 10 persons there are as many as $10^2\text{-}10$ = 90 pathways. Note also the hierarchical potential to deploy leadership capital from the top while paying full attention to all persons. This is a big deal.



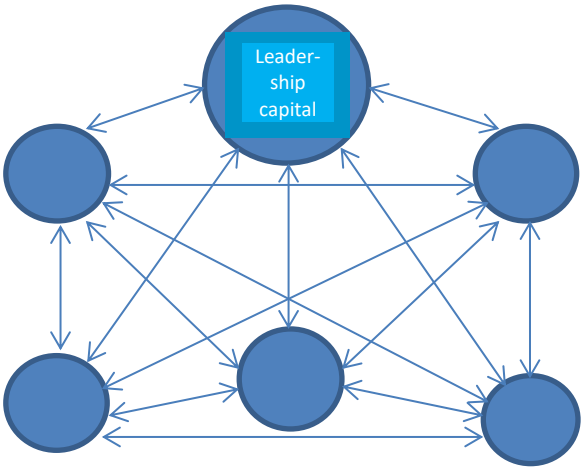
One person yields zero pathways



Two person team yields two pathways



Three person team yields six pathways



Six person team yields 30 pathways

Democracy is a catalyst that creates additional pathways for the optimal deployment of capital

Stahl (2019) reported recent developments in functional magnetic resonance imaging (fMRI) that reveal thought patterns by detection, analysis and color diagrams displayed on a computer screen. This type of mind reading gives the same answer irrespective of the native language or cultural background of the subject. The implication for entrepreneurship is possibly enhanced communications by international team members. Also, corrupt dictators (see chapter

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13) can be identified in a medical checkup of those running for political office. The electorate can make better informed choices.

In passing, we mention the problem of legitimate logical and binary thinking, and group thinking that can be obstacles to communications along potential pathways. We note the ability of music to connect that which people have in common. Music and sports cut through polarization and binary logic to facilitate political and other problem solving. They can bring together people who might otherwise not think to associate. Consider also, the possibility that genetics can make people predisposed to liberalism and conservatism (Hibbing, Smith and Alford, 2014). It is quite astonishing that in the advanced democracy of the USA, these characteristics appear to be split nearly evenly in the population. Assume that both liberalism and conservatism make important contributions to economic decision making. Democracy can deploy these traits in a meaningful way. On the other hand, the absence of democracy could permit one of these two traits to dominate the economy. The outcome may be a reduction in diversity and a weaker economy.

One of the essential elements of rule of law that needs to be understood is property rights. Property is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged. Property rights are essential to wealth creation. However, land has not always been owned as private property. It turns out that the vast majority of people in the world do not have property rights. This is obvious with respect to communist and former communist countries. But it is also true for most other countries as well. Unlike the USA most countries employ some form of communal ownership of land. From the point of view of the entrepreneur, communal land cannot be used as collateral for a bank loan. For this reason, communal land is dead capital (de Soto, 2000). Privatizing and titling these lands would create collateral and release massive amounts of investment capital and wealth, far in excess of foreign aid. Western European countries employ various types of lease hold systems where land reverts back to the government or to the crown as the case may be upon expiration of the lease. In order to avoid such limited property rights, the USA implemented the system of fee simple land ownership where automatically unless otherwise stated, ownership can be traded, transferred or bequeathed to family members, etc. We now know that USA property rights and rule of law is a great attractor of capital in the form of human ideas of imagination and creativity.


Rule of law is a catalyst that creates the stability that attracts capital.

As was the case in Medieval Britain, much of African land today is still owned communally, rather than individually. By virtue of the parliamentary statute law, the enclosure of land began in England in the 1500's. Beginning around 1550 the enclosure movement resulted in the privatization and division of land among cultivators. There were the Tudor enclosures between 1550 and 1700 and the parliamentary enclosures in the century following 1750. There were numerous objections in the 1600's. The Katt's rebellion in 1549, the Oxfordshire rebellion

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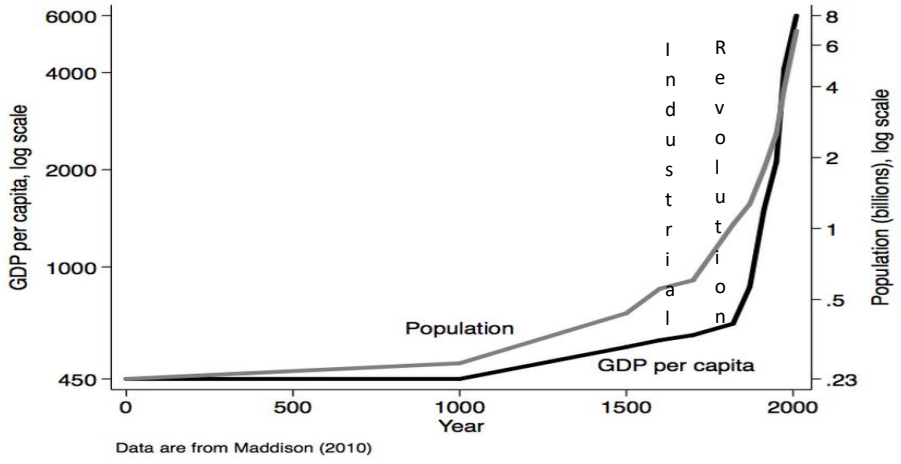
in 1596, the Midland revolt of 1607 and others up to the Swing riots of 1830-1831 were all defeated by the state (Charlesworth, 1983). Practically all of Britain was private property by 1850. This led to property rights, increase in the value of property and economic development. Had the lands remained in common, the residents might have done nothing with it. The exclusive owners of private property developed the land and land use for economic growth and the beneficiaries who included the un-landed classes.

The confluence of democracy extending from Magna Carta in 1215, rule of law through property rights in the 1500's, the cognitive revolution through the royal charter of 1662 for the study of science, and capitalism through the limited liability business law of 1811, is our best explanation of the perfect storm: possible random convergence of methodologies that led to the industrial revolution on or between 1760 and 1840. They are inextricably linked. The critical role of Adam Smith, the father of modern economics and his theory of division of labor and the invisible hand for creating surplus capital cannot be overestimated. This led to massive economic growth hitherto unknown. There is no intention here to whitewash the catastrophes of English hegemony and dastard colonialism. It appears that bad actors will invariably weave their way into the best company. The industrial revolution could have happened anywhere in the world but it happened in England. It spread to Western Europe and the USA. Japan may have had its own industrial revolution. Their economies have grown exponentially while, with few exceptions, poverty persists everywhere else. Before the industrial revolution, with few exceptions, everybody was poor. Since the revolution, standard of living has risen everywhere that what we are calling CDR policies has intentionally or otherwise been adopted to permit the revolution to succeed.



Before and after the industrial revolution

Chapter 12 contains the seminal presentation of a CDR econometric model for the a priori computation of world average endogenous growth. The estimate reported there is 1.8%. We mention in passing an interesting observation that this equates to $\frac{1}{4}e^2$, where e is Napier's constant (Euler's number) and the base for the natural logarithm. A small number of countries have been growing at a much higher rate while most have experienced no growth or negative growth. Independently of the CDR model, the widely reported ex post estimate for developed

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countries is approximately 1.8%. When CDR is unbridled, job creation can outstrip population as is typical in the case of the developed countries that resort to immigration for acquiring desired personnel.

The economic growth in Western Europe, USA, Japan and elsewhere, has demonstrated that economic growth does not cause price inflation. For example, USA growth in years 2017, 2018, and 2019 is substantial, unemployment is low, people are working and succeeding and there is no inflation to speak of. A Goldilocks economy. Japanese inflation rate is a trifling 0.2 percent per annum. In passing, we mention that this is a contradiction of the implication of the Phillips curve (inflation implies falling unemployment), another one of the paradigms that must give way to the CDR growth model. The explanation of this counter intuitive reality, counter to commonly held beliefs, is worth documenting. Ever since the industrial revolution, while it is true that sticker prices of products have on average risen, the number of their features (quality, complexity, power, and ability) has exploded. The price per feature of products produced has fallen. For example, today's smart cell phone has the power of a supercomputer of the past, occupies a tiny fraction of the space, and has hundreds of times more consumer-oriented features to boot. So, standard of living has been rising due to all the new features and functions that people can employ to improve their lives. The principle applies similarly to all products and services.

Once one accepts CDR global time invariance one must accept several contradictions to prevailing economics and accept a new counter intuitive paradigm. This paradigm is contrary to commonly held beliefs. All wealth has its source in the human capital ideas of imagination and creativity. Ideas are converted to capital stock of knowledge, machines, computers, etc., that only depreciate. Chapter 8 contains the seminal presentation of a unitary capital elasticity of G that provides an optimal policy guide for the CDR reinvestment strategy that maximizes G. The estimated optimal reinvestment reported there is 21%. It turns out that year 2014 world average gross fixed capital formation (GFCF) was independently reported at 21%. This correspondence between the theoretical CDR prediction and the empirical GFCF lends evidence to validate the CDR growth model.

Uncommon sense

Before science, mankind relied on what we think of as common sense to make decisions. Common sense by itself dictates that things must be done the only way we know they can be done. Beyond that, human DNA had to change to permit certain new operations. For example, longer arms to pick out of reach high hanging fruit. Cognition and science on the other hand, permitted man to design and construct a ladder and climb that ladder to reach the fruit. There would have been a time when the idea of acquiring that fruit would have lacked common sense. So might be the idea of a ladder. The owner of the idea too might be the subject for similar derision and scathing criticism. Common sense was replaced by uncommon sense….an entirely different strategy. Science and the cognitive revolution reintroduced human capital which we now know is the genesis of wealth. It would make perfect common sense for people to suggest to Henry Ford that what were needed were faster horses.

We would like to point out how rapidly entrepreneurship and CDR can raise standard of living. Consider the story of a coastal community subject to annual tsunamis, and where the primary food supply is common sense chicken meat. The tsunamis drown the chickens, killing them and creating a devastating shortage for the residents. For whatever reason, the chicken farmer learns that while chickens drown, ducks float. He and the residents democratically made a

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rule of law business decision to switch from chickens to ducks, uncommon sense by way of tradition, and the entire community is lifted out of poverty. The increased standard of living occurs not in generations, but in the short time it takes for incubation, gestation, and maturity.

The garbage bag was invented in the home by a homeowner before it climbed the corporate ladder. Janitor James Spangler's vacuum cleaner invention cleaned up the world. His lowly job as a janitor may have played a key role in this contribution that also climbed the corporate ladder. Lest we become embroiled in the legitimacy of supply side trickle down economic theory, notice that none of the above is particularly top down in source or structure. Like many, they represent supply side that trickled bottom up.

Up to five years ago common sense told us that USA oil reserves were declining, placing economic growth in jeopardy. Now, new uncommon sense horizontal drilling, hydraulic fracturing, retorting, pyrolysis and shale make USA self-sufficient in oil and an exporter of natural gas. Shale is a natural resource, but it was always there and what made the difference was scientific knowhow.

Chapter 7 presents a unique application of the heterodox CDR model to the information theory of economics for explaining entrepreneurship and wealth. Common sense ideas are guaranteed to have no entrepreneurial value. The reason is that everything is already known about them. They contain no surprise. Knowledge is about the past and entrepreneurship is about the future. While uncommon sense ideas are not guaranteed to be good ideas, the mere characteristic of being surprising is what gives them any chance of being valuable. Still, in a low CDR (high noise) cacophonous environment (channel), a new idea (signal) does not make it through the decision-making process and is ignored. In a high CDR (low noise) environment, the signal to noise ratio is high and the new idea is duly noted. It is given full consideration.

Management theory and CDR

The current consensus of management study is that the top three functions for twenty first century success are creativity, communications and collaboration. Creativity translates to human capital ideas of imagination and creativity. Communications and creativity translate to democracy. That is, management theory has recognized the true source of wealth and it is high time that economics acknowledge this. But, both of these fields of study must understand that rule of law is what attracts capital and democracy is what deploys capital optimally. This in summary is the CDR theory and the CDR index that measures and predicts GDP. Furthermore, while this is a new discovery via econometric and statistical data analysis and extrapolation, it has always been true. It is a general theory of economics.

The ultimate discovery from this research is that monetary and machine aids to poor countries have by themselves been mere ephemeral analgesics. The machinery is subject to depreciation and obsolescence, and the money invariably creates more debt than anything else. What poor countries need is help to raise their GDP by raising their CDR index. How to raise the CDR index in a timely way is an unanswered question. How to raise the level of democracy? How to reduce corruption and raise rule of law? Perhaps, instead of thinking of tackling these two problems directly, maybe it is possible to create incentives that will raise them automatically. All this is outside the scope of this book. But one cannot help noticing the remarkable and phenomenal rise in the GDP of Singapore. As it turns out the government leaders and workers in Singapore are remunerated by a bonus system that is tied to economic performance. Fundamental management theory states that rewards are best related to objectives if high performance

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outcomes are desired. So, is this the reason for Singapore's GDP success? Whether it is or not, the system seems reasonable and appears to be harmless.

The presence of pernicious corrupt dictators is a particularly vexing problem in the theory and practice of political economy. We know from this CDR and other research that the root cause of poverty is corrupt dictatorship. But there is no clear theory or well-defined methodology for modifying or removing inimical corrupt dictators from office. The only thing we know with any certainty is that "power tends to corrupt and absolute power corrupts absolutely." Chapter 13 contains a seminal presentation of a game theoretic model enlightened and informed by the CDR model epistemology. The corrupt dictator and a team of nation builders (such as a proposed parliament or congress) are presented decision options and corresponding economic CDR growth outcomes. The assumption is that there exists a Nash equilibrium where the two parties can agree to permit CDR and economic growth to prevail without the need for riots, wars and bloodshed. However much it amounts to a distasteful bribe, both parties might have a preference for a settlement emolument over physical altercations that can continue ad infinitum. A Hobson's choice. History has revealed two types of dictators. One is the monarchical corrupt dictator where there is some tradition, lineage and claim to bloodlines. These characteristics make them in some ways predictable. The other is the sole proprietor corrupt dictator where there is no tradition, no lineage and no claim to bloodline. Their only characteristics appear to be highly erratic behavior, and total self-interest with little or no regard for anyone else. Even worse, they surround themselves with a malevolent kakistocracy, chorus of thespians pretending to be a benevolent cabinet of governors. Still, hope abounds that this is only an interregnum since in either case, the computation of the Nash equilibrium only requires that the dictator be rational in the sense of having a utility for money that is monotone increasing.

There are numerous theoretical arguments for why corrupt dictatorships cannot be overcome and how modern communications, banking networks and rapid travel threaten the possibility of an international corrupt dictator nexus. The proponents are typically the victimized residents of victimized countries. They are compelled by common sense reasoning and personal experiences. Even Adam Smith identified the wealth of nations as a special status that needs to be accounted for by some good new uncommon sense reasoning. Achievement of poverty is easy. Just do nothing! In the counter narrative, residents of rich countries now know better, not to stand for corrupt dictatorship, because they have experienced the benefits of freedom and the application of the theories of Adam Smith. Pre Magna Carta, the people of England suffered under corrupt dictatorship. Post Magna Carta England is a solid demonstration that corrupt dictatorship can be overcome. A tyrannical monarchy was transformed into a constitutional monarchy. The USA chose a constitutional republic. Every nation must choose how they do it but economic freedom and CDR are the only demonstrable methods for increasing wealth and standard of living: the ascent of the nation state over tribalism. We are prisoners of hope.

Wealth and forced labor

One of the contentious issues often discussed in society is that of wealth and forced labor. There is a perception that forced labor represents stolen labor or wealth. And, we can all agree that wheresoever the practice is discovered, it should be stopped, the perpetrator prosecuted, and reparations paid by the beneficiaries to victims. The reason is forced labor is immoral and as we will explain below (and in chapter 13), it is economically inefficient. Understanding the inefficiency provides an incentive to avoid the practice altogether in the first place. Before we can evaluate that proposition, we must distinguish between wealth creation and wealth transfer.

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Forced labor does not create wealth. That sounds odd, cold and insensitive when one considers stolen and uncompensated labor. That is, it sounds thoughtless when one considers the cruelty associated with it. But that conclusion was reached after a great deal of cogitation and thought about wealth and poverty in general and about CDR in particular. What we discover from CDR research is that the only source of wealth is the human capital ideas of imagination and creativity. Human capital is converted to capital stock of knowledge, machines, computers, devices, etc. Human capital is subject to appreciation. Capital stock is subject to depreciation and obsolescence. Rule of Law creates the stability that attracts capital and democracy creates additional pathways for the optimal deployment of capital for the production of goods and services. The activity of forced labor deprives society of the human capital part of the human being. This also includes the immoral strategies of redlining and incarceration of innocent impecunious members of society and political dissidents. It may be possible for forced labor of one man by another to transfer wealth from the former to the latter, but there is no net creation of wealth, and net wealth is reduced. Adam Smith thought that it was not economically viable. By his accounting, the net product of free labor is twelve times that of forced labor (Weingast, 2015). That is, free market tenancy is a Pareto improvement over forced labor. We show that CDR contributes thirteen times more to *G* than do natural resources (Appendix BB). Is this ($12 \simeq 13$) correspondence between natural resources and forced labor an uncanny coincidence? Is this further evidence that human capital ideas of imagination and creativity are as different from natural resources as they are from forced labor? Is the objectified human being the economic equivalent of the natural resources object after the distillation of each? Only triskaidekaphobia would automatically rule out this mathematical possibility. Should China reconsider the policy of currency devaluation to lessen the value of manufacturing employee personnel? The upshot is that forced labor is a bad idea.

Any institution or activity that practices the denigration of mankind of any class or creed diminishes them and must destroy human capital, the only source of wealth. Both the forced laborer and society lose. In a linear system that calls for force to perform work, a man that is twice as strong as another man can convert twice as much capital into wealth contribution. But, neither one of them creates wealth as the source of wealth is human capital (not human labor). So, any stolen wealth is not associated with labor. The stolen wealth is the devaluation of the human capital of the human being. Chapter 2 identifies this as potential harm to the psyche and self-efficacy of future descendants for generations. This epigenetic transgenerational sequela is worse and is especially harmful if left untreated (Weber-Stadlbauer, 2017). People who are hurt, hurt people. A permanent underclass and relatively low wealth community could persist. Whatever the wealth is that exists in America today, it would have been even greater if there were no forced labor in the past.

Consider also the following facts that imply that the US economy has benefited from the abolishment of forced labor. Forced labor was first abolished in the territory of Vermont in 1777. Vermont subsequently became a US state. The second to abolish forced labor was England in 1833. The third was Brazil in 1888. Of these three western states the US has the best economy and Brazil has the worst. In the east, forced labor was abolished in Russia in 1861. Forced labor is still legal in China, Pakistan, Bangladesh, Uzbekistan, Cambodia, India and Qatar. Legal or not, up to 70 million people worldwide depending on how they are counted, are in forced labor. Today, forced labor continues throughout much of the world that is impoverished where people are living on not much more than $2-$3/day. During the past 50 years most of the wealth created in the USA came from digital innovation (empires of mind, not forced labor and not natural resources). The city of San Francisco, home of Silicon Valley has the world's greatest number of

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billionaires per capita. Globally, natural resources contribute only 6%. Geography contributes only 4%. The US states in which forced labor was legal at the time of the civil war now have on average the least wealth. Although not offered as proof, this observation is consistent with our observation that forced labor is destructive of capital and wealth. We argue that if there never was US forced labor, the US average wealth would be even higher than it is today. Throughout time, the perpetrators and victims of forced labor have been of all skin colors.

In addition to the destruction of wealth by forced labor, there are also the lost economic opportunities for intergenerational wealth transfers via inheritances. But inheritances have an average longevity of only three generations. The heirs of successful entrepreneurs may simply not be interested in continuing the business operations that they inherit. In any case, as heirs themselves produce offspring, inheritances get divided into smaller amounts. There is also the 21% reinvestment to satisfy GFCF. Therefore, intergenerational transfer by itself is not a vehicle to be relied on. Instead, it is better to invest inheritances as a means for generating new wealth. As best we can tell, the safest bet is STEM and entrepreneurship education, and the political economic systems of capitalism, democracy and rule of law.

Wealth and RQ.

One of the contentious questions in education is how to measure intelligence quotient (IQ). And, assuming that a measure of IQ is available, how much does it tell us about creativity. Still, we believe that wealth is correlated with creativity. So, it may be better to consider measures of research quotient (RQ), where RQ is a propensity for inquiry, research and development that can lead to new discoveries. This in turn leads to new products and services. Here too, it may not be possible to design a dispositive test for people who will contribute to a company's RQ, but we know expression of this potential when we see it. It is fair to assume that a high CDR environment will promote RQ, expression of human capital and therefore wealth.

Summary of findings from the CDR growth model and theory

An understanding of the following summary may benefit from a review of the definitions (see Appendix AA) and a review of comparisons of the new CDR growth economics to its predecessor in the extant literature (see Appendix CC). Once one recognizes that the true and only source of wealth is capital from human ideas of imagination and creativity, and that labor is corporeal only, the following findings flow directly:

Intangible *C*, *D* and *R* contribute thirteen times more to *G* than do tangible natural resources.
New ideas contribute approximately six times that of capital stock from old ideas.
The theoretical optimal reinvestment fraction estimated from CDR is equal to empirical GFCF.
Capital to *G* conversion is global time invariant.
Natural resources effect on *G* is negligible.
Government spending net effect on *G* is negligible.
Country population size effect on *G* is negligible.
Location effect on *G* is negligible.
Culture effect on *G* is negligible.
Population physical characteristics effect on *G* is negligible.
Wealth is unlimited.

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CHAPTER 2

Entrepreneurial Mindset and the University Curriculum

Reference: Ridley, Davis and Korovyakovskaya (2017).

Until recently, most American university management programs focused on the development of students for work in corporate settings with little focus on entrepreneurial skills. The need for graduates with an entrepreneurial mindset has grown. A framework for developing students campus-wide with an entrepreneurial mindset across the management education curriculum is proposed. First, foundational theories and concepts are introduced to students. Next, they learn, practice and reflect on skills necessary for entrepreneurship. Student entrepreneurial mindset is further developed through business plan and case competitions. Finally, students apply the concepts and theories via student-run companies housed within business, science, engineering and technology incubators.

INTRODUCTION

Mindset

Countries such as those of the former Soviet Union, Sub Sahara Africa, South America and formerly oppressed minorities in the Unites States of America appear to be frozen in time with regards to entrepreneurship. Each of these communities has received American aid with little to show for it. The reason is that little attention has been paid to the debilitating mindset that remained after their segregation from a modernizing world. This is despite the fact that many universities have introduced entrepreneurship education to raise the capabilities of practicing managers. This paper presents a management education design for engineers and managers who have only a paucity of entrepreneurial family background and experience. To reconstruct confidence, evidence is shown that capitalism, democracy and rule of law constitute a joint indicator for economic success and pathway to understanding the rationale and benefits of entrepreneurship. Then, support is provided through the integration of curricula, faculty research and invention mining, munificent incubators, community, and angel investment of financial and human capital. The objective is to raise the rate of entrepreneurship and business formation, gross domestic product, and the size of the world's economy for the benefit of all.

Pedagogy

Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. This pedagogical paper is designed to have a positive impact on any community that lacks a tradition of formal business activity. Ridley and Davis (2009) and Ridley, McKinley-Floyd and Davis (2008) proposed concepts that laid out strategies for entrepreneurship education and community transformation. Some of their strategies have already been implemented. Elements of entrepreneurship were added to a course while converting the method of teaching to live case study. Unlike traditional static paper case study, live case study involves multiple student visits to existing companies to gather data and information. Under the guidance of the professor, students construct a company supply chain,

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including random numbers, and create computer color graphics animated simulations of the supply chain. Not only do the students gain hands on experiential research and learning, they consider all elements of the data, including randomness and distribution. They are forced to review all of their quantitative prerequisite courses on statistics, operations research, calculus, accounting and finance, and learn to apply the principles of queuing theory, goodness of fit and other hypothesis testing. The end products are simulated pro-forma cash flow and income statements, and a balance sheet. There is no assuming away randomness by way of simple averaging. This is critical to arriving at correct answers when queues and asymmetric distributions are involved. The evidence of achievement is the several student intellectual contributions in conference presentations and proceedings publications (see Ridley, et., al. 2011, Brown, et., al. 2011, Abrams, et., al. 2011, Crafton, et., al. 2011, Ridley, Corner, et., al. 2012, Ridley, Foree, et., al. 2012, Ridley, Bryan, et., al. 2012).

There exist opportunities for more institutions to link entrepreneurship education to the creation of business enterprises that transform communities and bring wealth accumulation and economic viability to the individuals and communities in which these businesses operate (Mugge 2005). The basis of university and college entrepreneurship programs is that entrepreneurship is the single most important factor in determining whether a region or community achieves its full potential (Mugge 2005). Practicing entrepreneurs support entrepreneurial education and research (Zeitham and Rice 1987). Successful economic and technological models of regional development such as the Silicon Valley in Northern California, the Route 128 Corridor in Massachusetts, and the Research Triangle in North Carolina are clustered around universities. The establishment of an entrepreneurial culture and rapid development of technology-based clusters are two very important accomplishments that will serve as defining measures of a community's competitive advantage in a contemporary economy (National Governors Association 2004). U.S. News (2015) uses entrepreneurship to rate schools of business. Still, many universities lag behind in entrepreneurship course offerings. This is especially true of those that serve students from communities that lack a tradition of formal private business activity. Examples include formally oppressed minorities in the United States of America (USA) and former communist soviet countries like Russia and those constituting the Commonwealth of Independent States (CIS). While it is true that minority businesses in the USA grew 45.4 percent between 1997 and 2002, ninety percent had no employees (Harris, Edmunds and Chen, 2011).

Organization

The remainder of the paper is organized as follows. We begin with a review of the related literature. Prior research on mindset focused on factors that impact entrepreneurial intentions and self-efficacy, which if understood might enhance entrepreneurial activity and success. This paper focuses on the implication of extreme paucity of entrepreneurship in family background, leading to confusion about the factors governing economic success and perpetual avoidance of entrepreneurship. Next, we introduce an index that reflects the degree of capitalism, democracy, and rule of law (CDR index) that we assert is the main driver of global economic success. We offer CDR as prolegomena to thinking about entrepreneurship. The purpose is to counter a debilitating mindset and insurmountable obstacle that can stymie all other efforts to raise entrepreneurial intentions, self-efficacy and competence via entrepreneurship education and environmental munificence. This index is offered as a pathway to motivation and foundation for the pursuit of entrepreneurship activities at the university. The references to ancient scientists and inventors, their year of birth and death, and their need to overcome difficulties despite their

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genius, are intended to inspire students. Next, we introduce the concept of an Interdisciplinary Entrepreneurship Center (IEC). The paper proposes one framework scenario in which it might impact the institutional mindset. In that framework the IEC executes specific tactics via all relevant college and institutional activities as well as community sources of support and benefits. Concluding remarks include suggestions for further research.

RELATED LITERATURE

The interest in entrepreneurship seems constantly to be escalating. Berglund and Holmgren (2006) suggested that entrepreneurship has disseminated from an industrial sphere to other spheres such as the public, academic, private and the educational. In the academic sphere, a growing number of colleges and universities throughout the world now offer courses and programs in entrepreneurship (Gartner and Vesper 1994) within their business or engineering programs both at the undergraduate and graduate levels. Entrepreneurship programs are among the fastest growing initiatives in modern colleges and universities (Laud, Betts and Basu, 2015; Mattare, 2010). Harrington and Maysami (2015) articulate the role that entrepreneurially engaged regional universities may have in improving their communities. While considerable research and writing has been done with regard to the number of colleges and universities that now teach courses or that have such programs, little has been done with regard to what specific courses are taught and what a model curriculum might include in creating an entrepreneurial mindset.

Ede, Panigrahi, and Calcich (1998) indicated that the surging interest of many business schools in entrepreneurship education has been to the delight of the pro-entrepreneurship public, government, and the media, and there does not seem to be any documented research on attitudes and feelings of business students toward the entrepreneurship emphasis in the curriculum. The authors further suggested that business educators need to go beyond introducing entrepreneurship into the curriculum to fitting this curriculum to the needs of their present and prospective students. Hatten and Ruhland (1995) suggested that identifying and nurturing potential entrepreneurs throughout the education process could produce more successful entrepreneurs. Ede, et. al. (1998) indicated that their research pointed to the need for entrepreneurial interaction and mentoring in all aspects of the entrepreneurship curriculum. It cannot be left to experiences outside of course work.

Kussmaul, et. al. (2006) and several other researchers indicated that many institutions offer curricula that utilize interdisciplinary courses, where business and engineering students work together to gain an understanding of each other's disciplines. The authors further suggested that this approach enables students to enhance their understanding of entrepreneurial ventures and their ability to work with peers from other disciplines to see a project through to fruition. In recent years, there has been a strong interest in entrepreneurship from students outside of business and engineering (Farris, Levenburg, and Lane 2004) and future entrepreneurs will include significant numbers of students from non-business disciplines (D'Intino, et. al. 2010).

Bilen, et. al. (2005) suggested that their institution has been successful in creating an institutional entrepreneurial mindset that build students' life skills so they can succeed within innovative, product-focused, and cross-disciplinary teams. The authors further suggested that the broad goals of their school's program are to provide students with multiple exposures to what it means to have an entrepreneurial mindset and to facilitate the development of both the passion and the ambiguity-management skills needed for new product or venture creation.

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Fayolle and Gaily (2015) discussed the relationship between entrepreneurship education and a mindset of entrepreneurial intensions. We will revisit this below as we construct a course design for students with no entrepreneurship family background. Whereas research like Jang (2013) focuses on the role of individual student education on long term future entrepreneurship success (and are not conclusive), we focus on student and community transformation to correct an historical absence that might impact negatively on entrepreneurial intentions and outcomes for a whole class of students. Ilouga and Mouloungni (2014) argue that personal dynamics and psychological mechanisms are what matter, far more than economic and environmental constraints. Haus et. al. (2013) and Schlaegel and Keonig (2014) discussed the indirect effects of distal variables such as entrepreneurial traits, personality traits, entrepreneurial exposure and education.

CDR INDEX

The purpose of a business incubator is to provide a home where a new company gets its start. But, it can also be a bonafide institution where capital can find investment opportunities. Therefore, it may be wise to recall the purpose of the company itself. We recall from Ridley and Davis (2009) that this great invention that impacted the lives of more people than any other is the instrument of capitalism (Smith 1776, 2007). Before that (circa: the turn of 19th century and the industrial revolution), with the exception of feudal lords and beneficiaries of the 17th century Amsterdam stock exchange, the Dutch East India Company, and certain skilled artisans, all people were poor. Capitalism is the mechanism for capital formation. In addition, shareholders demand democracy and the rule of law. Nothing can be more motivational than recognizing the vast wealth that this mechanism has created (Micklethwait and Wooldridge 2003). To illustrate this, consider a CDR index = $f(C,D,R)$, that combines the degrees of capitalism (C), democracy (D) and rule of law (R) practiced in a country. Figure 1 illustrates the approximate relationship between wealth and health, and the CDR index. Health and wealth are shown to increase with CDR. Although no formal measure exists for the CDR index proposed here, the broad relationship depicted in Figure 1 is indisputable today. Therefore, we present it here as sufficient evidence of its existence. It is a critical component of entrepreneurial education which if not understood, can stymie all other efforts. Despite evidence to the contrary, it is easy to mistakenly conclude that economic development is attributable to natural resources, not CDR.

Concerns are often expressed regarding the rapaciousness of capitalism, and its unsuitability for civilized conduct when compared to its socialist counterpart. Of course, we are not proposing capitalism in the absence of democracy and the rule of law. For, in isolation, capitalism is as subject to abuse as any other tool or instrument. A surgeon's knife can save life, but in the wrong hands it is an efficient killer. The upshot of all this is that the relationship in Figure 1 is independent of the visible characteristics of the people in a country. As counterintuitive as it may seem to a certain mindset, the primary factors are not natural resources. Whereas natural resources can exacerbate the social ill effects of little or no democracy and injustice due to little or no rule of law (Norman, 2009; Frankel, 2012), economic success is dependent on the institution of policy to adopt and engineer a high CDR index.

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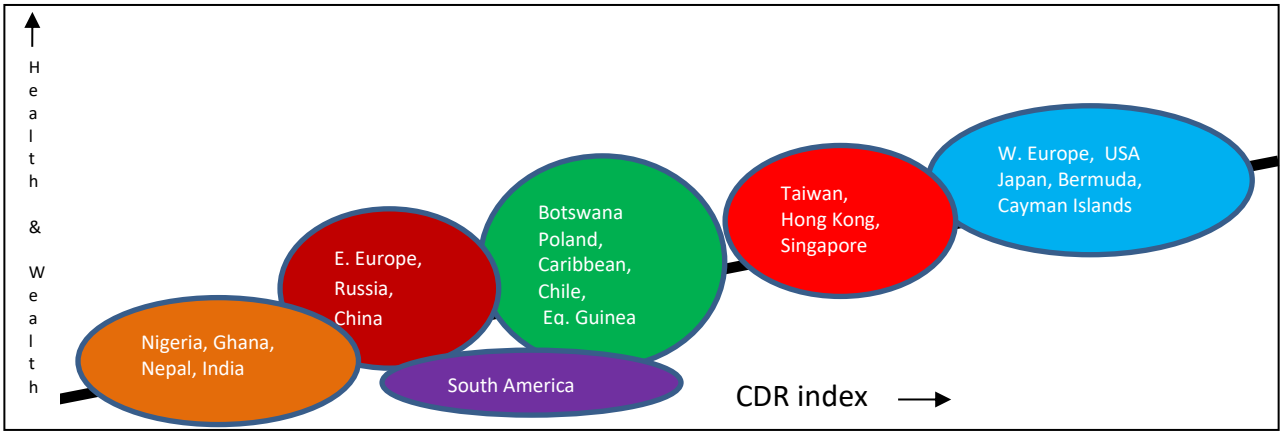
FIGURE 1
HEALTH & WEALTH VS CDR INDEX



Aside from a few tiny oil rich principalities and micro nations, USA, Western Europe and oil free Japan are prominent economic world leaders. However, notice how Botswana, Poland, Chile and Equatorial Guinea were able to break quickly away from their geographic neighbors once they adopted CDR policies. Bermuda and Cayman Islands, themselves small, are greater long standing beneficiaries of CDR than otherwise similar Caribbean islands. China has not made the switch to CDR and they are where they are. A mere accusation that Russia entered Ukraine counter to rule of law, and despite being awash in oil and gas, their post-communist economic growth collapsed once again.

While the USA shares the top position with some European countries, were it not for the American policy "Give me your tired, your poor, your huddled masses yearning to breathe free, the wretched refuse of your teeming shore. Send these, the homeless, tempest-tost to me, I lift my lamp beside the golden door! (Lazarus 1883)," US GDP per capita would be even greater, earlier. Furthermore, it is simply amazing what immigrants have been able to accomplish as they travel from low CDR territories to the high CDR of the USA.

INTERDISCIPLINARY ENTREPRENEURSHIP CENTER

In this paper we examine the potential impact on mindset of entrepreneurship through a campus wide IEC. One of the theories of the company is that it can outlive its creators. However, for this to occur, it demands maximal transparency provided by the rule of law. Like the company, if the IEC is to outlive its creators, full transparency is an operational imperative.

The Mission

We explain below why the IEC must be an independent institution on the university campus. In like manner, it must also have a unique mission. A suitable mission for the IEC might be stated as follows: To promote interdisciplinary entrepreneurship education across all colleges and schools of the university, with special attention given to the expansion of the pool of entrepreneurs by changing the mindsets of underrepresented communities and governments to enable their cooperative participation and to employ the principles of capitalism, democracy and the rule of law to expand and lift their minds to see over the obstacles that might otherwise defeat them.

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Impact on institutional mindset

Some members of society have no examples of entrepreneurs within their families and community. They cannot imagine the inner workings of business. They are not part of any meaningful conversation on business planning or day to day business operations. There is a poor dad but no rich dad (Kiyosaki 2011). They see a restaurant as a place to eat, not a place where business is being conducted. It may seem strange that a person can work and earn at one place of business, make purchases at another, and yet, not be able to decode the inner workings of either business. But, it is no stranger than illiterate persons living amongst people who read newspapers every day, and seeing signs that are all around them, yet themselves never learning to read. *Cogito ergo sum* in reverse.

Fayolle and Gailly (2015) showed that the positive effects of an entrepreneurship education program are all the more marked when previous entrepreneurial exposure has been weak or inexistent. Close relatives have been found to be positive role models (Mathews and Moser 1995, 1996; Scott and Twomey 1988; Shapero and Sokol 1982). This is consistent with the proposed framework that an entrepreneurship course should give special attention to the thought process of students who have no business ownership in their family background.

If the members of a community are historically oppressed, then the further back they look into their family history, the less likely they are to find an entrepreneur. Real life examples of this occurred in the communist countries of Eastern Europe, Russia and oppressed minorities in the USA. Both sets of people were forcibly segregated from the modernizing world. Even after the oppressive forces are lifted, there is almost a total inability to compete with existing business owners. The likely outcome is the noble practice of getting an education and finding a job. Not entrepreneurship.

Further to the above discussion of the CDR index, we recognize that wealth derives from ownership of the means of production. Technology as a means of production is an intellectual outcome. Therefore, wealth creation is an indirect product of the imagination of the mind and study by the mind. “Since new developments are the products of a creative mind, we must therefore stimulate and encourage that type of mind in every way possible (Carver 1864-1943).” This is distinctly different from the mere transfer of wealth through invasion, colonization, enslavement and theft. When the members of a deprived community own no means of production, they are almost absent of wealth. Furthermore, their poor economic condition is persistent. The least among them may even experience what is often referred to as a cycle of poverty. Any transfer of wealth through welfare systems is soon returned to its owner via consumption, plus labor value added, minus unproductive government agency employee payments. And, the wealth gap increases. The days are long but the decades are short and no progress has been made. More time will not cure this.

The only way for formerly oppressed communities to compete in business and acquire means of production is through extensive introspection, and academic and experiential entrepreneurship education via an institution such as the IEC. The IEC might take its guidance from scientist George Washington Carver: “Education is the key to unlock the golden door of freedom.” “Where there is no vision, there is no hope.” “There is no short cut to achievement.” “Life requires thorough preparation - veneer isn't worth anything.” “How far you go in life depends on your being tender with the young, compassionate with the aged, sympathetic with the striving and tolerant of the weak and strong. Because someday in your life you will have been all

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of these." (Carver 1864-1943). Teaching entrepreneurship is about encouraging students to dream big, then showing them how to act on those dreams.

Encouragement and development amongst the formerly oppressed that are underrepresented in business, is a good investment that the mainstream should welcome. For, if anywhere, somebody produces products at a lower price with the same quality or produces better quality at the same price, the total economic pie must increase for all to benefit.

Fayolle and Gailly (2015) also showed significant counter effects of the entrepreneurship education program on those participants who had been exposed to entrepreneurship. A realistic entrepreneurship course must point out the fact of high failure rate by business startups (Gerber, 2001). Initially, those facts, being alarming, might very well temper enthusiasm on the part of students who by virtue of prior exposure to entrepreneurship, can appreciate what is being presented. This suggests that an entrepreneurship course should provide a good understanding of the CDR effect, explain the common misconceptions and mistakes that may easily be avoided, as well as provide for interdisciplinary collegiality and experiential learning opportunities, and analytical and computer simulation methodology that raises risk management skills and builds confidence. Even then, students may need access to incubators, angel investors, and future venture capital. These are consistent with the proposed framework that follows. Indeed, they are the motivation.

Student clubs

Alexander Bell's (1847-1922) telephone invention was acknowledged as fascinating. However, many people thought it was a shame that nobody would have any use for it. After all, the telegraph was already in use (Morse 1791-1872, Edison 1847-1931). Telegrams were typed and delivered. Why would anybody want to hear a message and have to remember what was said? Even Bell considered his invention an intrusion on his real work as a scientist and refused to have a telephone in his study. Well, as they say, the rest is history. J. P. Morgan invested in Edison's electricity. In response, his father said "I'm disappointed in you…. This is the stuff of carnivals and fairs,…., you have been taken." It was fascinating to watch Motorola's Marty Cooper make the first wireless brick cell phone call on 6th Avenue in New York City, on April 3, 1973 (Shiels 2007). However, initially, the crowd gathered there could not understand why they should leave the land phone already installed in their apartment and enter the streets of New York City to make a phone call. Why not just call from the apartment with the phone already owned? The quiet and comfort of the apartment confused and trumped the notion of mobility. Today, young people get their first apartment without a land line. Mobility is all that they know. This led Marty Cooper to formulate the Law of Spectral Efficiency, otherwise known as Cooper's Law. The Law states that the maximum number of voice conversations or equivalent data transactions that can be conducted in all of the useful radio spectrum over a given area doubles every 30 months. "Marty is the most influential person no one has ever heard of," says Robert McDowell, a commissioner with the Federal Communications Commission, America's telecoms regulator.

The point is that inventions are often considered irrelevant by the many persons who do not see their applications. Indeed, many of the applications will not have been invented as yet. For that reason, entrepreneurship can be very lonely. Entrepreneurial type students need solace. Where better for them to find that than in an entrepreneurs club. They need to be among likeminded students. A genius is the one most like himself (Monk 1917-1982). Student clubs can contribute constructively to a sense of family away from home. Similarly, the student

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entrepreneurs club can help organize and run summer entrepreneurship camps for high school seniors. The exposure to entrepreneurship is invaluable. Moreover, exposure to the university campus will pay large dividends in future freshman recruiting.

Like the IEC, student clubs are independent. They function under the rules of the host university. But, they are of necessity developmental, albeit under the advice of faculty. Students must be allowed to make decisions. They must learn and practice intra and inter networking, learn and practice the conduct of meetings, Robert's rules of order (Zimmerman 2005), how to take minutes that record agreed on assignments of responsibility, and measure and monitor task completions. Students must make the election to pursue the scientific method and approach: Measure what is measurable and make measurable what is not so (Galilei 1564-1642). Faculties come and go, but widespread student and alumni involvement is the only way to build tradition and achieve longevity for the IEC. Student IEC academic curricula, research and management activities are discussed below.

Interdisciplinary Entrepreneurship course

The ultimate objective of the IEC is the creation of new business start-up based on the commercialization of technology, and lifestyle and social entrepreneurship. It is always possible to obtain these objectives on a one-off basis or on a short term basis. Great early American inventors did it entirely on inspired vision (Bell 1847-1922; Carver 1864-1943; Edison 1847-1931; Morse 1791-1872). However, to create a sustainable long term effort and raise the rate of entrepreneurial success, a targeted curriculum in entrepreneurship education must be developed.

Sometimes it is the people who no one imagines anything of, who do the things that no one can imagine! See screen playwright (Moore 2014) "the imitation game" on Alan Turing's crypt-analytical disambiguation of the Nazi German enigma cyphers. Only a few sui generis people invent, most people are required to implement. To be helpful they need to have the requisite mindset. Intrapreneurship is the practice of entrepreneurship within large organizations. It may include corporate ventures in which subsidiary organizations are spun off. Intrapreneurial leaders must take risks and exercise initiative, taking advantage of market opportunities by planning, organizing, and employing resources, to innovate new or improve existing products.

Hemmasi and Hoelscher (2005) found that unlike other students, only those with high nascent entrepreneurial inclinations are comparable to actual practitioners. Holmgren, et. al. (2005) found that entrepreneurship is located within the entrepreneur (see also, Sherman, 2005). Still, we propose that all business students need to become supportive of entrepreneurship as they assimilate into the wider community. For these reasons, an entrepreneurship curriculum must, inter-alia, educate three types of graduates, as shown in Figure 2. It must develop entrepreneurially minded graduates. These are the majority of graduates who go to work in various fields of endeavor, various professions, and various employments. For example, bank employees and officers need to be entrepreneur friendly and adaptable to change. An entrepreneurship program must educate entrepreneurial consultants. These are typically "A" students who remember all the theories, methodologies, strategies, rules, and regulations. Of course, an entrepreneurship program must create graduates who become entrepreneurs. These are the small minority that generate path breaking ideas and are willing to take the risks that are required to create new enterprise. Often, these are solid "C" students. Shrader and Finkle (2015) found that students who had been entrepreneurs scored significantly lower on college entrance exams and grade point average.

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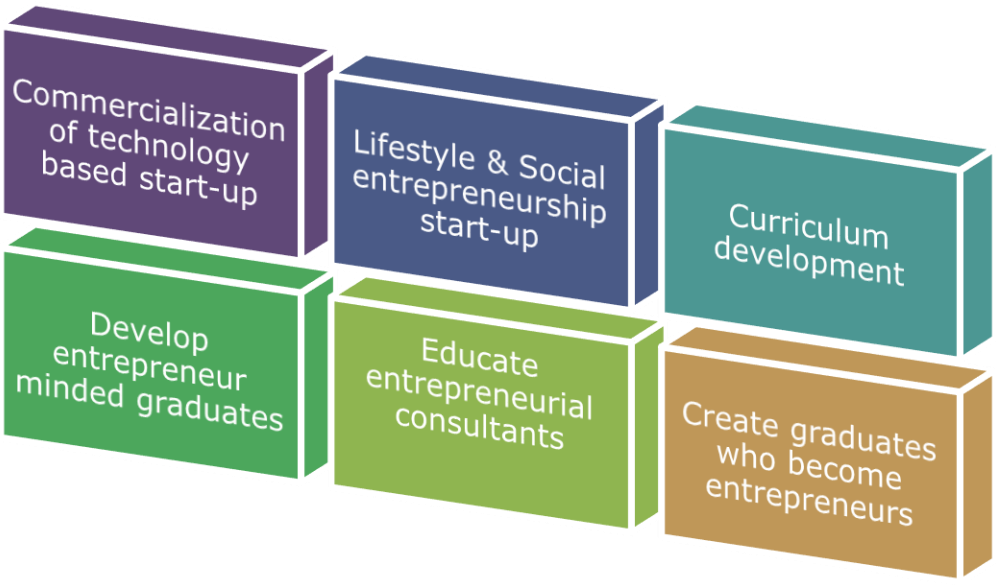
FIGURE 2
ENTREPRENEURSHIP EDUCATIONAL OBJECTIVES



Course Description

Consider a course constructed from the topics in Table 1. This course provides a framework for developing students campus-wide, including freshmen through senior level, with an entrepreneurial mindset across the management education curriculum. Special attention is paid to the thought process of those who have no business ownership in their family background. Indeed, it is the reason for early freshman introduction. First, students are introduced to the foundational theories and concepts of entrepreneurship in the core topics. They are given the opportunity to learn, practice and reflect on skills necessary for entrepreneurship. The student entrepreneurial mindset can be assessed and further developed through internal mock business plans and external business case competitions. Next, students are provided with opportunities to apply the concepts and theories via co-curricular activities such as student-run companies that are housed within business, science, engineering and technology incubators. Finally, this course will enhance student preparation for a senior level entrepreneurship course where they will prepare a full business plan based on real data. The wide breadth of academic disciplines represented suggests that the course be team taught. Unlike many university courses that use textbooks, this course utilizes published research papers and professional books.

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TABLE 1
INTERDISCIPLINARY ENTREPRENEURSHIP COURSE

Topic	Academic Discipline	Objective Impact on Mindset (development of skills, abilities, and experiences)
Developing an entrepreneurial mindset	Business: macroeconomics, entrepreneurship, management	Students learn the role of CDR; the role of the entrepreneur in the U. S. economy and countries around the world; to analyze forces behind entrepreneurship; the role of globalization (Kao and Mao 2011); to evaluate their potential as an entrepreneur; to push the envelope and profit from the lessons of failure.
Parliamentary procedures Types of business Taxation Intellectual property rights Business financing Personal financial management Estate planning	Business: law, finance	Students learn the legal requirements for shareholder meetings, voting and recording; types of business and how they are taxed; the principles of copyrights, trademarks and patents; about credit financing & rating; about wills & trusts.
Designing a competitive business model	Business: entrepreneurship, management	Students learn to differentiate between competing business models; to analyze how strategic management affects small business; to compare the characteristics of basic strategies and when to use them; the concept of competitive advantage and ways to create a competitive advantage.
Business ethics	Business: law, entrepreneurship, management	Students learn the legal framework for small business; to research, study and understand laws that apply to entrepreneurship and small businesses.
Building a new venture team	Business: entrepreneurship, management	Students learn to identify the building blocks of a new-venture team; to construct a "skills profile" to identify skills needed for the successful operation of a new-venture team; to observe team dynamics and learn how to manage task, process, and relationship conflicts; to learn techniques for assessing new venture financial liability.
E-commerce and the entrepreneur	Engineering, computer science, entrepreneurship, marketing, advertising, mass communication, creative writing, art	Students learn factors that an entrepreneur should consider before entering e-commerce; business and marketing strategies for promoting an e-commerce business; to design and develop an e-commerce website for posting content, blogs, messages on Facebook, Twitter and other social networks to promote a business; how to track website results; how to protect customer privacy.

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TABLE 1
INTERDISCIPLINARY ENTREPRENEURSHIP COURSE….continued

Design	Engineering, science and technology, art, marketing, mass communication	Students learn various design forms, elements, traits of elements and their relationships; the process of design, design analysis, and creative problem-solving; to think visually; optimal design principles; the difference between the commodity and the process of a business.
Franchising and the entrepreneur	Business: law, entrepreneurship, management	Students learn to contrast and compare types of franchising; to evaluate the advantages and disadvantages of buying a franchise; the legal framework and laws covering franchise purchases; how to franchise a successful business; the major trends in franchising.
Buying an existing business	Business: law, entrepreneurship, management	Students learn to evaluate the advantages and disadvantages of buying an existing business; steps of evaluation of an existing business; the negotiation process and how to structure the deal.
Pricing strategies	Business: Micro economics	Students learn to analyze relationships between pricing, image, competition, and value; effective pricing techniques for introducing new and existing products/services.
Managing cash flow	Business: finance, accounting	Students learn the importance of cash management in small operations; the fundamental principles of managing accounts receivable, accounts payable, and inventory; to differentiate between cash and profits; how to create a cash budget.
Sources of financing: equity and debt	Business: finance, accounting	Students learn to evaluate the differences between equity capital and debt capital; the advantages and disadvantages of equity and debt financing; to analyze sources of each type of capital available for an entrepreneur.
Global aspects of international entrepreneurship	Supply chain management	Students learn why entrepreneurs pursue opportunities around the world; the main strategies that a small business can use for going global; the major barriers to international trade and their impact on the global community; how to write a plan for a profitable export program.
Reading list	All disciplines	Students read research papers and professional books (not academic textbooks).
Vocabulary: List of common business terms	All disciplines	Students build a working vocabulary of business terms that enable them to understand documents and literature on business and entrepreneurship.

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In addition to the topics in Table 1, students must spend some time in one of the incubators (described in the next section) to receive some part of 4 credit hours. See Liao (2008), Jaber, Marle and Jankovic (2015), Danilovic and Browning (2007), and Mick and Linder (2005) for some discussion on the planning and programming of interdisciplinary teams and activities. Students may work on company or entrepreneur sponsored ideas to assess opportunities and validate ideas, develop and demonstrate pretotypes and prototypes, identify target markets, and create business plans. Planned activities must take students out of their departmental silos frequently enough to have lunch with students from other colleges and departments. Students must learn the difference between entrepreneurship and business management, and how to transition from entrepreneurial innovation to startup business management activities such as selling, phone answering, order acquisition, order processing, order fulfilment, payroll, services, and income tax returns, etc.

Space does not permit a complete analysis of all the topics in Table 1. Also, many of the topics listed are established standards. Their impact on knowledge and skill is well known. They are only listed here to suggest their impact on mindset. To illustrate mindset impact analysis, consider for example the first row. The impact of CDR was discussed earlier in the paper and is unique to this framework. So, consider now the impact of failure. The very nature of entrepreneurship is embodied in pushing the envelope. This implies a raised level of risk of failure. A refusal to risk failure implies a guaranteed pass for competitors. A failure does not have to be due to lack of due diligence. It may simply be due to an element of uncontrollable randomness associated with any business environment. The best that the entrepreneur can do is to learn as much as possible from failures. The second row is concerned with issues that might easily be overlooked by an inexperienced student run company. Many of the subtopics are not standard in a business curriculum. Yet, they are critical to entrepreneurship. For example, personal financial management is not a standard topic. But, a prospective student entrepreneur will not be eligible for business loan financing if their personal credit is unworthy. Personal financial management is as concerned with mindset as it is with knowledge and skills. Regarding the last two rows, the focus on professional books instead of academic textbooks is not a standard. In the standard, not only is it possible, it is quite likely that a business student will graduate with no real factual knowledge of the origins, history, development, status and leadership of major American corporations (Ridley and Davis 2009). A vocabulary list will enable meaningful access to the assigned reading.

Not all elements of success can be reduced to a scientific method. As much as we would like entrepreneurship to be formulaic, no two incubators are the same. As a result, their related problems are by definition episodic. They are nuanced and ambiguous. Students should recognize that many bad practices are known to lead only to bad outcomes, while good practices, although not guaranteed, can lead to good outcomes. Therefore, it is critical that students learn to develop the best of practices, with no chance of classroom texting and browsing since multitasking while learning is humanly impossible (Beland and Murphy 2015, Rosen 2013). Delayed gratification (Mischel and Ebbesen 1970), time management and the development of good personal study habits is required.

The opportunity to obtain a minor in entrepreneurship can be considered.

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Organizational structure

There are two possibilities of interest for establishing the organizational structure of the IEC. Each has its pros and cons for success. In one possible scenario (see Figure 3), an entrepreneurship grant is given to an academic unit, college, department or institute in the university. All activities are centered within that unit. This structure is relatively easy to manage. So is the assignment of responsibilities and monitoring of accountability. The physical facilities can belong to the academic unit. One such example of an academic unit is the business school. This appears to be reasonable since entrepreneurship has so much to do with business. Classes can be designed for business majors, and non-majors can be allowed to take them. However, while the results can be excellent, there might be little or no impact on the rest of the university.

FIGURE 3
PERIPHERAL RELATIONSHIP: EXCELLENT RESULTS WITH A HOLLOW VICTORY AND NO STUDENT, FACULTY OR UNIVERSITY DEVELOPMENT

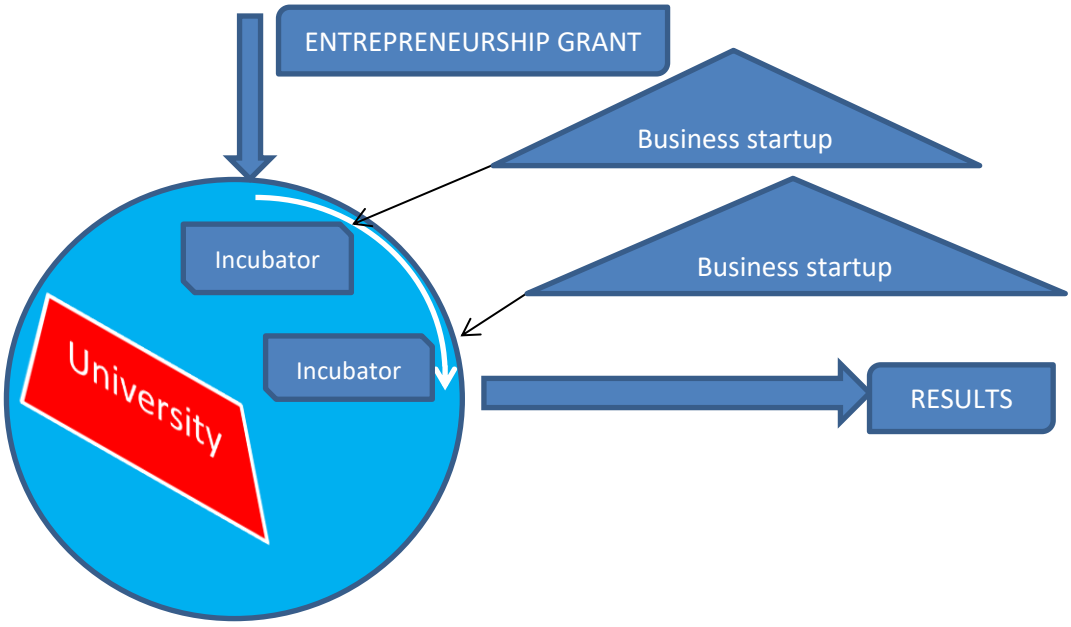

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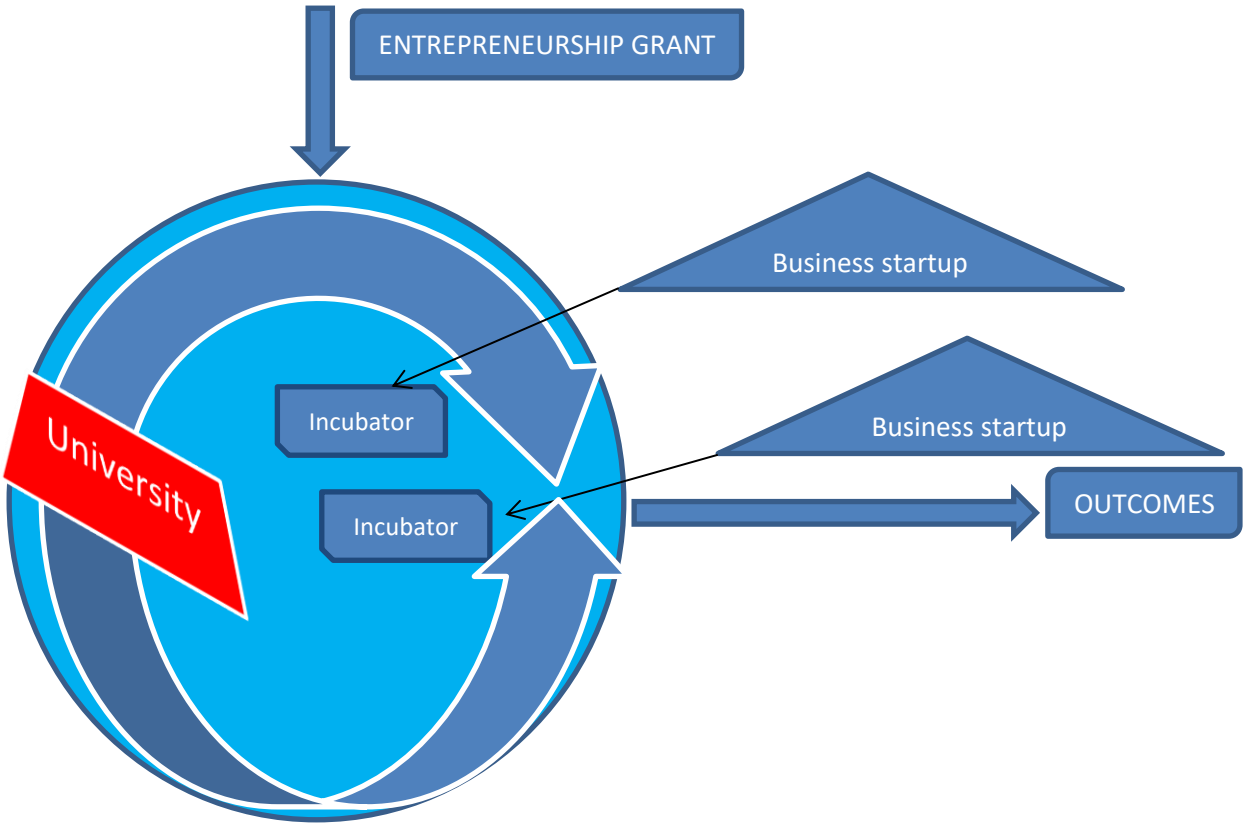
FIGURE 4

INTEGRATED RELATIONSHIP: EXCELLENT OUTCOMES. VICTORY FOR STUDENT, FACULTY OR UNIVERSITY DEVELOPMENT THROUGH CAMPUS WIDE INVOLVEMENT, EDUCATION, COURSE WORK, INSTITUTIONAL MEMORY



The preferred alternative is an integrated scenario (see Figure 4). An entrepreneurship grant is given to the university for integration campus wide, and community development. The managing unit is a separate IEC, independent of all colleges, schools, departments and institutes. The IEC is designed and directed to serve all university constituents equally. Nonbusiness entrepreneurs are identified in the professional schools such as law and medicine, engineering, science and technology. Technology, lifestyle and social entrepreneurship can grow out of various alliances on campus. The results are equally excellent outcomes, but greater in scope than the peripheral relationship, and with a lasting impact on the university and the community. In case there is resource limitation at the time of startup of the IEC, it may be necessary to locate it in a university college. At such time as it grows into a sustainable unit, direct college management can be adjourned *sine die*, and a new and independent center opened. If for any reason, due to reorganization, it turns out to be impractical, it can be return to the college.

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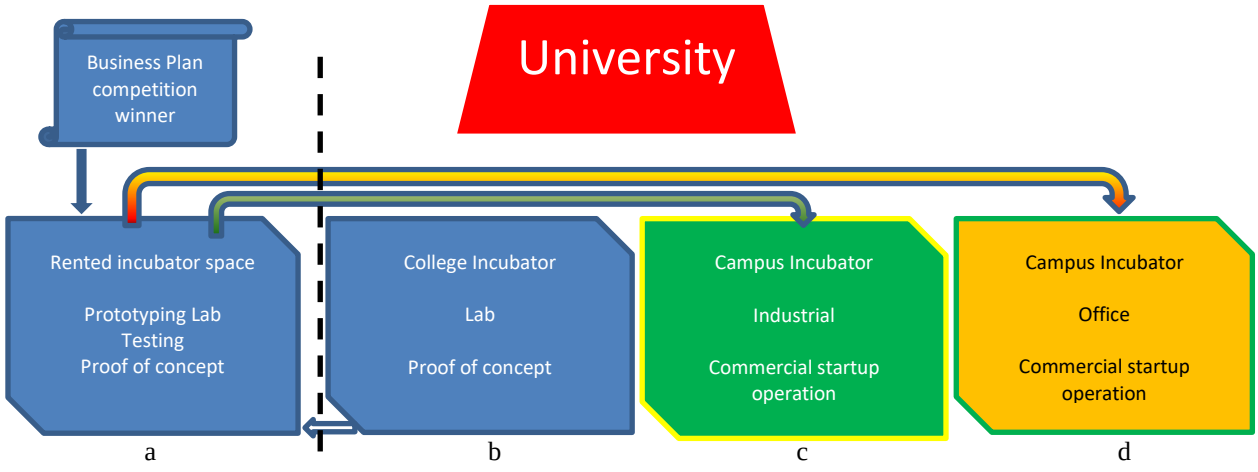
Incubators

There are different types of incubator depending on the stage of development of the business idea. Some technology based ideas require prototyping, testing and proof of concept. Large inventions derive from small discoveries (Ashton 2015). An incubator of that type is shown in Figure 5a. Such an incubator may be special purpose in design, but unrelated to university education. For example, Domi Station and Making Awesome, adjacent neighbors in Tallahassee, Fl. provide business coaching and rapid prototyping CNC/CAD/3D machines for making electronic circuit boards and device containers, respectively. Those elements of the process are vocational in nature, not academic. Renting space there may be the best option. Some technology based ideas require development in a university science laboratory, such as those used to teach and conduct university physics, chemistry and pharmacology research. An incubator of that type is shown in Figure 5b. Although specialized, great expertise and a Doctor of Philosophy are required. An idea leaving this incubator may still be theoretical and benefit from time in incubator 5a. Ideas that leave incubators 5a and or 5b as working devices then go to the industrial (5c) or office (5d) commercial startup incubator.

FIGURE 5
INCUBATOR TYPES



Entrepreneur's Day

Prior to the preparation of business plans, the university is engaged in a number of entrepreneurship activities. Those are academic activities. But, the university must have an annual event related to the entrepreneurs themselves (Figure 6). It is a day for the application of entrepreneurship by the campus entrepreneurs. Consider for example, university entrepreneur's day. On that day there are a number of activities. One activity is a business plan competition. A business plan forces the students to think through and understand their business. It can also be

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used to seek financing. The competition creates a winning business that receives a first prize cash award, recognition, and an opportunity to enter a commercial startup operation incubator for one year (Figure 7). At the time of the business plan competition the participants must sell their ideas. An end of semester competition date will maximize the time for students to prepare their business plans. And, a published deadline has a wonderful way of concentrating the mind.

One year after exiting the incubator, or on an even multiple of years thereafter, the business can apply to enter the Shark Tank style venture capital forum, where on entrepreneur's day they must sell their income statement and balance sheet to venture capital investors (Figure 8). Their idea may have been impressive on the day when they won the business plan competition, but the venture capital investors will want to know how well their idea was implemented and how well it was received by customers.

Integration

In addition to being cash poor, we are concerned with technology based entrepreneurship where larger investment and knowhow is required than for lifestyle and social entrepreneurship. The IEC objective is to positively impact the university and the related community. An integrated approach starts with multidisciplinary student teams brainstorming and mining faculty research for commercial ideas (see schematic diagram in Figure 7). This activity can be greatly enhanced with help from student members of the entrepreneurs club. There should also be physical and electronic notice boards for faculty to display ideas and inventions.

In addition to the interdisciplinary entrepreneurship course discussed earlier, extra-curricular student activity can increase student wisdom when enjoined by experienced business people from the external community. For example, the Economic Club of Florida (ECF) is a one stop shop for potential advisors and angel investors. Student members of the ECF can learn from the speakers who address the ECF monthly luncheons. This can be a live term paper source of information for courses that they are taking in business, economics, journalism, government, etc. Tallahassee Technology Alliance (TalTech) can be a source for students taking information technology courses. The Institute of Electrical and Electronic Engineers is a source for science and engineering students, and so on. Of these external organizations, the ECF is one of particularly great interest for networking because they comprise many bankers and investors. Members of ECF can speak at student club meetings, especially on the topic of business plan writing. They are a readily available source of angel investors. Other sources of investment are family, friends and alumni angel investors, venture capital, crowd funding and grantors.

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FIGURE 6
BUSINESS PLAN COMPETITION AND SHARK TANK STYLE FORUM ACTIVITY TIME LINE LEADING TO ENTREPRENEUR'S DAY

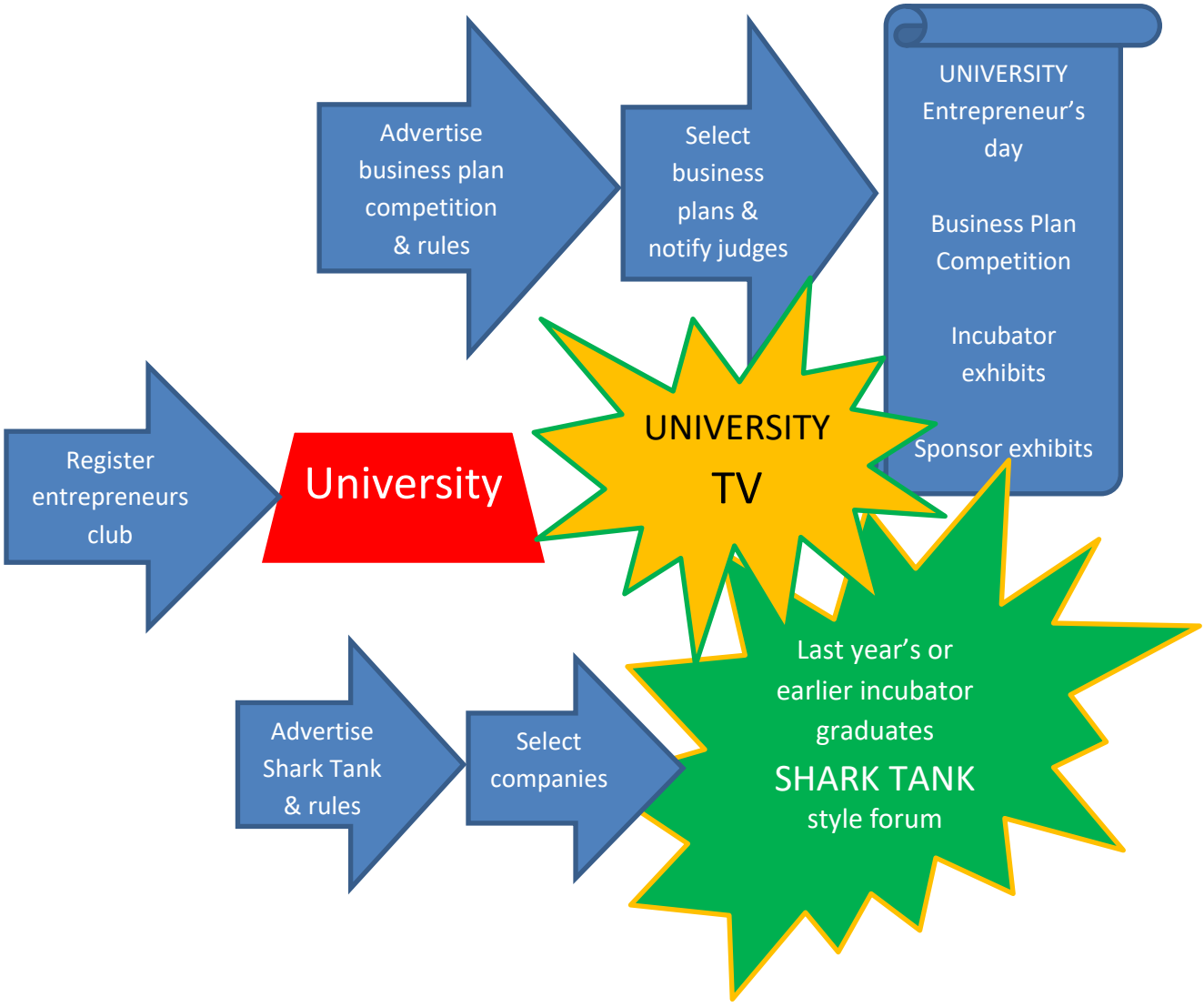

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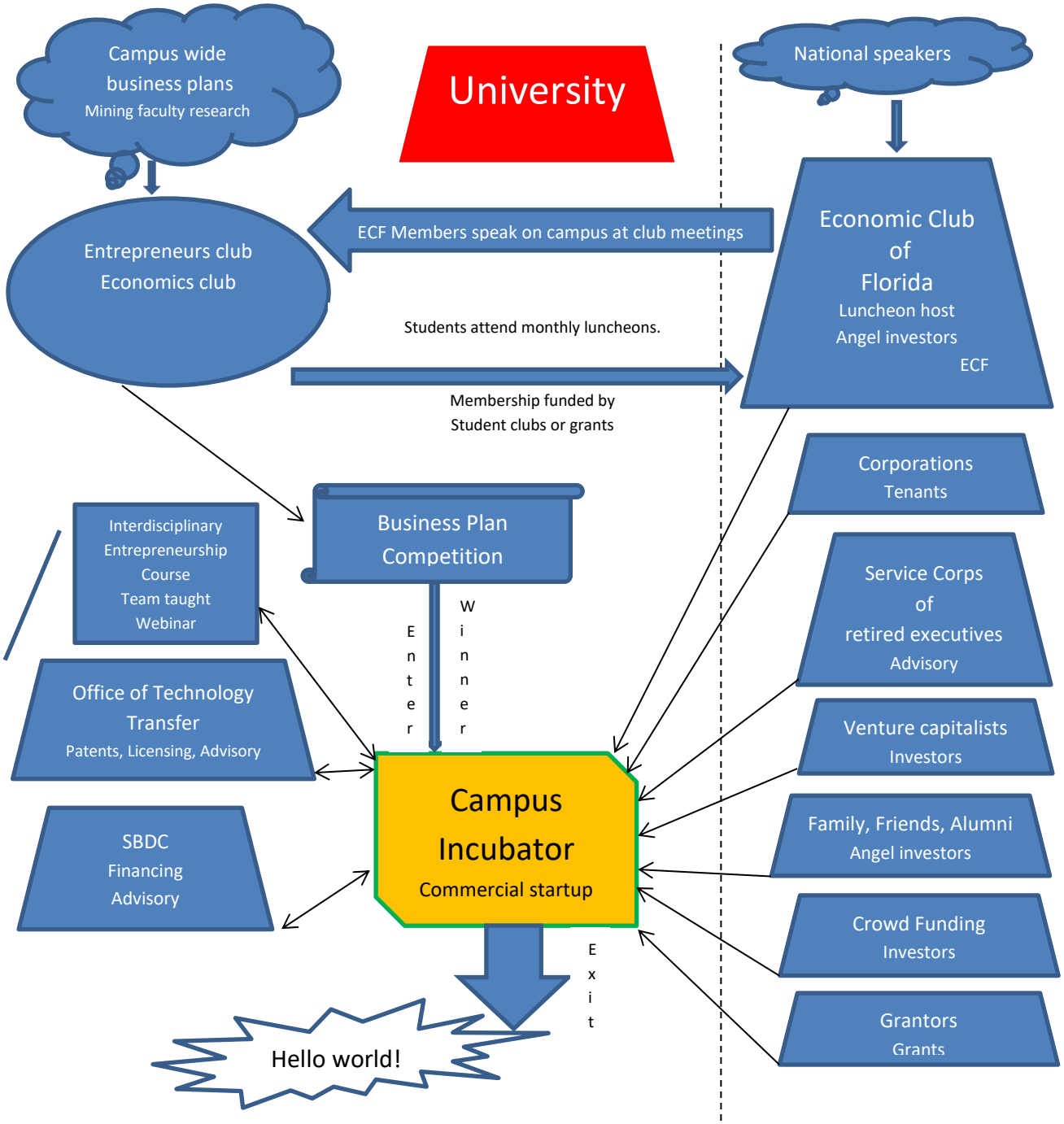
FIGURE 7
INTEGRATED ENTREPRENEURIALLY MUNIFICENT INCUBATOR SUPPORT MECHANISM, EDUCATIONAL DEVELOPMENT & COMMUNITY TRANSFORMATION SCHEMATIC



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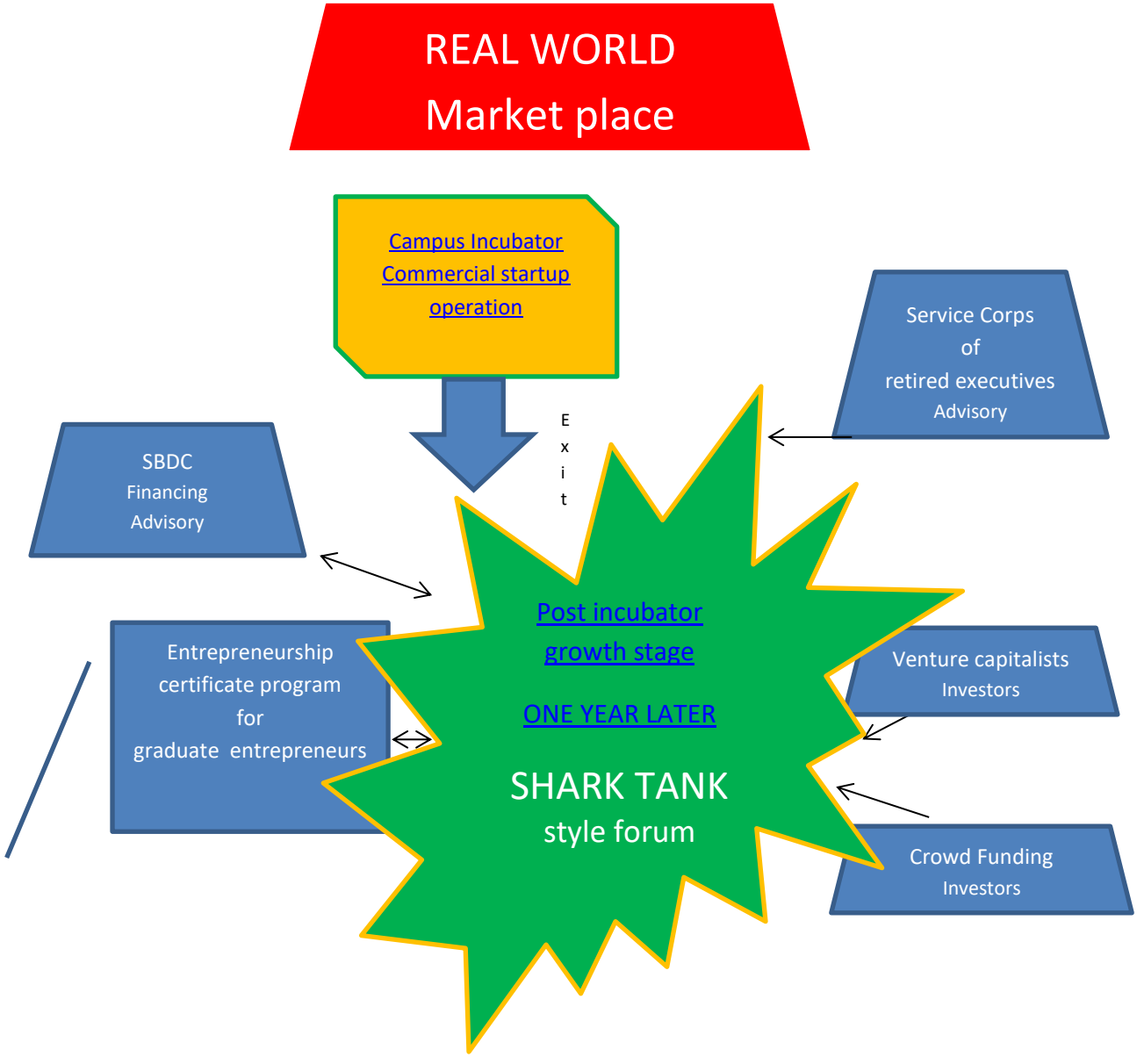
We know from Gladwell (2008) and Ridley and Davis (2009) that professional competence requires 10,000 hours of dedicated experience. That is, the equivalent of forty hours per week for five years. By definition, students will not have this experience. This poses an insurmountable problem. Barahona, Cruz and Escudero (2006) found that graduates are more likely to be entrepreneurs if their education was complemented with business and travel experience. Still, only some of this experience can be obtained through corporate internships. Therefore, the remaining lack of experience must be supplemented by placing an experienced angel investor on the startup management team or advisory board, as needed.

The Small Business Development Center (SBDC) and the Service Corp of Retired Executives (SCORE) are sources of advice on business plan writing, financial planning and loan acquisition. The university Office of Technology Transfer is available to assist with intellectual property acquisition such as copyrighting, patenting, and licensing.

FIGURE 8
SECOND STAGE POST INCUBATOR INVESTMENT BASED ON INCOME STATEMENT AND BALANCE SHEET



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Executive education

If there is one constant throughout the vicissitudes of time, it is change. Technology is continuously evolving, demanding the periodic renewal and upgrading of skills. To that end, entrepreneurs who have attained an undergraduate degree and who have been practicing in the real-world business for two or more years can benefit from executive education. They and other business leaders can study for a graduate certificate in entrepreneurship (Figure 8).

CONCLUDING REMARKS

The static case study method of teaching has been employed for many years. A logical replacement, better for creating an entrepreneurial mindset, is technology based dynamic live case study with color graphics animated computer simulation. The success of this was demonstrated by the seven student publications involving twenty five students in just two semesters referenced in this paper. Students can create key elements of a case, collect the related data, analyze them and develop comprehensive pro forma technical and economic evaluations, cash flow and income statements, and balance sheets. These are required to understand the business and to apply for financing. When obtained by computer simulation, these documents are more realistic. Live case study provides some experiential learning and real-life contact with real business operations. That notwithstanding, the creation of startup business by students presents the insurmountable problem of student professional inexperience. This demands the presence of an experienced angel investor on the startup management team, or advisory team, as needed.

Entrepreneurship involves risk. Education, research, development, best practices and application of the scientific approach can reduce risk. There will be some favorable and unfavorable outcomes. Complete risk avoidance is easily attainable by simply doing nothing at all. Except that that is not entrepreneurship. Doing nothing produces no outcomes, neither good nor bad. Experienced people know not to try anything new. Students know that they should try everything new. A meeting of these two mindsets might produce the requisite synergy. Computer simulation is not an optimization tool. It is a method for developing and evaluating realistic alternatives, including risk classification, and selection of a best-case scenario. Chance favors those who are prepared. So, it is not about being right. It is about doing what is right. That way, risk is reduced and outcome expectation is maximized. Knowing is important but how to deal with the unknown is even more important.

In addition to structured education, entrepreneurial students need a club to provide a family away from home. Time spent in entrepreneurially munificent incubators provide needed guidance, nurture and visibility. Visits to local and other incubators provide needed exposure to complement the entrepreneurial mindset. A weekly televised forum on entrepreneurship involving students, faculty, and visitors, and broadcast on the university TV channel and/or satellite radio, can provide special interest exposure of incubator companies to potential investors, general exposure to future university freshman recruits, and favorable public relations in general.

A CDR index was introduced for the first time in this paper. The positive wealth-health, and CDR index relationship paradigm is indisputable today. Recommendations for future studies include the formal measurement of the CDR index. Then, the wealth-health CDR relationship can be calculated. This may lead to a source of useful CDR analytics that serve to change the zero-sum mindsets of academicians; and of those communities and governments that have yet to recognize that low CDR is the real obstacles to their economic success. Economic success is a

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function of the CDR index, not the visible characteristics of people in a country. In the archetypal model for entrepreneurship education, diversity has the potential to expand the pool of innovators and thereby increase the size of the world's economy, to the benefit of all people. A plus sum mindset in which the best ideas can rise to the top.

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CHAPTER 3

Wealth is all in the mind

Reference: Ridley (2017a).

Capitalism (C), democracy (D) and rule of law (R) spawned the industrial revolution in England. Subsequently, the people of that country, its neighbors known as Western Europe, and their majority descendant United States of America (USA) who adopted the practice of CDR, *have enjoyed unprecedented wealth as measured by purchasing power parity adjusted real per capita gross domestic product* (GDP). *The countries that have not adopted these practices have remained relatively poor. This disparity is independent of natural resources (N), government spending, country size, location, culture, physical characteristics and various beliefs commonly espoused.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship

Introduction

Governments routinely debate the cause of poverty. The manmade *D* and *R* institutions developed and evolved over many centuries (North, 1991). But, almost all people remained poor. The exceptions were feudal lords, and beneficiaries of the 17th century Amsterdam stock exchange, the Dutch and English East India Companies, and certain skilled artisans. While these entities managed to transfer some wealth to themselves, little if any was created and much was destroyed through invasion, looting up to the international convention of The Hague in 1899, and wars.

In 1662, King Charles II of England created a royal charter for the study of science. The technology that that created, and the 1811 New York limited liability law and other versions attributable to England (1855) and Germany (1892) created the mechanism of CDR and the perfect storm that combined to start the industrial revolution (*circa* 1840). See Figure 1. Adam Smith (1776, 2010) who lived during the beginning of wealth creation in England never posed the question of poverty. Perhaps it is because he knew that the cause of poverty is the inaction of doing nothing. His question was an "Inquiry into Nature and Causes of the Wealth of Nations." We now know that he found the answer to be *C*, especially when facilitated by the catalysts *D* and *R*. Before the industrial revolution, poverty was the normal state of existence for mankind. England, its Western European neighbors, and their majority descendant USA that adopted CDR, became rich. Most of the world that has not adopted CDR remains relatively poor. We attribute this to the mechanism of the GDP generating process from *C*, *D* and *R* wherein *C* is attracted to

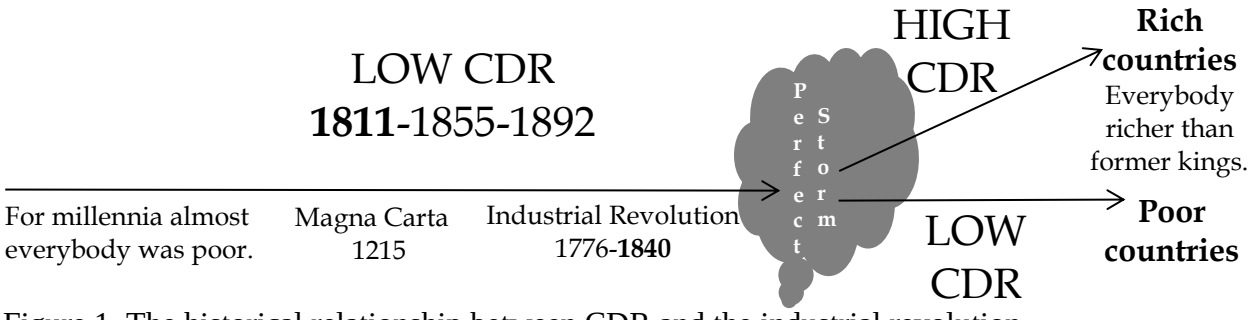

Figure 1. The historical relationship between CDR and the industrial revolution.

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R and *D* releases the imagination and creativity of the human mind for the superior deployment of *C* in the generation of GDP. Later, we will show that natural resources, government spending, country size, location, culture and physical characteristics are not the causes of wealth.

The Source of Wealth

Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. Capital stock that can be invested is about the past. Entrepreneurship is about the future. Entrepreneurship is expressed as quanta of information that must get noticed in order to serve any purpose. That requires low noise communication channels. The entrepreneurship signal must be relatively high and *D* and *R* must promote low noise channels. That is, a high signal to noise ratio (Gilder, 2013, Romer, 1990). Low *D* and *R* serve only to promote a high noise channel of infighting, unproductive conflict, and social disequilibrium through which the entrepreneurial information cannot pass, and goes unnoticed. Low *D* and *R* are synonymous with corrupt dictatorships and low GDP countries.

Entrepreneurship, the source of all wealth creation from ideas and imagination, is depicted in figure 2. Poor people in low CDR countries are frustrated into a mindset that capitalism is the cause of their poverty and refuse to participate in a corrupt economy (see Brosnan and de Waal, 2014 on the evolution of responses to unfairness and Barclay and Stoller, 2014, Brandstätter and Königstein, 2001, Güth, Schmittberger and Schwartze, 1982, Jensen, Call and Tomasello, 2007 on the ultimatum game). They believe that the rich got rich at their expense. It is critical to tap the ideas of the whole population. Increasing political and economic freedom raises GDP (Friedman, 1912-2006, Gwartney, Lawson and Hall, 2015). As it turns out, Adam Smith recognized that a capitalist is a person who seeks to deploy personal effort so as to benefit himself maximally. That is, all rational human beings are capitalists. Therefore, a capitalist cannot be the enemy of the poor.

The capital stock component of *C* is endogenous but *D* and *R* are exogenous catalysts (term coined by Baron J. J. Berzelius in 1835) that create alternative pathways and lower the effort required to acquire and convert *C* into GDP (see Dominiak (2016) for components of capital in the business unit). *R* is the opposite of corruption and is an essential component of property rights, where property is a potentially fungible legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged (de Soto, 2000). *R* attracts *C*, and *D* releases knowledge of how to deploy *C* for optimal GDP. This is how human capital idea is converted into wealth and capital stock that can be reinvested, minus depreciation and obsolescence. Capital stock is inexorable. Despite Piketty (2014), without new human capital ideas, capital stock will decline continuously. The rich will eventually join the ranks of the poor. Each new human capital idea will raise the total level of *C*. The components *C*, *D* and *R* are each of a different structure. *D* and *R* do not take part in the *C* to GDP process, and remain in tact and available for the next cycle when it occurs.

One good reason for poor countries to regain a positive mindset is because wealth is a plus sum game. Since ideas are unlimited (Lotto, 2017), it follows that wealth is unlimited. Space travel is one example of the potential for limitless growth. The USA has demonstrated this, rising out of and beyond the world in which it began, through the atmosphere, and into space. If this is not sufficiently inspiring for the poor to become believers, the poor in rich countries should at least consider that they are richer than former Kings like Charles II who never had indoor plumbing or running water. Recognize the relentless time consuming hard work and devotion to low cost manufacturing of products by entrepreneurs, made affordable to the poor, so that they may have a better living standard and more leisure time. Finally, recognize that entrepreneurs are

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a gift to humanity and anything done to impede their activities can only destroy capital and threaten a return to widespread poverty. Later, we will show that poor countries must focus on raising their level of CDR if they are to raise their GDP.

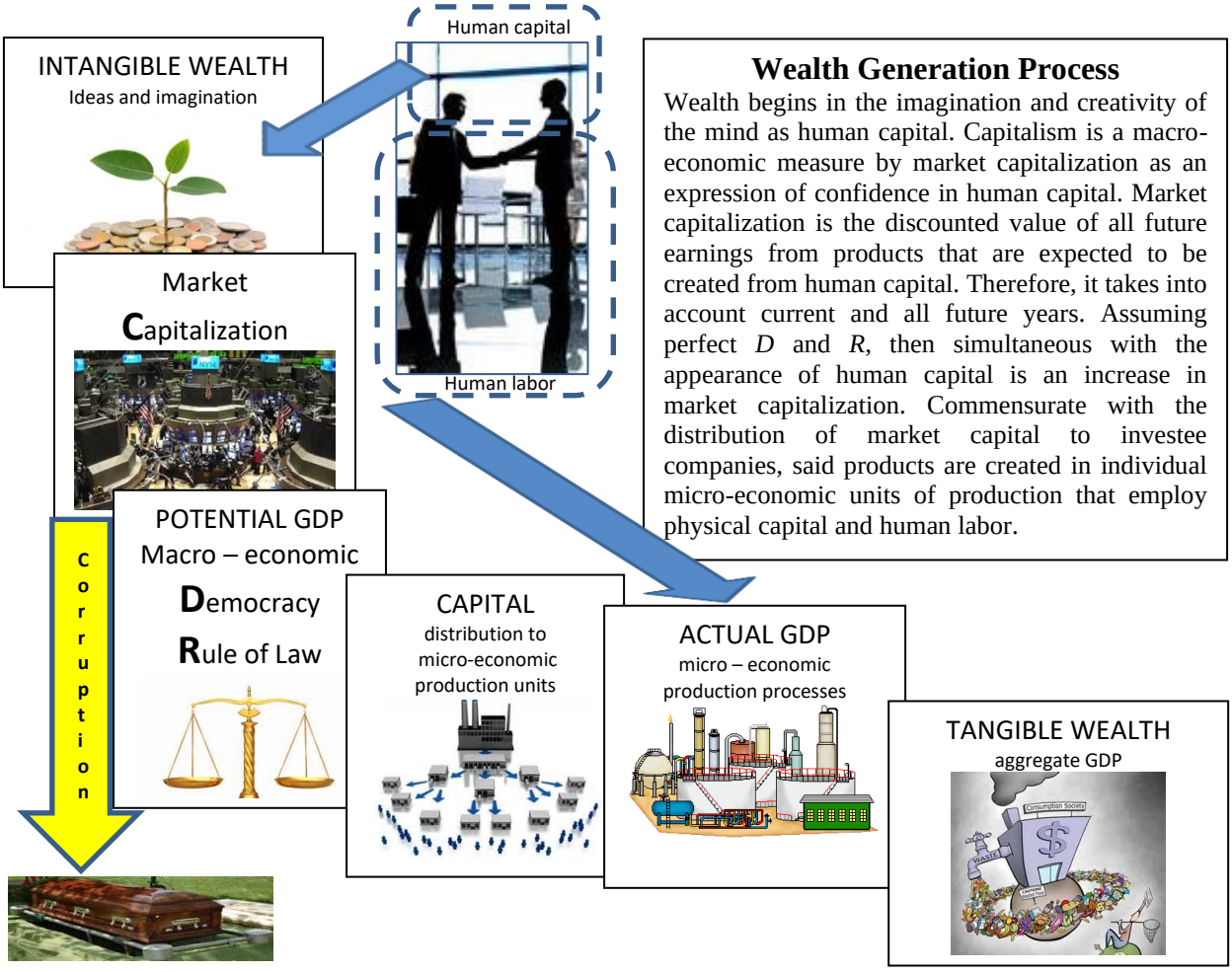

Figure 2. CDR wealth process: Capital to GDP conversion in the presence of Democracy and Rule of Law.

Relative contributions to GDP

To determine the relative contributions of *C, D, R, N* to GDP, these variables were ranked for all countries of the world then placed on a standardized scale of 0-1. Then GDP was regressed on *C, D, R* and *N* to obtain the fitted equation (*Click here for data and calculations*):

$$G = 1.53C + 0.14D + 0.23R - 1.21C{\cdot}D{\cdot}R + 0.38N$$

$t =$ (6.60) (1.69) (2.60) (4.40) (5.59)

Variation in GDP explained by this equaiton = 83%

59% 5% 10% 3% 6%

where *G* is the per unit standardized GDP and GDP can be estimated from GDP= *G* (highest GDP-lowest GDP) + lowest GDP.

The t statistic is significant at the 10% level for all variables. The equation explains 83% of the variation in GDP. The residuals (not shown) are perfectly random, indicating that there are no other systematic variables that are responsible for explaining GDP. The contribution from N is

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6%. Furthermore, without human capital natural resources would not be identifiable. This finding dispels the commonly held belief, that they are important. The positive direct contributions from *C*, *D*, and *R* are 59%, 5%, and 10% respectively. The indirect contribution of 3% from the interactive *C·D·R* term is due to friction between decision makers in the deployment of *C*. The coefficient of *C·D·R* is negative because it subtracts from the GDP associated with the theoretical optimal but unknown decisions. The measurement of *C* is based on publicly traded stocks, so the remaining 100-83=17% that is unexplained may be due entirely to the numerous small businesses that are not publicly traded and for which no data are or will ever be available. Other studies such as Barro (1996) did not include an interactive term and yielded inconclusive results regarding the effect of *D*. The Solow (1956) growth model does not apply here because it employs only capital stock instead of total market capitalization.

Examples of high and Low CDR countries

The regression line in Figure 3 shows the relationship between GDP and CDR for seventy-nine countries for which a complete data set is available. These countries include almost the entire world's population. Also plotted are twenty-one countries, selected for their contrast between culture, history, population characteristics, appearances and size, income and CDR. These countries are all over the world map. The diameters of the bubbles are directly proportional to the square root of population. It is remarkably clear from this vexillological chart that GDP increases with the CDR Index. The related computations are given in Appendix BB.

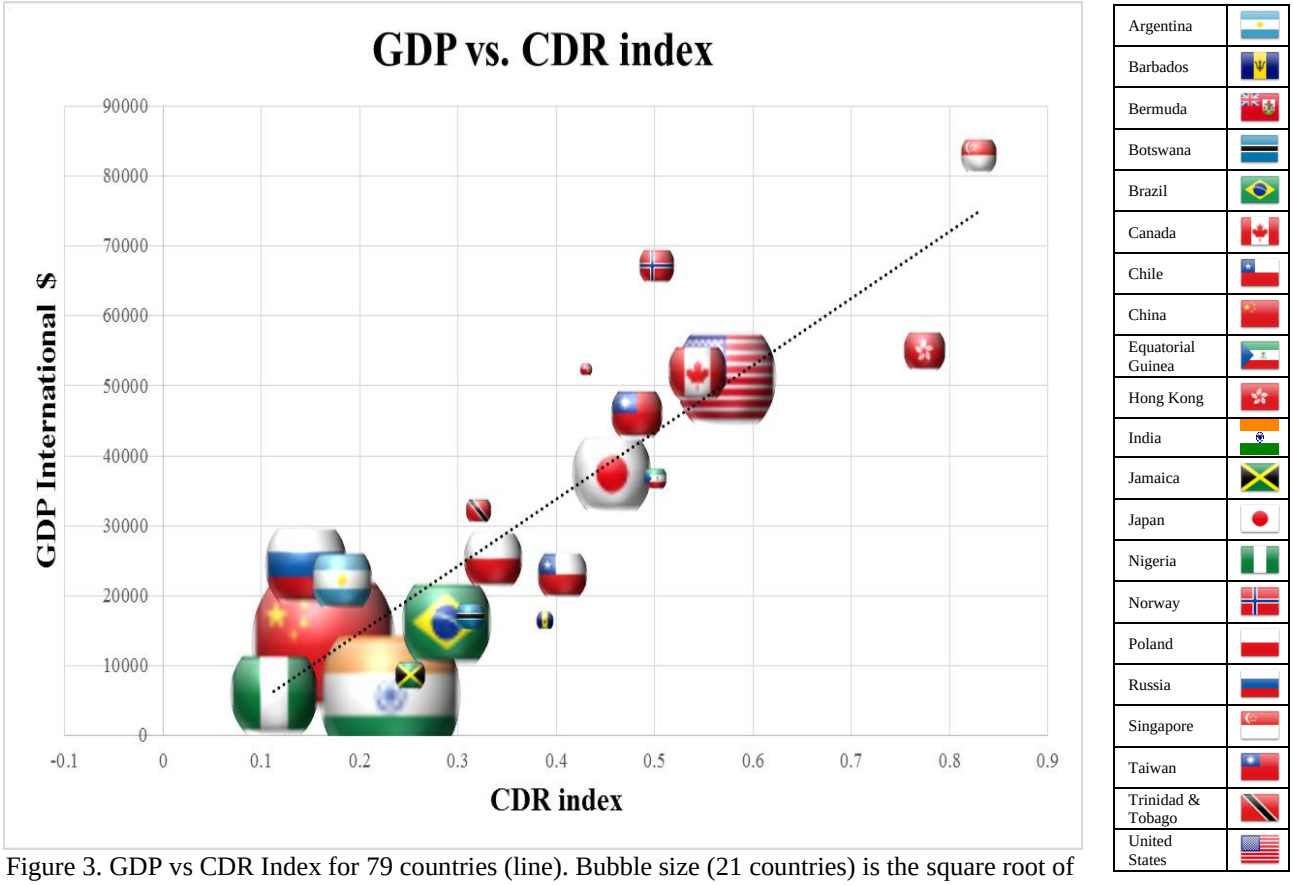

Figure 3. GDP vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population.

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The United States and Western Europe comprise high CDR countries with high GDP. Some countries have benefitted from the possession of natural resources. But, the benefits are much smaller than they first appear to be. Auty (1993), Sachs and Warner (2001), Ross (2001), Sala-i-Martin and Subramanian (2003), Humphreys (2005), Wadho (2014) explain many ways in which natural resources have actually been a curse. Indeed, countries with an abundance of natural resources are more often than not poor. They include for example Russia, Nigeria, Brazil, India and China, to name just a few. They are low CDR and GDP countries. In contrast to victims of the natural resource curse, small western countries with common histories, high CDR and GDP are Bermuda, Cayman Islands, and to a lesser extent, Trinidad & Tobago and Barbados. Other former British colonies with high CDR and GDP are Singapore and Hong Kong in asia, and Equatorial Guinnea and Botswana in subahara Africa. Still other elevated CDR and GDP countries that are very different from their neighbors are Poland and Chile.

Natural resources

As seen from the regression model, the commonly held belief that natural resources are the source of wealth is not true. Furthermore, natural resources can and do often have a negative effect via a phenomenon known as the Dutch disease paradox (Ebrahim-zadeh, 2003), otherwise known as the natural resource curse. Typically, a country that discovers a natural resource will contract with international companies that have related expertise to extract and place it on the world market in return for royalty payments. When the natural resource enters the international market, the country's currency is upwards revalued. Currency traders are more willing to be paid in the currency of the natural resource country than previously. Citizens can buy more from abroad. Nobody would want it any other way. As it turns out, the higher currency value raises the cost of exports and drastically reduces the country's other exports. Agriculture declines. Tourism declines. This hurts everybody except those in the geographical area of the natural resource. This leads to rampant speculation of corruption. The impact is fewer total exports, a net negative impact on GDP and numerous social ill effects (Hirschman, 1958, Seers, 1964). There are widespread losses of non-natural resource related jobs. There is disruption, dislocation, and social crisis. The regression model shows that the effect of natural resources rents contributes only 6% to GDP. Even where natural resources play a significant positive role, the very existence and utility of the resources can only be detected by human beings who know the relevant science and application of the resource. That is, if there is a natural resource it is the human brain.

Winston Churchill (1943) said that the "empires of the future will be empires of the mind." This was his testament to the massive and saddening waste from world war two over natural resources. His remark was consistent with what became a switch to massive wealth creation by the likes of General Electric, International Business Machines, Intel, Microsoft, Apple and now Google, all completely unrelated to natural resources. This is clear evidence that the source of wealth always was and still is the imagination and creativity of the human mind.

Government spending

If per capita government spending and population size are included in the regression model, their coefficients are not significant and there is no change in the percentage of GDP that is explained. Government taxes and expenditures merely cancel.

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Country size

An examination of Figure 3 shows that as the chart is traversed from left to right, the sizes of the bubbles do not increase or decrease in a systematic way. Therefore, country size does not matter.

Location, Culture, Physical characteristics

The countries represented in this analysis include all country locations, cultures and physical characteristics and there is no pattern to suggest that these variables affect wealth, beyond the effect of *C*, *D* and *R*.

Conclusions

Prior to the industrial revolution poverty was the normal state of human existence. Wealth changed hands by means of colonialism and transfer by force. But, no wealth was created. That changed with the creation of capitalism as the mechanism for assembling capital via the limited liability company instrument, democracy and the rule of law. All rational people are capitalist and capitalism, democracy and rule of law is the demonstrated path to great wealth. High CDR countries have become wealthy and low CDR countries have remained relatively poor. This, iconoclastically, independent of natural resources, government spending, country size, location, culture, physical characteristics and various beliefs commonly espoused. The only true natural resource is the human mind. Contrary to Thomas Malthus (1798), that resources are limited, each human being brings his or her own wealth of ideas, imagination and creativity. What are commonly referred to as natural resources only become resources when the human mind thinks of them and how they can be utilized. As one such natural resource is depleted, another is discovered. For example, fossil fuels have already been replaced in part by uranium, which may be replaced by thorium. We will always think of something, if only we think. If we do not think, we will think of nothing. Wealth is not a zero-sum game. If wealth is all in the mind and the imagination and creativity of the mind is unlimited, then wealth is unlimited. A country that knows where it is going will not get far. A country willing to create an entrepreneurial environment of risk taking and investment in the unknown may experience unlimited growth. Space travel is one example where the world as it was once known was surpassed. The orderly line up of countries in the GDP vs. CDR chart is remarkable, and suggests global equality of efficiency after adjustments for country factors of productivity. The key to high GDP is to attract capital and direct it to the best democratic and rule of law abiding industries. The obvious recommendation is for low GDP countries to raise their CDR and for high GDP countries to assist them wherever possible to expand entrepreneurship and raise the size of the world's economy (Ridley, 2016, Ridley, Davis, Korovyakovskaya, 2017) for the benefit of all.

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CHAPTER 4

Micro Intrapreneurship

Reference: Ridley (2017c).

Before the advent of science, the human DNA *had to change if man was to survive, advance from the middle to the top of the food chain and achieve through physical ability. Science reintroduced human capital, the genesis of wealth by way of a cognitive revolution. Combined capitalism, democracy and rule of law* (CDR) *is a mechanism for converting said wealth into tangible goods and services through micro intrapreneurship that can be made consequential of a particular negative income tax that requires employment and interaction with commercial activities. Transfer welfare payments that create dead capital can be redirected to investments in living wage supplements for the support of micro intrapreneurship.*

Keywords: Institutional interactions; Political economy; Capital Formation; Democracy; Rule of Law.

Introduction

The purpose of this paper is to discuss a mechanism for engaging human capital ideas of imagination and creativity via a negative income tax requiring employment and interaction with commercial activities that employers need to have performed. Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. Entrepreneurship is practiced by an entrepreneur. Intrapreneurship is inside entrepreneurship practiced by an intrapreneur within a large firm without incurring the associated risks. Intrapreneurs have the resources and capabilities of the firm at their disposal. It may help us to understand entrepreneurship even better if we identify micro entrepreneurship separately from entrepreneurship. With that in mind we recognize entrepreneurship as corporate outcomes of innovation that appear as new products and services. There are also the reduced costs and higher profits from the implementation of improved methods. Much of this kind of entrepreneurship is now globalized via today's high technology manufacturing and transportation industries. On the other hand, micro entrepreneurship is localized activity which is of great interest, partly because it is connected to the aforementioned corporate outcomes and partly because of the success of small business outcomes made possible by microloans.

The remainder of this paper is organized as follows. First, the status of economics and its role in advancing economic growth is reviewed. Next, the wealth generation process as accounted for by a new CDR model is explained. Next, the negative income tax is connected to employment and the micro intrapreneurial process. Concluding remarks contain suggestions for future research. Because of the absence of explicit definitions in the extant literature for concepts such as capitalist, capitalism, entrepreneurship and other consequential terminologies, defining nomenclature are given in Appendix AA.

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Economics: Descriptive or Prescriptive

Prior to the advent of science, human beings had to experience an evolutionary genetic modification in DNA in order to acquire new skills for survival and adaptation (Harari, 2015). The arrival of formal science and a cognitive revolution made it possible to leverage tools and physical and chemical material transformation methodologies to acquire new skills and create new outcomes. Prior to the industrial revolution, with the exception of feudal lords, and beneficiaries of the 17th century Amsterdam stock exchange, the Dutch and English East India Companies, and certain skilled artisans, all people were poor. As best as one can tell, the frameworks for capitalism, democracy and rule of law: Magna Carta of 1215, the English King Charles II 1662 royal chart for the study of science, and the New York 1811 limited liability law created the perfect storm for the start of the industrial revolution around 1776-1840. Following the industrial revolution, ten percent of the world became rich and continued along that growth path. At the same time there is the vexing problem that ninety percent remain poor. If the field of economics is responsible for the rich outcomes it must bear ill will to the unfortunate ninety per percent. Otherwise, would it not by now have done more for the ninety percent? Is it possible that economics is entirely growth descriptive and can only tell us how we got to where we are?

For economics to be growth prescriptive it must tell us where wealth comes from. Extant economics tells us that wealth comes from land, labor and capital and that wealth derives from some aggregate production function such as $Q=f(K,L)$, where K is capital stock and L is human labor (Solow, 1956). Well, if wealth comes from factories, then one might well ask, where do factories come from? To answer that question, we must understand the genesis of the source of wealth. If one could suspend belief in the production function only temporarily, it would not take long to realize that all wealth comes from the ideas of imagination and creativity of the mind. To begin with, there is no such thing as an aggregate production function. A production function maps physical units of inputs to physical units of outputs from a single machine. Therefore, there can be no such thing as a macroeconomic function when the inputs are different types of items. Also, there is the fallacy of composition that we can simply jump from microeconomic conceptions to an understanding of production by society as a whole (Cohen and Harcourt, 2003).

Another problem with the aggregate production function is that K is capital stock and the function does not explain where K comes from. It turns out that K has to be a reinvestment of prior income from the conversion of human capital to income, and the production function does not in any way account for that particular original human capital. Likewise, in the production function, L is labor in which human capital is confounded with human physicality. It is not adequate to simply say that labor may be unskilled or skilled. Skills are not related to human brawn. Skills are related to human intelligence and intelligence is human capital. If human capital knowledge is learned from an entrepreneur then it is capital stock and is part of K. That is, skill is capital stock. The human being has the ability to convert skill in a seamless fluidic adaptation to a machine such that the capability of the machine is automatically expanded.

CDR Institutional Structure and the Genesis of Wealth

This leads us to consider the new Ridley (2017a) aggregate growth function $G=f(C,D,R)$, where G is living standard as measured by per capita real gross domestic product adjusted for purchasing power parity, C is the degree a capitalism (capital formation) as measured by total market capitalization, D is degree of democracy and R is degree of rule of law. Market

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capitalization includes the total value of all outstanding stocks. It is the discounted value of all future earnings. It reflects entrepreneurial human capital and all capital stock (machinery, technology, skills, knowledge taught to others and programmed into computers and stored in various recording devices), less depreciation and obsolescence. Ridley (2017a) shows the relationship between *G* and the CDRindex for 79 countries that represent practically the entire word. The CDR regression model and corresponding vexillographical chart are reproduced in Appendix BB. It turns out that the fitted CDR function is CDRindex = 1.53*C* + 0.14*D* + 0.23*R* - 1.21*C*·*D*·*R*, where *G* = CDRindex(highest *G*-lowest *G*) + lowest *G*, highest *G*=$83,066 and lowest *G*=$1,112. CDR explains 83% of the variation in *G* with a straight line. This establishes that after adjusting for country factors of production, the conversion of *C* to *G* is constant across the world. That is, the CDR model is global invariant. The conversion of *C* to *G* must obey the laws of natural science that are the same everywhere. The genesis of wealth is the human mind and wealth is realized when *R* attracts *C* and *D* deploys *C* effectively. What makes one country more productive than another is its ability to attract more *C*. In addition to the excellent statistical fit to all of the world's available data, the residuals from the CDR model (not shown) are completely random, establishing that there are no other omitted variables that would explain any systematic variations in *G*. The 17% percent of unexplained variation in *G* includes random unpredictable events such as natural disasters like hurricanes and earthquakes. It also reflects the fact that only publicly traded stocks are included in the model. There are no data available for the study of non-publicly traded private business operations that contribute to *G*.

Another temping fallacy is to assume that wealth comes from natural resources. It turns out that natural resources contribute only 6% to economic growth. We might suspect this from knowledge of mercantilism that created no wealth and only shifted some wealth from many victims to a few aggressors. And, this is confirmed by the regression in the Appendix BB and observing those rich countries that possess no natural resources. For examples consider Japan, Singapore, Hong Kong, Bermuda and Cayman Islands. The intangibles *C*, *D* and *R* when combined contribute about 13 times as much as natural resources. The true resource is the mind and the knowledge of what to do with natural resources. One is also reminded of the dangers of the Dutch disease (Auty, 1993, Ebrahim- zadeh, 2003, Girvan, 1971, Humphreys, 2005, Ross, 2001, Sachs and Warner, 2001, Sala-i-Martin and Subramanian, 2003, Wadho, 2014), also known as the natural resource curse.

Ideas, Wealth and Surplus Wealth

The process of wealth generation is depicted in Figure 1. See also Ridley (2016), Ridley, Davis and Korovyakovskya (2017) and Korovyakovskaya and Ridley (2017) on the pedagogy of entrepreneurship education. Capital *C* begins as exogenous human capital with the capitalist. Smith, 1776, 2010 and Rand, 1961, 1990 suggest that a capitalist will apply their personal effort so as to maximize their benefit. And, by an invisible hand (Smith, 1776), such application will benefit society more than if it had been intended for society. Smith's only other book was on the theory of moral sentiments (Smith, 1759, 2006). Therefore, one should not assume any immorality or prevarication implied by the pursuit of self-interest. There is nothing inherently rapacious about capitalism or the capitalist. After all, we are talking about capitalism with the expressed protection of democracy and rule of law. Even in the face of immediate disaster it is best for one to help one's self first if one is to be able to help others next and ultimately. The upshot of this argument is that all rational human beings are capitalists. This is distinctly different from corruption which is eschewed by potential providers of capital (Brosnan and de

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Waal, 2014, Barclay and Stoller, 2014, Brandstätter and Königstein, 2001, Güth, Schmittberger and Schwartze, 1982, Jensen, Call and Tomasello, 2007). As far as the economy is concerned, corruption, like depreciation and obsolescence, generates dead capital. Even in the presence of perfect CDR, entrepreneurship is human capital (Skousen, 1990, Casalegno, Pellicelli, Civera, 2017) that at a minimum, must replace depreciation and obsolescence if growth is to continue.

Human capital less dead capital (due to corruption, depreciation and obsolescence) is converted via a *C* to *G* generation process. The conversion process employs people and the economy grows. Some of this growth becomes real tangible wealth of goods and services. A fraction of *G* is reinvested. From time to time technology replaces people who then become at least temporarily unemployed. Such structural unemployment can coincide with higher national income. As income increases rich societies have elected to created welfare transfer payments to unemployed people. This does not contribute to employment and further growth. Instead, it becomes dead capital (see the below section on negative income tax for a discussion on alternatives).

The *C* to *G* conversion process also includes the development of machinery and the teaching of entrepreneurial technological knowhow to other people. Faria, et. al. (2016) found that institutional effects from learning and developing human capital can be highly significant. Just as division of labor creates surplus capital (Smith, 1976), this division of human capital creates surplus wealth. Machinery, computers, recording devices and knowhow stored in human minds, collectively constitute capital stock. Reinvestment involves the development and deployment of capital stock and must be distinguished from entrepreneurial capital. Entrepreneurial capital is exogenous and capital stock is endogenous. Human capital is all capital associated with the human brain. All human labor is associated with brawn. This operating definition of homogenous labor is consistent with the original theory of comparative advantage (Ricardo, 1817). When physical machine capital and labor (human capital + human physicality) meet, all relevant human capital is transferred to the machine capital such that the machine capacity might increase. Human capital that is irrelevant or made irrelevant through disuse or misuse is for all practical purposes dead capital. It is for this reason that a negative income tax is introduced below.

The role of chemical catalysts was first suggested by Berzelius (1779–1848). *D* and *R* provide a similar function in the economic catalysis that lowers the effort required to convert *C* into *G*. While *R* produces the stability and security that attracts *C*, *D* creates additional pathways via which human decision making can deploy capital effectively. *D* and *R* are heterogeneous exogenous catalysts. Heterogeneity permits these catalysts to exist in different structures from capital and raw materials, etc. At the end of an economic cycle, *D* and *R* are not used up like raw materials in a manufacturing process. They are not themselves converted into anything else. They remain intact, ready for continuous use in the next cycle. They are determined entirely by leadership decisions that actively guard against dictatorship and corruption. The only meaningful way for a country to raise its *G* is by raising its CDR index. This is accomplished by the democratic election of government and corporate officers by citizens and shareholders respectively, and by employee participation in capital projects, services and operations.

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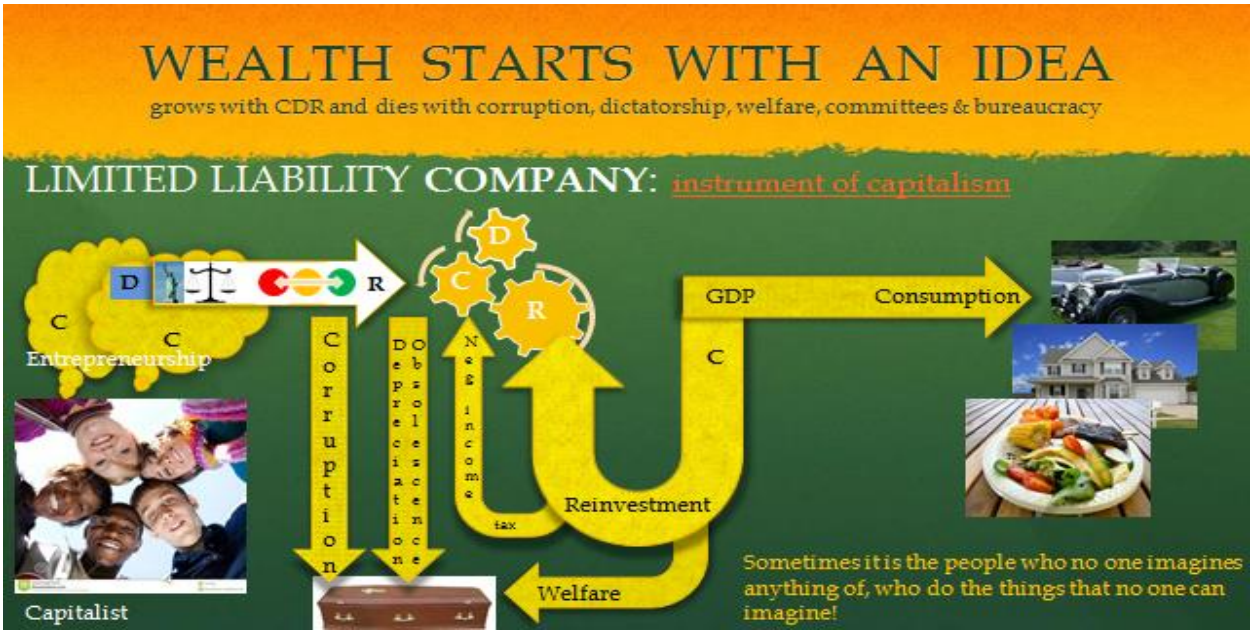

Figure 1. *C* to *G* generating process in the presence of *D* & *R* catalysis. Red signals failed *D* & *R*, green signals successful *D* & *R*.

Negative Income Tax and Micro Intrapreneurship

One of the problems with economic success is what to do about workers made indigent due to displacement by technology. No rich country wants to be defined by its poor. Many countries have instituted minimum wage laws. But, none of them has overturned the economic law of demand which stipulates that when the price of labor rises the quantity demanded falls, ceteris paribus. Minimum wage laws only serve to make the least qualified persons unemployable (Sowell, 2015). So, rich countries have instituted welfare for the unemployed. Still worse, to quote Friedman, 1921-2006 "Welfare programs involve some people spending other people's money for objectives that are determined by still a third group of people. Nobody spends somebody else's money as carefully as he spends his own. Nobody has the same dedication to achieving somebody else's objectives that he displays when he pursues his own. Welfare is antithetical to Adam Smith's (1776) invisible hand." Friedman also saw the government welfare administration establishment as one that benefits its employees more than the intended beneficiaries. Even still worse, since the unemployed cannot contribute to the pool of human capital stock, they are reduced to dead capital. This adds insult to injury for all the people who helped to build efficient production systems in which they were previously employed.

Friedman's plan was simple. Replace the entire welfare establishment with a modified income tax return. If the income tax return shows an income that is above the minimum taxable income, the return is accompanied with a corresponding tax payment. If the income tax return shows an income that is below the minimum taxable income, the participant receives a corresponding payment from the government. This idea was praised by King (1967) "I am now convinced that the simplest approach will prove to be the most effective — the solution to

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poverty is to abolish it directly by a now widely discussed measure: the guaranteed income." While apparently simple, requiring only the existing systems for checking for eligibility, etc., it does not require any work to be performed. Even simpler is 'Universal Basic Income,' a flat amount that would be paid to all citizens regardless of their value to a potential employer. But, no work is required and once again there is no reduction of said dead capital.

Wealth is independent of population. Everybody brings their own wealth into the world. One does this through one's own human capital that sustains one's self and maintains the living standard at the population average. If human capital is not to become dead capital, each able bodied person must be employed and thereby engaged in activities that convert *C* into *G*. A negative income tax that stipulates employment can accomplish this. Furthermore, experience and acquisition of capital stock from other people will occur naturally and normally. Unemployment due to a minimum wage law can only reduce wealth generation. If the government wishes to stipulate what it considers to be a living wage, it can supplement wages in the amount of the difference between the living wage and the wage that an employer is willing to pay. This will end unemployment for anybody wishing to work. In additional to its wealth generating effect, this alternative to welfare transfer payments is more humanitarian than welfare. To the extent that the employer is willing to pay some part of the wage, the negative income tax saves the government money. The net result has to be a higher average standard of living for society.

The only source of welfare transfer payments is income from *C* to *G* generation. Such transfers might otherwise have been reinvested in capital stock. Another way is to consider them as accelerating the depletion of capital stock. Either way, it represents the creation of dead capital. Minimum wage employees will tend be low in knowhow. But, they may possess valuable human properties that are not attainable from machines. Examples of these might be creativity and interpersonal people to people customer communications skills. They may also be capable of many micro intrapreneurial contributions. The related ideas might be outside the purview of the high skilled employees and not ordinarily be noticed. One might say that the low skilled employee who is actually performing the work, even with a modicum of acuity, is quite likely to observe variances that at a very minimum can be brought to the attention of their supervisor. Low *D* low *R* will create a high noise environment in which micro intrapreneurial ideas go unnoticed. A high *D* high *R* low noise environment (Gilder, 2013, Romer, 1990) will permit detection of micro intrapreneurial ideas. The bottom line outcome is that the negative income tax minimum wage supplement could pay for itself and some. The other payoff is the experience acquired by the worker that adds to capital stock and might induce the employee to pay the full amount of the specified living wage such that there is no more need for a wage supplement by the government.

Microloans and Micro Entrepreneurship

Microloans are mentioned here in passing because of their relationship to human capital. Microloans to individual businesspersons in developing countries are successful examples of what might be considered micro entrepreneurship. Hope International (1997-2017) turned from gifting food, materials, and cash to making microloans. The gifts were all based on the ideas of the givers. The gifts only created a dependency and dead capital. Microloans attracted people with business ideas of their own and pride in those ideas. That is, human capital of micro entrepreneurship. The loans have a stellar rate of repayment with interest that match the pride of the owners of the ideas. This observation is consistent with the CDR model in which wealth

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comes from ideas and the bearers of the ideas need a suitable environment to bring them to fruition.

Unlimited Wealth

Since the industrial revolution, the economies of ten percent of the world have grown, creating immense wealth. Since wealth is created from ideas of unlimited creation and imagination (Lotto, 2017) then wealth must be unlimited. One example is the United States of America (USA) that has risen through the atmosphere and into space travel. This is just one example of indicating the potential for unlimited wealth when CDR is implemented even for a period of time that is relatively short within the scope on human existence. If the entrepreneurial component of C is the main factor, then micro intrapreneurship will further expand the possibilities. While all this is happening, ninety percent of the world continues in poverty. Of course, they need to raise their CDR.

Concluding Remarks

All wealth originates from the brain of the human being. It is represented in human capital ideas of imagination and creativity. A global invariant $G=f(C,D,R)$ model of capital democracy and rule of law accounts for almost all of standard of living. After adjusting for country factors of production, productivity is determined by the amount of capital that a country attracts. Rule of law attracts capital and democracy deploys it most effectively. Deployment involves the distribution of capital to multiple individual production units with production function $q=f(k,l)$, where k is a fraction of total capital and l is corporeal labor, and the value of the q's sum to an aggregated domestic income. Poor countries can raise their standard of living by raising their CDRindex. Democracy and Rule of law are catalysts, not used up like raw materials, and will always remain intact and available if that is what is desired. Entrepreneurship appears as quanta of innovation information that requires high democracy high rule of law low noise environment if it is to be detected. Micro intrapreneurship will require an even lower noise environment. The steady economic growth in Western Europe, Bermuda, Cayman Islands, the out of world experience of the USA space activity, the rapid post world war two rise of Japan, the recent rapid rise and success of Singapore and Hong Kong, and the promise of Botswana, Equatorial Guinea, Poland and Chile are evidence of the immense possibilities for intrapreneurial human capital, democracy and rule of law.

As countries become rich technology advances and replaces human labor. Some labor moves into higher level job functions, but some become structurally unemployed. This is exacerbated by minimum wage laws (Sowell, 2015). Welfare transfer payments as a solution ultimately makes dead capital out of people. A negative income tax can be used to subsidize employment by paying the difference between what societies consider a living wage and what an employer is willing to pay. The negative income tax can replace dead capital producing welfare transfer payments and convert them into an investment in human capital micro intrapreneurship that will pay for itself and some as work experience is gained. This experience combined with continuing education will be even more beneficial. Future research might provide a financial incentives theory for an employee to demonstrate newly acquired experiential skills, climb above the government subsidize entry level category, and impress an employer to pay the full amount of the living wage.

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CHAPTER 5

Division of Human Capital creates Surplus Wealth

Reference: Ridley (2017b).

The results of an experimental abstraction of economic development for 79 countries resulting from their proximity to the highest form of capitalist economic adaptation, democracy and rule of law is reported. A structural contribution uses a least squares regression format to isolate and measure marginal effects of institutions on per capita real gross domestic product adjusted for purchasing power parity. Instead of focusing on natural resources, poor nations can improve their economic positions along a continuum by rearranging the institutional cultural priorities of capitalism, democracy and rule of law that promote trade and entrepreneurial development within their societal borders.

Keywords: Institutional interactions; Political economy; Capital Formation; Democracy; Rule of Law.

INTRODUCTION

The idea that proper institutional blends foment the highest economic development, living standard and growth has a dearth of saliency in modern literature of political economy. North (1991) suggested that emergent economies resulted from the proper mix of social, political and economic institutions. He argued that human beings devise prescribed constraints on behavior that bind instructional interactions as a set of rules that act as a dominant ideology or what is in common parlance called rule of law. Although somewhat nebulous, rules of law comprise the codicils to a societal constitution that outline the rights of micro-agents, property rights, and statutes that limit liability when one party injures another. Alternatives to rules of law are cultural adaptations which include taboos, customs and traditions that govern codes of conduct that find their way into formal rules and laws, and thereby distinguish one society from another.

The purpose of this paper is to use the general institutional foundations of political, economic and social arrangements tied together by rules of law outlined by North, to devise a metric of marginal contributions to livings standards. Living standard is measured by per capita real gross domestic product adjusted for purchasing power parity (G) over 79 countries for which a complete set of data is available. Institutional strength is measured by proximity to the highest form of capitalist economic adaptation, democracy and rule of law. Hereinafter, the social and political institutions will be denoted: capitalism (C), democracy (D) and rule of law (R), and the regression model will be referred to as the CDR model. D and R are manmade institutions designed to improve commercial trade and the human condition. These institutions developed and evolved over many centuries (North, 1991, Acemoglu, Johnson and Robinson, 2005). But, it was not until the 1662 Royal Charter from King Charles II of England for the study of science created adequate technology, and the 1811 New York limited liability law and other versions attributable to England (1855) and Germany (1892) created the mechanism of C that C, D and R combined to initiate and facilitate the industrial revolution. It could have occurred anywhere in the world that this combination might have existed, but it occurred in England. Prior to the industrial revolution, with few exceptions, all people were poor. The exceptions were feudal lords, and beneficiaries of the 17th century Amsterdam stock exchange, the Dutch and English

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East India Companies, and certain skilled artisans. The world saw a history of unnecessary wars, invasions, looting of resources, and wealth changing hands. There was destruction of wealth but little or no creation of wealth. Toward the end of the second world war, Winston Churchill (1943) said that the "empires of the future will be empires of the mind." This was his testament to the massive and saddening waste from the war. It appears that the experience taught him to recognize that there had to be a better way for national achievement. His remark was consistent with what became a switch to massive wealth creation by the likes of General Electric, International Business Machines, Intel, Microsoft, Apple and now Google, all completely unrelated to natural resources and related wars of conquest. This is clear evidence that the source of wealth always was and still is the imagination and creativity of the human mind. The rich countries that adopted the policy of CDR became rich and continue to get richer while the low CDR countries have remained relatively poor. We attribute this to the mechanism of the *G* generating process from *C*, *D* and *R* wherein *C* is attracted to *R* and *D* releases the imagination and creativity of the human mind for the superior deployment of *C* in the generation of *G*.

This paper elucidates the wealth generating mechanism suggested in the Ridley (2016) and Ridley, Davis and Korovyakovskaya (2017) CDR model. In-country wealth distribution is an entirely different matter that is best investigated elsewhere. For example, see Piketty (2014) and Krugman (2009) that advocate government intervention and more progressive taxation of income and wealth. Better thought through concepts based on increasing economic freedom (Friedman and Friedman, 1980, Friedman, 2002, Gwartney, Holcombe and Lawson, 1999, Gwartney and Lawson 2003, Heritage Foundation, 1995-2016, Sowell, 2015, Rand, 1961, Homburg, 2015) advocate reduced government and the empowerment of people, are consistent with the CDR model, and appear to be working (Gwartney, Lawson and Hall, 2015). An extreme philosophical view on freedom is objectivist epistemology as described by Rand (1990). Whereas objectivism is the philosophy of rational individualism, democracy is the mechanism for creating new pathways that connect people. People of course may comprise rational individuals. This is useful because it is a way to deploy the human capital from which *G* is generated.

The remainder of the paper is organized as follows. First the rich and poor person dilemma is demystified since the potential wealth of a country cannot be tapped without full and willing participation of all citizens. Next, the combined *C*, *D* and *R* impact is illustrated by a vexillological chart while commonly held beliefs in natural resource, government spending, country size and population physical characteristics are dispelled.

ONE PERCENT VERSUS NINETY NINE PERCENT

The poor insist on the apocryphal claim that 1% of people get rich off the sweat of 99% of people. This ad hominem has done nothing to raise the lot of the poor. Neither has the advocacy of the rent seekers who claim to represent their interests. Piketty (2014) claimed to have discovered that return on capital is outpacing growth in *G*. The implications there are that inherited wealth will grow just by virtue that it is capital and the inheritors of wealth will simply continue to get even richer relative to the 99%. That is the 1% can sleep, otherwise take no action, and get relatively richer. A modicum of reasoning should tell us that this is impossible. Capital stock will depreciate and become obsolete. In time it will become zero. It is inexorable. Only new ideas can replenish capital and wealth. To grow, capital must be invested in new ideas that must come from somewhere and there is no reason to believe that it will not come from members of the 99%. Furthermore, such investment creates new products and services that benefit the 99%, typically on a massive scale. That is why the poor in the United States of

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America (USA) experience a living standard that is far better than that of the preindustrial revolution members of any royal family since none of them ever had indoor plumbing.

As it turns out, the 1% includes entrepreneurs who are routinely mischaracterized as intending to pursue wealth. Whether that is true or not, the entrepreneur very soon learns quite to the contrary that their life is one of long days of experimentation, design and development, disappointment, joy of discovery, and risk taking. Finally, when they create a new product, they must find ways to manufacture it in quantity and at a cost that makes it affordable to the 99%. That leaves literally no time for recreation. Assuming that wealth is the final outcome, the 1% can only live in one house at a time, drive one car at a time, eat three meals per day, etc. Therefore, the profits of the entrepreneur have nowhere to go but to investment, growth and new job creation. The 99% on the other hand enjoy an increased standard of living, labor saving devices, and more leisure time. The 1% really does sweat the details. So, they might say that the 99% live off the sweat of the 1%. The 99% should not focus on equality of income for that will surely make them unhappy. They should simply focus on equality of consumption. At any time the 99% can put a stop to all this. All they have to do is not purchase the products of the 1%.

When all things are considered, we recognize that the entrepreneur is a gift to humanity. Anything done to impede their activities can only destroy capital and threaten a return to widespread poverty.

SOME HIGH AND LOW CDR & G COUNTRIES

The regression line in Figure 1 shows the relationship between *G* and the CDR for 79 countries for which a complete data set is available (the regression model and the CDR index are given below in the section: Relative contributions to *G*). The populations in these countries represent almost the entire world. Also plotted are twenty-one countries, selected for their contrast between culture, history, population characteristics, appearances and size, income and CDR. These countries are spread wide on the world map. The diameters of the bubbles are directly proportional to the square root of population. There can be no doubt that *G* increases with the CDR Index. The scientific relationship (Prakash and Sharma, 2016) is undeniable. Country size has no bearing on *G*.

As expected, Western Europe, USA and Canada comprise high income countries. Despite differences in their types of economies, for example relatively small variations in elements of socialism and capitalism, what they have in common is high CDR and that accounts for their high G.

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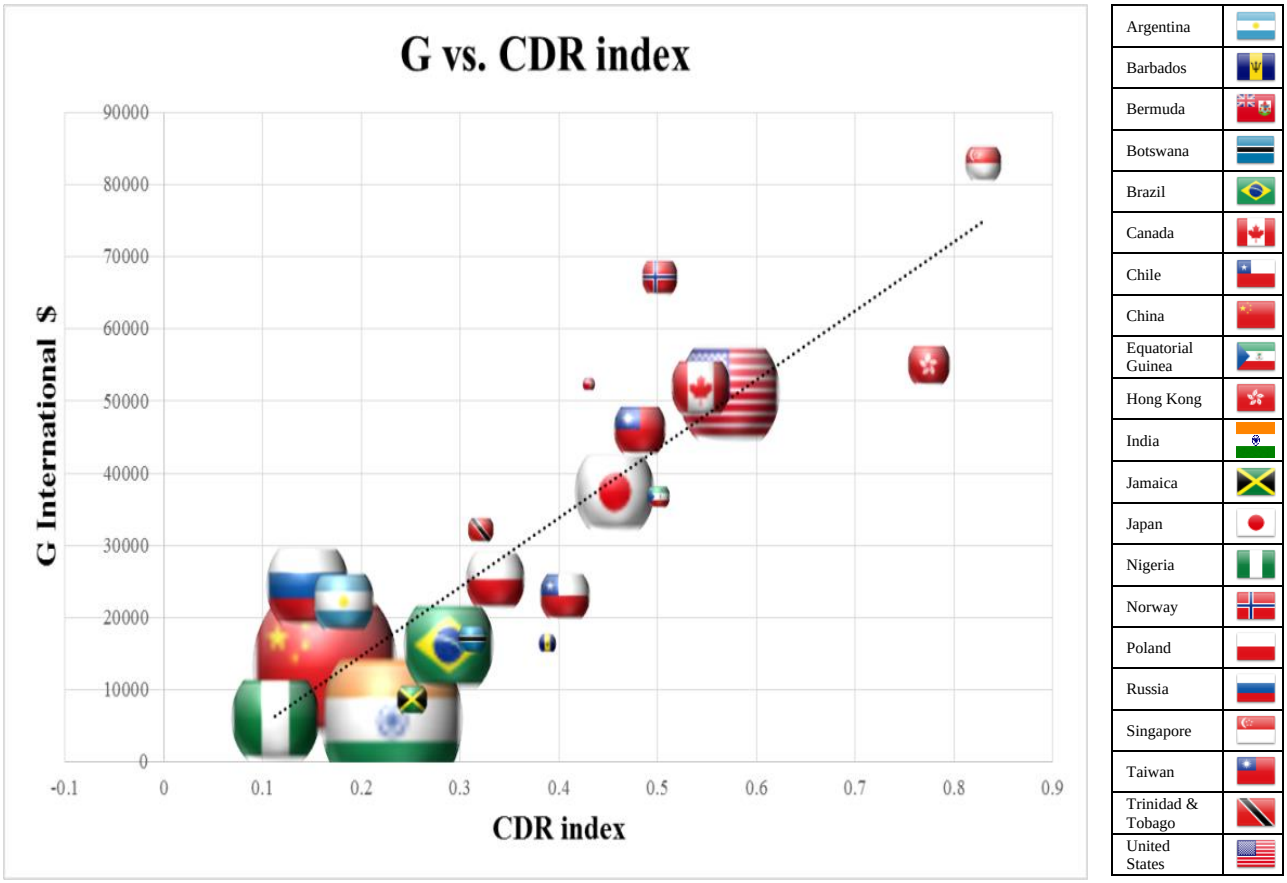

Figure 1. Year 2014 G vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population.

One of the recent surprises is Singapore with *C*=0.58, *D*=0.52, *R*=0.96. Although not the best example of democracy, together with its high ranking in *R*, the low *D* ranking is still high enough to attract capital and attain a high CDR index of 0.83. The outcome is soaring high *G*=$83,066. Another surprise is Hong Kong with *C*=0.87, *D*=0.92, *R*=0.93. Its CDR index of 0.77 is lower than that of Singapore due to Hong Kong's high negative interaction effect. That and some random negative effect unaccounted for by the CDR model yield *G*=$55,097. Yet another recent surprise is China. It has become well known for recent high percentage growth rates, albeit applied to a very low base. Because of its very large population it has a large gross domestic product. But, when adjusted for population size the *G* is low. As best as one can tell, this is attributable to its low *D* ranking, low *R* ranking and therefore low CDR index. One of the commonly held beliefs is that size matters. But, as the chart is traversed from left to right, there is no systematic change in bubble size.

One of the commonly held beliefs is in the importance of natural resources. Some countries have benefitted from the possession of natural resources. But, the benefits are much smaller than they first appear to be. Auty (1993), Sachs and Warner (2001), Ross (2001), Sala-i-Martin and Subramanian (2003), Humphreys (2005), Wadho (2014) explain many ways in which natural resources have actually been a curse. Indeed, countries with an abundance of natural resources are more often than not poor. They include for example Russia, Nigeria, Brazil, India and China, to name just a few.

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One scenario of the natural resource curse is the Dutch disease paradox (Ebrahim-zadeh, 2003). For example, Jamaica was once a leading agricultural country. A significant source of research and development with knowledge of crop rotation and the creator of numerous advanced methodologies and techniques, Jamaica was a successful agricultural producer and exporter. Then, bauxite ore was discovered. The first discovery of the red ferruginous earth called Jamaican bauxite was in 1869. Exploration and development work began in the 1940s. Exportation began in June 1952. Production increased rapidly, and by 1957 Jamaica became the leading bauxite producer in the world, with a production capacity of almost a quarter of all the bauxite mined in the world in that year. They had contracted with international companies with related expertise to extract the ore, produce alumina and place it on the world market in return for royalty payments. Alumina extraction requires massive quantities of energy. So, bauxite was sent to a cheap energy country, Canada, for hydroelectric extraction. When the bauxite entered the international market, the country's currency was upwards revalued. Currency traders were more willing to be paid in Jamaican dollars and hold Jamaican dollars than previously. It had the world's fastest growing economy. The Jamaican currency was already strong. Its currency strengthened even further. During the 1960s, one Jamaican dollar was equivalent to as many as two US dollars (Figure 2). Jamaicans could travel to Miami, USA and make purchases that were favorable to their currency. Nobody would want it any other way. As it turns out, the higher currency value raised the cost of exports and drastically reduced the country's other exports. Agriculture began to fail. Even tourism was threatened. The value of the Jamaican dollar fell steadily downward to one US dollar by 1978. Since then it continued to fall at a steady but faster rate ever since. One must ponder what the outcomes might have been had the exchange rate been right adjusted by choice earlier rather than by force as it was later.

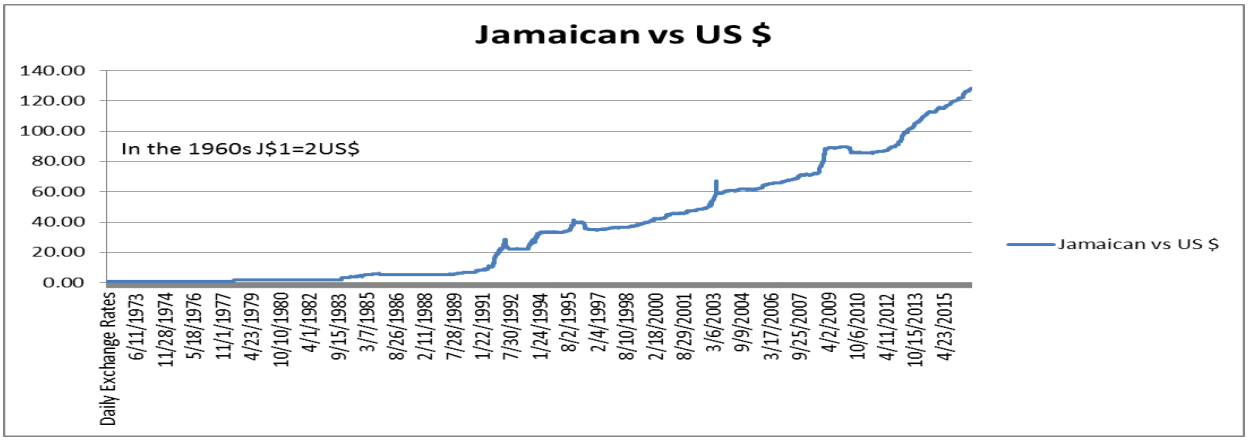

Figure 2. Jamaican vs US$.

Growth in the bauxite industry, led to rampant speculation of corruption. That was not unfounded. Theories arose on a foreign capital and economic underdevelopment enigma (Girvan, 1971). The net impact was no increase in total exports and no increase in *G*. There were numerous social ill effects (Hirschman, 1958, Seers, 1964) that gave rise to a negative impact on *G*. There was widespread loss of non-bauxite related jobs, disruption, dislocation, and social crisis. Jamaica was a democratic country with regular and vigorous elections. But, social unrest introduced violence into the election activities. Government policies long based on capitalism were traded for socialism as a means to correct perceived injustice. Rule of law declined and there was capital flight, not the least of which was an exodus of human capital in the form of

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highly educated and experienced scientist, mathematicians, engineers, and other professionals. The year 2014 numbers were *C*=0.018, *D*=0.74, *R*=0.56 as the CDR index and *G* ended up at 0.25 and $8,610 respectively.

In contrast to Jamaica that was a victim of the Dutch disease natural resource curse, Cayman Islands, a former dependency of Jamaica, until 1972 is a high CDR high *G* country. Other western countries with common histories, high CDR and high G are Bermuda, and to a lesser extent, Trinidad & Tobago and Barbados. Other former British colonies with high CDR and G are Singapore and Hong Kong in asia, and Equatorial Guinnea and Botswana in subahara Africa. Still other high *G* high CDR countries that are very different from their neighbors are Poland and Chile.

THE WEALTH GENERATION PROCESS

We can best understand where wealth comes from by decomposing the souce of wealth then examining the wealth generating process. The process is depicted in Figure 3. The system comprises CDR where *C* represents capital. *C* starts in the form of exogenous human capital that belongs to the capitalist. A capitalist is a person who seeks to deploy personal effort in such a way as to maximize the benefit to him or herself (Smith 1776, 2010, Rand, 1961). No rational person would seek less. Therefore, all rational human beings are capitalists. Potential contributors of capital can refuse to participate in a corrupt economy (see Brosnan and de Waal, 2014 on the evolution of responses to unfairness and Barclay and Stoller, 2014, Brandstätter and Königstein, 2001, Güth, Schmittberger and Schwartze, 1982, Jensen, Call and Tomasello, 2007 on the ultimatum game). Initially, exogenous conceptual intangible imagination and creativity wealth is converted to real tangible wealth through a production process. The related knowledge can be taught to other human minds as capital stock. Just as division of labor creates surplus capital, this division of human capital creates surplus wealth. *D* and *R* are catalysts that create alternative pathways and lower the effort required to convert *C* into *G*. *R* attracts *C* and *D* releases knowledge of how to deploy *C* so as to best produce *G*. Attraction and distribution of capital are orthogonally distinct features and catalysts are neither substitutes nor complements. In the absence of *D* and *R* catalysts, growth is possible but there is no new capital from entrepreneurship, capital is limited by depreciation and obsolescence, and growth is minimal. There are at least three important applications of democracy to the superior deployment of capital. One application is the election of government and corporate officers by citizens who know their own needs. A second application is the distribution of votes according to shares of corporate stock. A third application is in the numerous decisions associated with investment in capital projects, services and daily operations. This is the process by which a human capital idea is converted into wealth and capital stock that can be reinvested, minus depreciation and obsolescence. Without new human capital ideas, capital stock will decline continuously. Each new human capital idea will raise the total level of *C*. The components *C*, *D* and *R* are each of a different structure.

G that is not consumed is reinvested in capital stock and a negative income tax (see the below section on entrepreneurship and the appendix). Corruption, depreciation, obsolescence and transfer welfare payments, are synonymous with dead capital.

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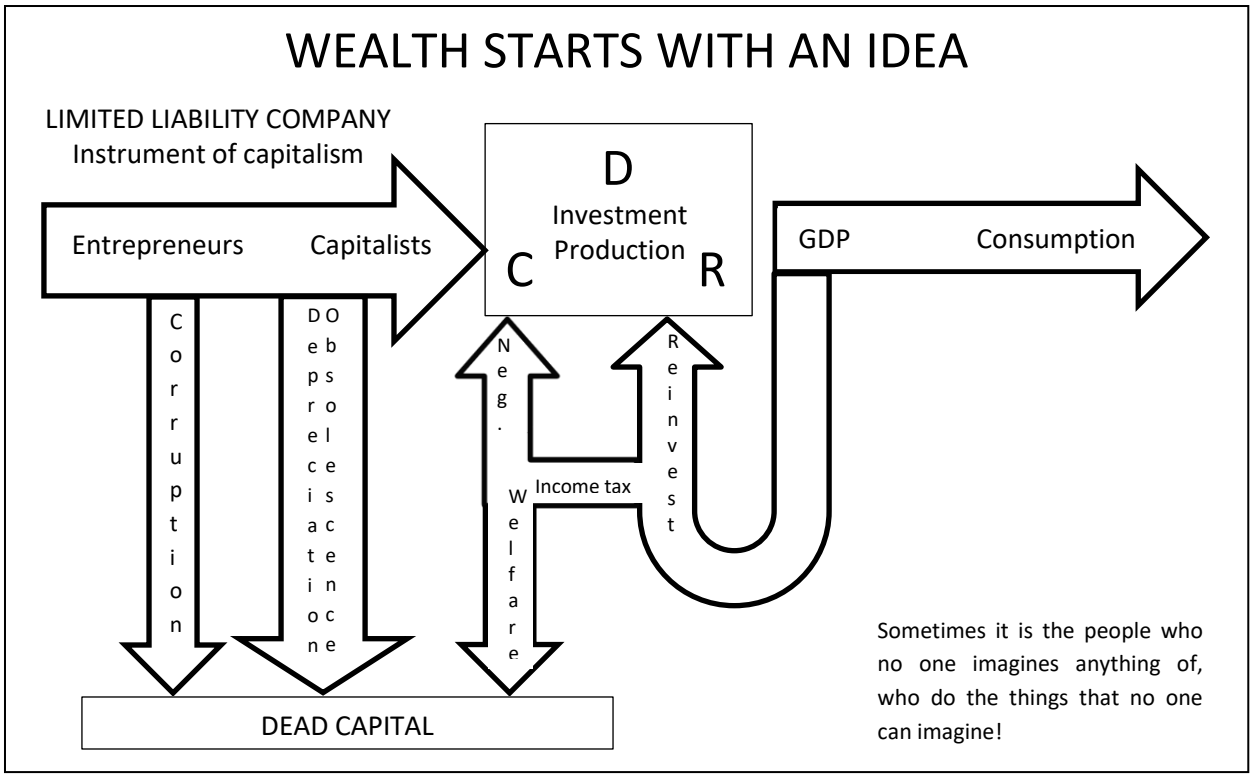

Figure 3. *C* to *G* generating process in the presence of *D* & *R* catalysis.

CDR STRUCTURES

The structure of *C* is exogenous human capital of ideas acquired from capitalists through entrepreneurship, sweat equity, and endogenous capital stock added to the stock of capital generated from prior investments less depreciation and obsolescence, measured by outstanding shares of stock that correspond to financial investment in the capital markets.

The Structure of *D* is the exogenous creation of pathways for connecting human capital through idea generation, extraction and combination.

The structure of *R* is the exogenous creation of governance that enforces contracts and property rights, and discourages corruption.

Catalysis is a term coined by Baron J. J. Berzelius in 1835 to describe the property of substances that facilitate chemical reactions without being consumed in them. Catalysis can speed up or slow down a process. Either way, the equilibrium composition of reacting components and products are the same. Homogeneous catalysts are present in the same structure as the reacting components and products. Heterogeneous catalysts are present in a different structure. Therefore, *D* and *R* must be exogenous heterogeneous catalysts. That way, they are relatively easy to separate from the product. This is important since *D* and *R* must remain robust and incorruptible by the wealth production that it facilitates. In summary, economic growth is *G* production from capital *C*, in the presence of the exogenous catalysts *D* and R. Growth is a chemical process that results in a physical stock of capital that can be reinvested together with additional human capital. The human capital component of the process is what is now commonly referred to as entrepreneurship.

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As a vignette to the foregoing account, we recognize that the human being is a most complex, fascinating and magnificent sack of chemicals. Therefore, it is quite conceivable that D and R are the chemical catalysts that create the pathways and rules that connect human beings together. A synergistic triumph in which, the whole community is indeed greater than the sum of the human beings. We also recognize the magnitude of this massive simplification and the absence of accounting for human spirit. But, we also recognize that the mere observation of the power of the connected is an inspiration in itself.

RELATIVE CONTRIBUTIONS TO *G*

To determine the relative contributions of C, D, R and natural resources (N), we standardize the variables to guarantee upper and lower bounds of $0 \leq g, C, D, R, C \cdot D \cdot R, N \leq 1$ as follows:

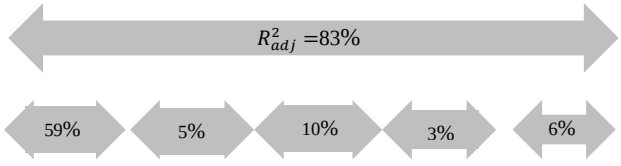
g	= (*G*-lowest *G*)/(highest *G*-lowest *G*)
G	=Per capita real gross domestic product adjusted for purchasing power parity
C (Capitalism)	= (per capita capitalization-lowest per capita capitalization)/ (highest per capita capitalization - lowest per capita capitalization)
D (Democracy)	= (lowest democracy rank-democracy rank)/ (lowest democracy rank- highest democracy rank)
R (Rule of law)	= (lowest corruption rank-corruption rank)/ (lowest corruption rank- highest corruption rank)
N (Natural resources)	= (per capita total natural resource rents-lowest per capita total natural resource rents)/(highest per capita total natural resource rents- lowest per capita per capita natural resource rents).

Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries.
G, Market capitalization, Democracy ranking, Corruption ranking and Natural resource rents are year 2014 published data from the World Bank fact book.

Then, we regress g on *C*, *D*, *R*, and *N*. The result is the estimated equation:

$$g = 1.53C + 0.14D + 0.23R - 1.21C \cdot D \cdot R + 0.38N$$

$$t = \quad (6.60) \qquad (1.69) \qquad (2.60) \qquad (4.40) \qquad (5.59)$$



where g is the per unit standardized *G* and *G* can be estimated from *G*= g (highest *G*-lowest *G*) + lowest *G*.

The above linear interactive model explains 83% of the variation in *G* (for the reader who is curious about a log linear modeling approach, the result of fitting $g = \beta_0 \cdot C^{\beta_C} D^{\beta_D} R^{\beta_R} N^{\beta_N} + random\ error, where\ the\ \beta's\ are\ output\ elasticities,$ is the very low value of R^2_{adj}=0.36). One of the commonly held beliefs is in the impact of government spending. As it turns out, when added to this CDR model, the coefficient of government spending is approximately zero, insignificant, and R^2_{adj} remains unchanged. The consilience of $R^2_{adj} = 83\%$ and random unsystematic residuals is high enough to place the linear interactive model among scientific models. The measurement of *C* is based on publicly traded stock. Therefore, the 17% that is not explained by the model is due to the inability to capture capital invested in businesses that do not have publicly traded stock. Such data are private and will always be unavailable. The contributions of *C*, *D* and *R* are positive. But, the contribution from the interaction between *C*, *D*

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and *R* is negative. The reason is that while the *D* makes a positive contribution via the deployment of human capital and capital stock, all the human decision makers will not agree one hundred percent. Any disagreement must subtract from the theoretical optimal contribution. If there were perfect agreement and the agreement was the best possible decision, then the contribution from the interaction would not be negative. From the relative contributions to *G*, we see that the greatest contribution is 59% from *C*. The contribution from *D* is 5%. The contribution from *R* is 10%. The contribution from the interaction between *C*, *D*, and *R* is 3%. The 6% contribution from natural resources is negligible, in addition to the potential for disaster due to the Dutch disease. Therefore, N is dropped and the CDR index is defined as CDRindex = 1.53*C* + 0.14*D* + 0.23*R* - 1.21*C*·*D*·*R*. The CDR index is the vector inner product (dot product) of the global constant [1.53 0.14 0.23 -1.21] and the country [*C D R C*·*D*·*R*]. If there are no *D* and *R* catalysis, growth is reduced. New capital from entrepreneurship is negligible. The only capital is capital stock from prior investments. After depreciation and obsolescence, growth is minimal. The *G* is estimated from *G*= CDRindex(highest *G*-lowest *G*) + lowest *G*.

Przeworski and Limongi (1993) reviewed eighteen economic growth versus democracy studies on various data samples ranging from 1949 to 1988 (see Adelman and Morris, 1967, Dick, 1974, Huntington and Dominguez, 1975, Weede, 1983, Kormendi and Meguire, 1985, Kohli, 1986, Landau, 1986, Sloan and Tedin, 1987, Marsh, 1988, Pourgerami, 1988, Scully, 1988, 1992, Barro, 1989, Grier and Tullock, 1989, Remmer, 1990, Pourgerami, 1991, Helliwell, 1992). The findings were distributed equally between yes and no, and no findings at all. For still more on democracy see Barro (1996) and , Przeworski and Limongi (1997). Those studies, as well as other models such as those of Barro (1996) and Solow (1956) excluded the interactive term, which inter alia, explains why the CDR model results are significantly different.

One important element that is missing from this model is the loss of capital due to natural disasters. If different countries have different but persistent geographic propensities for natural disasters, a more accurate model might be one that accounts for natural disaster reduction in *C*. Jamaica is an example of a country that is plagued by hurricanes and earthquakes.

ENTREPRENEURSHIP

The above estimated *G* function shows that the intangibles *C*, *D* and *R* contribute approximately (59+5+10+3)/6≈13 times as much as the tangible natural resources to the explanation of *G*. In addition, the above discussion on the Dutch disease reveals how natural resources can create more problems than they solve. The wealth generating process wherein *C* is converted to *G* in the presence of the catalysts *D* and *R* creates a stock of capital that can be reinvested. But, that is based on old knowledge about the past. Any further annual increase in *G* must come from new ideas (discovery of natural resources (*N*) and other new disruptive unexpected ideas), otherwise known as entrepreneurship. Entrepreneurship is about the future. However, entrepreneurship comes in the form of quanta of information that must get noticed if they are to serve any purpose. To be noticed entrepreneurship requires a low noise channel. The entrepreneurship signal must be relatively high and the *D* and *R* must promote a low noise channel. A high signal to noise ratio is required (Gilder, 2013, Romer, 1990). Low *D* and *R* serve only to promote a high noise channel of infighting, unproductive conflict, and social disequilibrium through which the entrepreneurial information cannot pass, and goes unnoticed. This wealth maintenance positive equilibrium positive *G* disequilibrium CDR benefit enigma appears to elude poor countries.

After the CDR index has been raised, there are any number of innovations that if implemented will lift millions of people out of poverty. Such results can be attained in a

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relatively short period of time. In addition to the remarkable entrepreneurial breakthroughs, there are numerous small contributions that create wealth. These come from many sources, especially people who are employed. Since wealth begins with human capital contribution to *C*, a negative income tax can raise employment, experience gathering, and contribution to wealth (see Appendix). Further enhancement innovations that involve high technology will require a very knowledgeable community that must be attained through education and will take more time. But, the journey is as rewarding as the planned end result. In any case the end result will be routinely upward revised as new ideas are created. That is, there is no finite end.

WEALTH IS UNLIMITED

Since wealth is the creation of the human mind, and since ideas are unlimited (Lotto, 2017), it follows that wealth is unlimited. The clear evidence for this is that countries that adopted what we present here as the CDR method, have increased their wealth continuously since the industrial revolution. They have gotten richer and richer to the point of, for example, the USA rising out of and beyond the world in which it began, through the atmosphere, and into space. Space travel is only the first indication of the potential for limitless growth.

CONCLUSIONS

In order to progress, the poor need no longer be rancorous. No longer be implacable in the belief that wealth can only be created through rapacious capitalism, colonialism and subterfuge. Likewise, it is best to end the euphemisms and pretense that colonialism ever created wealth when all it did was transfer property by force. The truth is that all rational people are capitalist and capitalism is the best way to deploy creativity for the benefit of all. If wealth is all in the mind and creativity is unlimited, then wealth is unlimited. It follows that all country wealth will approach infinity. As clear evidence of this, we have seen that the high CDR countries (Ridley, Davis, Korovyakovskaya, 2017) have already attained a living standard that is out of this world. The USA has gone beyond the end of the atmosphere and into outer space. It does not matter where a country starts. Once CDR is implemented, even the smallest increments of growth are followed by more, with no foreseeable limit. There is nothing to suggest that low CDR countries should not leapfrog over steps that are already well known in high CDR countries. For example, land line telecommunications systems can be foregone in favor of wireless cellphone systems. There is no need to trot out obsolete medicinal cures when better ones are known. This suggests that a country should adopt and raise its CDR, paying great attention to high CDR countries as a strategy to acquire and contribute to the most modern technologies that are suitable and relevant to them. Just as division of labor creates surplus capital, division of human capital creates surplus wealth. However, the theory of phenomenological learning (Biesta, 2012) implies that the way in which democracy releases knowledge from each individual human being is inimitable. So much so that low CDR countries may have to develop democracy in their own culturally unique way. Fortunately, never before have low CDR countries had as much access to high technology computer color graphics animated simulation learning tools and systems that permit accelerated individual learning.

Since the perspicacity and capital that started in the human brain and was converted to capital stock depreciates over time, there is never a final winner in a capitalist system from the beginning to the end of time. Capital gain and loss is a continuous process that continues indefinitely. Leaders at one point in time that stop generating new ideas eventually fall behind

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new and emerging leaders. The change in position is due in part to depreciation of the prior leader's capital, obsolescence of old capital when compared to new capital from various sources and the acquisition of capital by the new leader. Furthermore, since wealth is infinite, it matters not who the leader is so long as the laggers are improving their wealth. So long as both leader and lagger are creating capital, the world economic pie increases to the benefit of all. This understanding is the inspiration for poor countries to proceed with an optimal plan to raise their CDR, and for rich countries to assist them in raising their CDR (Ridley, 2016, Korovyakovskaya and Ridley, 2017, Ridley, Davis, Korovyakovskaya, 2017).

The only true natural resource is the human mind. What are commonly referred to as natural resources only became resources when the human mind thought of their applications. As one such natural resource is depleted, another is discovered. For example, fossil fuels have already been replaced in part by uranium, which may be replaced by thorium. We will always think of something, if only we think. If we do not think, we will think of nothing.

APPENDIX: Negative Income Tax

Sometimes technology will outperform human beings thereby creating structural unemployment. This is a good argument for a government administered welfare program and a minimum wage policy. However, "Welfare programs involve some people spending other people's money for objectives that are determined by still a third group of people. Nobody spends somebody else's money as carefully as he spends his own. Nobody has the same dedication to achieving somebody else's objectives that he displays when he pursues his own. Welfare is antithetical to Adam Smith's (1776) invisible hand." (Friedman, 1912-2006). See also Friedman (1987). As it turns out, welfare is the perfect mechanism for creating rent seekers who use the resources of the government (or company, organization, individual) to obtain economic gain from others without reciprocating any benefits to society through wealth creation. Friedman's simplest plan was simply to replace the entire welfare establishment with an income tax return. Whereas a positive return above a specified amount might be accompanied by a tax payment to the government, a return that is below the specified amount would be accompanied by a tax receipt from the government. Simple but does not require any work to be performed.

The idea of negative income tax was proposed as early as the 1940's. But, the first major experiments were performed in New Jersey and Pennsylvania, USA. Subsequent experiments were conducted in Iowa, North Carolina; Indiana; Washington; Colorado, USA; and Manitoba, Canada. The negative income tax is distinctly different from 'Universal Basic Income,' a flat amount that would be paid to all citizens regardless of what an employer would value them were they to be employed. This would be a type of welfare payment that requires no work to be performed and cannot inject human capital entrepreneurship into the economy via the workplace.

We have established that wealth is a function of CDR, independent of population. This means that the population generates wealth through ideas that are sustaining their standard of living. That is, on average, additional population creates additional wealth. Unlike other proposed negative income taxes, what is suggested here is a negative income tax that involves people working, gaining experience, and thereby enhancing the probability of having ideas that contribute to self-sustaining wealth. Since ideas are the sole source of wealth, it is critical to enable a population's ability to contribute sufficient wealth to maintain its standard of living. A minimum wage that exceeds what employers are willing to pay is certain to raise the unemployment rate and potentially reduce wealth generation. Alternatively, a government wage supplement equal to or greater than the difference between the minimum wage and what

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employers are willing to pay will end unemployment for all who wish to work. Such an effective negative income tax will facilitate potential wealth generation, while satisfying any justifiable humanitarian cause associated with the welfare portion that it replaces. It is also cheaper for the government since the employer will pay part of the cost associate with any prevailing minimum wage, up to the custom value that the employee is worth to the employer.

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CHAPTER 6

Determinants of Gross Domestic Product – a new perspective

Reference: Ridley (2019).

A parsimonious measure of the relationship between wealth and the factors capitalism(C), democracy(D) and rule of law(R) is summarized in a CDR *index. While the economic freedom index is a good economic indicator it is not designed to predict gross domestic product. The* CDR *index is a good predictor. Government spending and country-size is shown to have no effect on wealth per capita. The* CDR *effect on wealth is approximately thirteen times that of natural resources. Since government spending and the impact of natural resources on wealth are negligible, government policy must focus on building institutions for raising the* CDR *index.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship

JEL:P16

1. Introduction

The purpose of this paper is an empirical study of the relative importance and possible uniqueness of capitalism(*C*), democracy(*D*) and rule of law(*R*) for wealth generation. Much of the research in political economy is devoted to the study of poverty and how to end it. Adam Smith (1776) did not focus on poverty. One reason may be because it is well known that one way to attain poverty is simply to do nothing. What is far more challenging to explain is the phenomenon of wealth. The United State of America (US) and Western Europe charted the path of wealth that keeps on growing, while with only few exceptions like Japan, the vast majority of the world remained impoverished. Thanks to Smith (1776) we have some insight into the answer. Before we proceed, we invoke the scientific principle that places this research in the category of economic science. That is, we break down the process by which per capita real gross domestic product adjusted for purchasing power parity (*G*) is generated into its elementary components, study the effects of each then reconstruct *G* through their interaction and summation. *G* equates to standard of living. Precise definitions are summarized in the nomenclature in Appendix AA. In particular, because of the lack of definition of the term 'capitalism,' we differentiate between capitalist, capitalism and the company. In prior research these three elements were often referred to jointly as capitalism. There exist sentiments that capitalists are people who become rich at the expense of the poor. If our findings are to be acceptable as beneficial to ending poverty, the poor must recognize that all rational human beings are capitalists, and that goods producing capitalism cannot function unless it serves its customers (Adam Smith,1776), who in turn are people. Furthermore, through the indefatigable entrepreneur, capitalism works continuously towards improving quality and reducing the cost of goods to make them affordable to everybody. The net result is continuous movement toward equality of consumption, thereby making income inequality far less relevant in practice. From this perspective, capitalism is a deal that the poor just cannot refuse. Note also that we define rule of law as the opposite of corruption (Goel, Mazhar and Nelson, 2016, Czap and Nur-tegin, 2012) and the enforcement of property rights and contracts. Less corruption should increase chances for the poor.

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A good place to start is to identify some countries that are diverse in almost all ways except that they have instituted *C*, *D*, and *R*, and also enjoy the benefit of high *G*. The concept of CDR as an index was introduced by Ridley (2016) and Ridley, Davis, Korovyakovskaya (2017). The index is calculated in a *G* model given later in this paper. Examples of high *G* countries are oil free Hong Kong and Singapore; Poland, Chile, Botswana, Equatorial Guinea, Trinidad & Tobago; and natural resource free Bermuda, Cayman Islands, and Barbados. Others can be found in the data table in the appendix. Further details on how *C*, *D*, and *R* interact to generate *G* will be explained later. Suffice it for now to recognize that poor countries, even those in the immediate vicinity of the above mentioned succeeding countries have one thing in common: low *C*, *D* and *R*. That way we can quickly dismiss claims that country size, physical characteristics and natural resources are what matter. We proffer that lack of economic growth might well be debilitating, but the causes are due to a defeatist mindset. We argue that wealth comes from the mind, and while mindset is very stubborn, it costs almost nothing to change mindset. We proffer that *G* comes from the application of human capital. The outcome of a *G* generating process results in capital in the form of labor saving plant and machinery which is reinvested, minus depreciation and obsolescence, to generate additional *G*. Concomitant with this process is the process of learning that builds human capital in the form of knowledge. And, the cycle repeats. This process occurs in all countries. But, in poor countries, as much or more capital leaves than arrives, the growth cycle is routinely aborted before capital is accumulated. Also aborted is the acquisition of leisure time to think outside the box and the growth of an educated population segment. In a more formal setting leisure time can be traded for aggressive research and development. We will show that the reason is astonishingly simple. Capital is attracted to countries where there is *R*. So, what we will actually show is that high *G* countries are associated with high *R* ranking amongst all countries.

Turning now to the poor countries, consider equally diverse low *G* countries. Examples of these are Eastern European countries, those of the former Soviet Union such as Russia and Ukraine, Sub Sahara Africa and South America. Each of these formerly oppressed communities has received American aid with little to show for it. The reason is that little attention has been paid to the mindset that remained after their segregation from a modernizing world. To reconstruct confidence, this paper contributes a parsimonious model that shows that the CDR index constitutes a joint indicator for economic success and pathway to understanding the rationale and benefits of raising their CDR index. Incontrovertible evidence shows that a country must put its CDR index above natural resources. Financial aid to corrupt countries is money that will just be stolen and end up in bank accounts in high CDR countries. If rich countries wish to help poor countries, they will do best to provide aid via raising the CDR index of the receiving country. de Soto (2000) explains that property rights are sparse outside of Western Europe and the United States, and that help with a method to create property rights is the most needed type of foreign aid.

The remainder of the paper is organized as follows. Section 2 reviews the research on democracy and rule of law. Section 3 presents the $G=f(C, D, R)$ model. Section 4 analyses data for 79 countries representing almost the entire world for which data are available. Section 5 summarizes some conclusions and implications for entrepreneurship. Because of the absence of explicit definitions in the extant literature for concepts such as capitalist, capitalism, entrepreneurship and other consequential terminologies, they are clarified in concise nomenclature in Appendix AA.

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2. Literature Review

2.1 capitalism-democracy-rule of law

The following is a brief account of business and economic history before and after CDR and the corresponding times before and after the industrial revolution. The mechanism of CDR is achieved through the limited liability company (Micklethwait and Wooldridge 2003). The earliest modern limited liability law was enacted by the American State of New York in 1811. A combination of English King John's Magna Carta of 1215, English King Charles II's Royal Charter of 1662 for the study of science, the subsequent English and German limited liability laws, set the stage for the perfect storm that led to the English industrial revolution. It could have happened anywhere in the world where the prevailing conditions were to accumulate. But, as it turned out, it happened in England. Since then, it's Western European neighboring countries and their US settlers and immigrants have never been the same. Whether they realized it or not, they adopted CDR policies and amassed untold wealth.

Ridley, et. al. (2008) and Ridley and Davis (2009) reminded us that the company is among the inventions with the greatest impact on our lives. The low CDR policy countries have remained relatively poor. There were some similar starts that stopped between Magna Carta and the industrial revolution. After all, King John did renege. But, by the time Magna Carta spawned the bill of rights of the US constitution, it appears that all the other factors for sustainable economic growth were in place. We assume that all this is fairly well known by now, especially by the governments of all rich countries, and that is why they continue the practice of CDR policy. However, the unyielding duplicitous governments of poor countries refuse to end corruptive practices, and remain poor. There is much confusion in this regard. Even in rich countries, the poor and otherwise less fortunate communities and their feckless local leaders insist on blaming the rich for attaining their wealth at the expense of the poor. In reality, said low income citizens in the high CDR policy countries have by virtue of indoor plumbing, running water, and modern communications, etc., a higher standard of living than did former kings and queens who lived before the industrial revolution. The purpose of this paper is an empirical study of the relative importance and possible uniqueness of CDR for *G* generation.

Democracy and Rule of Law have been classified as political freedoms that are relevant to economic growth. While Rule of law is well established as a requirement for positive economic growth (Barro, 1996), the precise effect of democracy on economic growth is as yet unsettled in twenty two published studies on various data samples ranging from 1949 to 1990 (see Adelman and Morris, 1967, Dick, 1974, Huntington and Dominguez, 1975, Weede, 1983, Kormendi and Meguire, 1985, Kohli, 1986, Landau, 1986, Sloan and Tedin, 1987, Marsh, 1988, Pourgerami, 1988, Scully, 1988,1992, Barro, 1989, Grier and Tullock, 1989, Remmer, 1990, Pourgerami, 1991, Helliwell, 1992, Przeworski and Limongi, 1993, Barro, 1996, Przeworski and Limongi, 1997). Unlike the CDR model, none of these studies included a growth model interaction variable. The following two subsections indicate how the interactive CDR model resolved this question.

2.2 Positive vs Negative democracy

The above previous findings were split equally between positive and negative democracy effects on economic growth, and no relationship at all. To solve this problem, we present a statistical regression model that includes both a positive democracy term and a negative $C{\cdot}D{\cdot}R$ interaction term that contains democracy. The positive democracy effect applies if all other variables could be

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held constant. By definition, democracy must permit disagreement. The negative *C·D·R* effect shows the logical friction between capitalism, democracy, and rule of law that is to be expected while all three make significant contributions to explaining *G*. Democracy permits participation by investors who naturally insist on proportional voting rights. Democracy empowers the common citizen whose vote counts the same as the most important citizen. This has a positive impact on *G* as it releases human knowledge and enables problem solving brain-ware. However, in a proportional representation democracy where 51-99% percent make the decisions and 1-49% disagree, the resulting friction regarding the prevailing rules and the capital deployment decisions, must generate some negative *C·D·R* contribution to *G*.

2.3 Economic Freedom

One of the arguments for *D* and *R* has been its promotion of economic freedom that in turn, has been demonstrated to improve standard of living. The following is a review and discussion of the pros and cons of the CDR index and the economic freedom of the world index (EFW), and the reasons for proposing the CDR index.

The Liberty Fund conferences that were held between the years 1986 to 1994 introduced the EFW. The purpose of the index is to track advancement in economic freedom, prosperity, and opportunity, and to promote these ideas (Gwartney, et. al. 1999, Scully and Slottje, 1991, O'Driscoll et al., 2001, Hanke and Walters, 1997, and Messick, 1996). The Heritage Foundation (1995-2016) also publishes an economic freedom index that is calculated from 50 equally weighted independent variables that are grouped into 10 major factors. Equal weights tend to mask their relative importance. That in turn makes it unclear as to where to apply effort to raise the index. Gwartney and Lawson (2003), Leblang (1996) and Keefer and Knack (1997) suggested the addition of property rights to the index. Property rights are a compelling feature for economic growth. But, they are a complex legal proposition, the extent of which the average person might not fully understand. On the other hand, the concept of fairness and justice are intuitive. Also, unlike animals, human beings possess a rich vocabulary of language that enables them to master the art of gossip (Harari, 2015). Through that mechanism, they are able to communicate observed incidents of corruption, and translate them into their opinion on how it deprives them of fairness and justice. In any case, in this paper, we define rule of law as the opposite of corruption, and expect it to capture the impact of property rights.

To minimize disagreement among countries, Lau and Lam (2000) suggested using variable weights to construct an economic freedom ranking. Still, some of the 50 endogenous variables are difficult to or impossible to improve exogenously because there is no access to their mechanism for government to implement national policy. That renders them only descriptive. Furthermore, the EFW index is not intended to predict *G* (de Haan and Sturm, 2000). Gwartney, Holcombe and Lawson (2006) used the EFW to obtain an R^2_{adj} =52.5%, considerably lower than the 83% obtained from the CDR index reported in this paper. Other advocates of economic freedom include Hayek (1944), and even more so Friedman (2002). Advocates of institutional economics include Hamilton, 1919, North, 1991, Hodgson, 2000, Acemoglu, Johnson and Robinson, 2005, and Gilder, 2012, 2013, 2016 (see also Stirati, 2015). Advocates of fiscal government spending include Keynes (2007) and Samuelson and Nordhaus (2009). But, Connors and Norton (2012) found a negative link between government spending and economic growth. In this paper, the *G=f*(*C, D, R*) model includes *D* and *R* institutional variables but excludes government spending because it had no effect on *G*. The effect of government spending was investigated by adding a variable for government spending to the *G* model. It turned out that it had absolutely no effect on R^2_{adj}. Since

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government's only source of revenue is taxation, it appears that taxation and government spending are offsetting. Furthermore, they do not contribute to economic freedom. As an aside, note that the administrative costs of *D* and *R* are relatively small enough to be negligible. Therefore, the government related expense of *D* and *R* need not be explicitly included in the model. Since *D* and *R* are catalysts, they facilitate but do not generate *G*, and are not consumed by the *C* to *G* generation process. Also, the inclusion of a *C·D·R* interaction term in the model explains why the result (no government effect) is different from other models (e.g. Gwartney, 1999 positive vs Connors and Norton, 2012 negative government effects) that do not include an interaction variable.

The parsimonious CDR model requires only 3 variables to explain most of *G*. That is, compared to 50 descriptive variables in the freedom index. Unlike the freedom index, the coefficients in CDR are optimal global constants that are weighted by country *C*, *D* and *R* to explain and predict *G*. The *C*, *D*, and *R* variables are more easily understood than the freedom index. They are also more easily accessible. They are easier to increase via exogenous government policy. Since they are manageable, they are prescriptive.

2.4 Direction of causality

In the CDR paradigm, *C* is measured by total market capitalization and is the total value of all outstanding publicly traded stocks. *C* is equal to exogenous human capital of entrepreneurship (ideas of imagination and creativity) plus capital stock. It is expected that some fraction of *G* generated from capital may be reinvested in capital stock, less depreciation and obsolescence. But, that fraction too is exogenous because it is a management decision that is external to the *G* generating process. And, in the absence of new entrepreneurship, capital stock will diminish and eventually disappear. Prior to disappearing, capital stock may be considered endogenous. However, the total exogenous and endogenous capital are converted to *G* and must be used as predictors of *G* in any *f*(*C*,*D*,*R*) regression model. The coefficient of *C* may be biased due to the endogenous component, but the model can still be an efficient predictor of *G*.

The above prior findings were also unsettled regarding the direction of causality between economic growth and democracy. But, *D* and *R* are freedom variables and Gwartney, Holcombe and Lawson (2004, 2006) showed the direction of causation to be from EFW to GDP. *D* and *R* are exogenous utilities, the decisions on which are made by elected government leaders and managers. People and governments make choices. They cannot decide to have wealth. Wealth is determined in the marketplace. However, there is no wealth requirement to acquire a desire for liberty and justice for all. *D* and *R* can be implemented severally or jointly, independently of wealth. Their implementation creates market capital through the confidence that they generate. Market capital enables the *G* generation process. So, we see that *D* and *R* are catalysts that facilitate *G* generation while remaining unchanged by the process. *D* and *R* are not consumed and are available for the next and all subsequent cycles of the *G* generating process.

3. Methods: Estimating the CDR Index

3.1 Standardized g model

The ordinary least squares *G* model is specified as follows:

$$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \beta_N N + \varepsilon$$

where, the intercept β_0 and the coefficients β_C,β_D, β_R, β_{CDR},β_N are all dimensionless,
ε is a random, normally distributed error with a mean of zero and constant standard deviation,
and where all model variables are standardized as follows:

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g $= \frac{G - \text{lowest } G}{\text{highest } G - \text{lowest } G}$

G = per capita real gross domestic product per capita (PPP)

C(Capitalism) $= \frac{\text{per capita capitalization} - \text{lowest per capita capitalization}}{\text{highest per capita capitalization} - \text{lowest per capita capitalization}}$

D(Democracy) = lowest democracy rank − democracy ranklowest democracy rank − highest democracy rank

R(Rule of law) = lowest corruption rank − corruption ranklowest corruption rank − highest corruption rank

N(Natural resources) $= \frac{\text{per capita total natural resource rents} - \text{lowest per capita total natural resource rents}}{\text{highest per capita total natural resource rents} - \text{lowest per capita total natural resource rents}}$

These transformations standardize the variables and ensures upper and lower bounds on $0 \leq g, C, D, R, C{\cdot}D{\cdot}R, N \leq 1$.
This sets up the construct of the CDR index to permit estimation of G in any year for any country by inverse transformation when the highest *G* and lowest *G* are known for the year.
The corresponding source data are listed in Appendix A. Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries. *G* is measured in $/capita/year.

4. Data and Analysis of results

4.1 Fitting the g Equation

The data for fitting the year 2014 *G* model are given in Appendix A. The fitted *G* equation for 79 countries representing almost all people in world for which a complete data set is available is shown below. The model was re-estimated for years 1995 through 2016 for which data were available and the results were approximately the same. The estimation of 6 coefficients leaves 79-6=73 degrees of freedom for error. The estimated intercept (not shown) turned out to be 0.00. That is, with all variables standardized to 0-1, then with no *C*, *D*, *R* or *N*, no *G* is generated. The t values are student t statistics, from which we see that all estimated regression coefficients are non-zero at a 10% ($|t \text{ statistic}| > t_{0.1,73}=1.67$) level of significance. The model explains 83% of the variation in *G*. That is, 17% is unexplained by the model. An examination of the residuals from the model (in Appendix B) shows that they are normally distributed and completely random. There is no indication that any systematically varying part of the model may be missing. Therefore, it is possible that none of the 17% of unexplained *G* can ever be explained. They may be due to purely random elements that cannot be measured. Also, those random elements could theoretically be made up of capital that is invested in businesses that are not publicly traded, and for which data are not available. The F ratio = 81 > $F_{0.01,5,73}=3.28$ indicates that there is a fit at a 1% level of significance. There is only a 1% chance of reaching this conclusion erroneously. If only *C*, *D*, *R*, *C·D·R* are included in the model, R^2_{adj} = 0.77. The F ratio=66.3 > $F_{0.01,4,73}=3.58$ indicates that the CDR model, is a good fit at a 1% level of significance. Therefore, we conclude that variations in *G* are accounted for by the CDR index.

$\hat{g} = 1.53C + 0.14D + 0.23R - 1.21C{\cdot}D{\cdot}R + 0.38N$

t= *(6.60)* *(1.69)* *(2.60)* *(4.40)* *(5.59)* F ratio = 81.

Partial correlations (contributions to R^2_{adj}):

59% *5%* *10%* *3%* *6%* *R^2_{adj}=83%.*

where ^ denotes estimated or fitted value and *G* can be estimated from
$\hat{G} = \hat{g}$ (highest *G*-lowest *G*) + lowest *G*.
Highest *G*=83,066. Lowest *G*=1,112.
Click here for the supplemental data and calculations.

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4.2 Component contributions and causal effects

The total R^2_{adj}, is obtained by estimating the regression model with *C, D, R, C·D·R* and *N* all together. The partial correlations are obtained by estimating the regression model with *C, D, R,* and *N* separately. The partial correlation for *C·D·R* is the total R^2_{adj} minus the sum of the *C, D, R* and *N* partial correlations.

The first observation here is the negligible contribution to *G* of 6% from natural resources (*N*). It is consistent with the well-known theory of the Dutch disease paradox (Ebrahim-zadeh, 2003) that natural resources can have positive or negative effects on wealth, depending on some prevailing economic conditions (Auty, 1993, Frankel, 2000, Sachs and Warner, 2001, Ross, 2001, Sala-i-Martin and Subramanian, 2003, Humphreys, 2005, Norman, 2009, Wadho, 2014). A negative impact can occur if the monetary value of a countries currency is upwards revalued after the discovery of a natural resource, and all other exports, such as agriculture fall as a direct result. There are also numerous social ill effects that can arise with a negative impact on *G* (Hirschman, 1958, Seers, 1964). These include widespread loss of jobs unrelated to new natural resource discoveries, corruption, disruption, dislocation, and social crisis. This is a warning that natural resources can be inimical to nationally broad long run economic growth.

The largest contribution to *G* comes from C (59%). The next largest (10%) comes from *R*. The next largest (5%) comes from *D*. The next largest (3%) comes from *C·D·R*. So, the intangible CDR contributes 59+5+10+3=77%. That is, 77/6 ≈ 13 times more than natural resources. This reinforces the importance of not relying on natural resources, and focusing on CDR. It should dispel any argument that the reason rich countries are rich is because they have the resources, implying natural resources. The real resource is the mind. Even the natural resources owe their relevance to recognition by the mind, via study of the natural sciences (Kuhn, 2012). To help understand this consider the journey from the silk road to silicon valley (see Garten, 2016, Gordon(2016), and the enormous wealth and philanthropy produced by high technology companies: IBM, GE, Intel, Microsoft, Apple and Google, etc., that are unrelated to natural resources.

The CDR index is summarized as follows. The estimated country CDR index is the vector inner product (dot product) of the global constant [1.53 0.14 0.23 -1.21] and the country [*C D R C·D·R*]. Or, the CDR index = CRDs index + CDRp index. The CDRs sum index = 1.53*C* + 0.14*D* + 0.23*R*. That is, a country CDRs index = 1.53, 0.14 and 0.23 weighted by its country *C*, *D* and *R* and summed. The CDRp product index = -1.21·*C·D·R*. That is, a country CDRp index is the product of -1.21 and its *C, D* and *R*. Because all the variables are standardized to fall between 0 and 1, the CDR index will estimate *G* in any year for any country by inverse transformation when the highest *G* and lowest *G* are known for the year from $\hat{G}$= ĝ (highest *G*-lowest *G*)+lowest *G*.

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4.3 Marginal Contributions

Since the *G* model is a cross country model, the parameters are global constants. The *C* to *G* generating process is constant at 1.53 for all countries. The efficiency of the means of production varies from country to country. But, since the model explains all systematically varying *G*, the only errors are entirely random, not attributable to any between country variations. So, the parameter pertains to the technology of the conversion process after adjustments for country factors of productivity. Any differences in human skills are absorbed into capital. A country that is 'perceived' to have better means of production, is really one that attracts or otherwise possesses more capital. The higher capital (not the process) is what is responsible for the higher *G*.

The contribution to *G* depends on a wide variety of combinations of *C*, *D* and *R*. For purposes of simplicity, assuming that they rise together, then estimated contributions for different levels of *C*, *D* and *R* are plotted in Figure 1. The marginal return on the expected per capita market capitalization $\partial E(\hat{g})/\partial C = \hat{\beta}_C + \hat{\beta}_{CDR} D \cdot R$ =1.53-1.21·*D*·*R*. Estimated marginal returns for different levels of *D* and *R* are plotted in Figure 2. For the particular scenario depicted in Figures 1 and 2, for the most part, the contribution to *G* increases as *C*, *D* and *R* increase. The contribution increases at a declining rate. Above about 0.75, there is less contribution to *G*.

The purpose of Figures 1 and 2 is to describe global characteristics, not any one country. It would be pure chance if any country were to match these *C*=*D*=*R* or *D*=*R* configuration exactly. However, it just so happens that Denmark has the global characteristic of being highest on both *D* and *R*, so their *D*=*R*=1. For them, marginal return on *C* is approximately 0.3. Their *C*=0.3, so their *C*·*D*·*R*=1.0x1.0x0.3=0.3. The *D*·*R* multiplier in this product just happens to be 1.0 and has no effect. For them, contribution to *G* is 0.53.

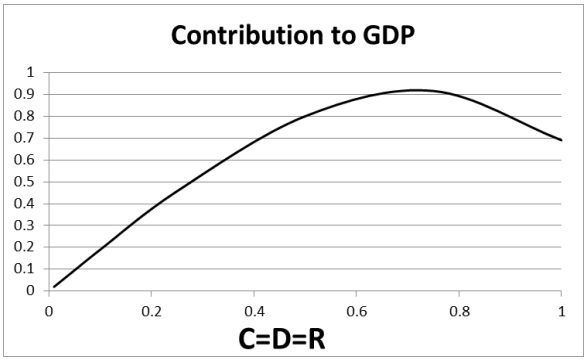

Figure 1.

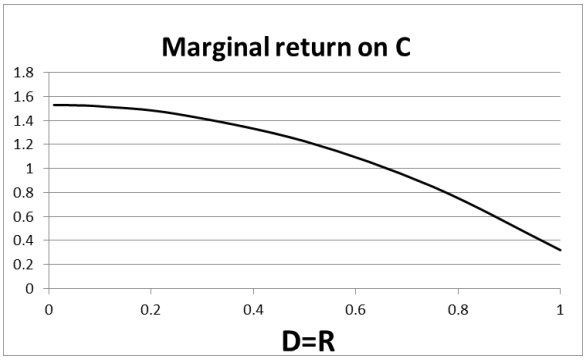

Figure 2.

4.4 G Generating Mechanism

The way that *G* is generated is as follows. Consistent with the explanation given in the previous section on direction of causality, *C* is a partially exogenous and partially endogenous variable and *D* and *R* are exogenous catalysts. *C* is measured by market capitalization which represents discounted future earnings. Therefore, the CDR model takes into account the impact of *C* on *G* in current and all subsequent years. Investment capital, not the least of which is foreign direct

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investment, eschews uncertainty. So, *R* attracts *C*. Knowledge is mined through *D*. Each in their own way, *D* and *R* operate as catalysts to create additional pathways and lower the effort required for the elements of *C* to work in the generation of *G*. But, *D* and *R* do not take part in the *G* generating process. They are not consumed. Instead, they remain unchanged and available for the next and subsequent cycles of the process. As the process repeats via continual reinvestment, wealth builds in the form of assets, including knowledge, minus loss of *C* due to depreciation and obsolescence. *D* and *R* provide economic benefits. The un-harmful side effects include social equilibrium, less crime, investor confidence, and fighting the Dutch disease.

4.5 Graphical Analysis

The relationship between *G* and the CDR index for 79 countries representing nearly all people in the world for which data are available is shown in Figure 3. Of the 79 countries listed in Table A1 (in Appendix A), 21 countries were selected for further analysis (bubbles). More than 21 countries would create more clutter than clarity. They were selected to illustrate contrast between culture, history, population characteristics, appearances and size, income and CDR. These countries are all over the map. The sizes of the bubbles depict population, where the bubble diameter is proportional to the square root of population.

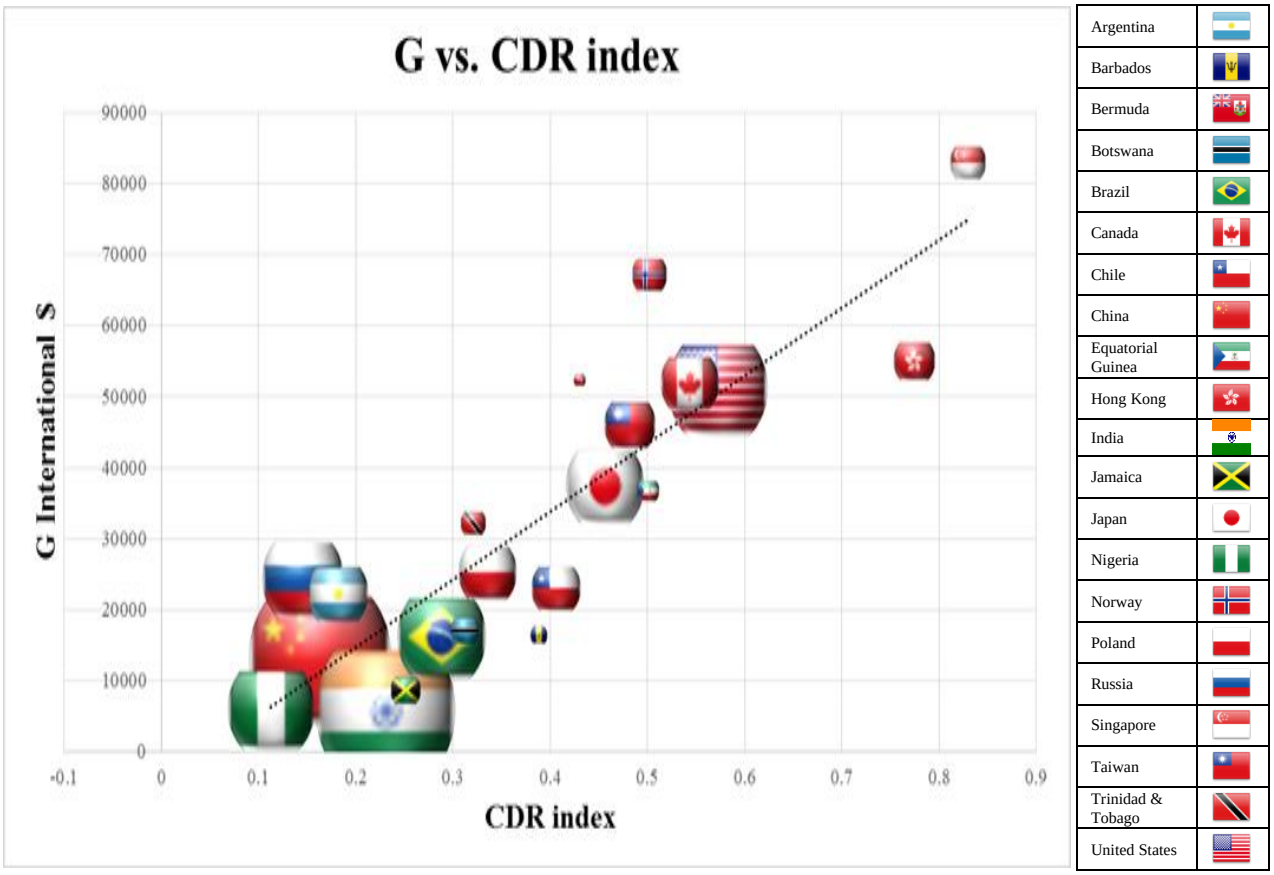

Figure 3. Year 2014 *G* vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population.

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It is quite astonishing how clearly *G* increases with the CDR Index. The model fit is no less than excellent. It is quite apparent that country size has no bearing on *G* (see also Simon, 1977, 1987, Bauer, 1972). As the chart is traversed, there is no systematic change in the size of the bubble. A closer examination shows that natural resources have little if any bearing on *G*. For example India, Brazil, Nigeria and Russia have abundant resources. Yet, they are low in *G*. What they have in common is low CDR. On the other hand, Norway does have abundant oil and has high *G*. The only difference appears to be that it has high CDR. Singapore and Hong Kong are void of natural resources yet they have high *G*. What they have in common is high CDR. Equatorial Guinea data are not reported and its CDR is estimated for this graph, based on written reports of its introduction of democracy. Botswana and Equatorial Guinea are included because they are sub Saharan African countries where corruption was rampant and where political elections and rule of law were introduced and *G* increased (see also Toh(2016)). That is, they made a start. Poland, Chile, Botswana and Equatorial Guinea adopted CDR policies and have broken quickly away from their respective geographic neighbors. Cayman Islands (not shown) and Bermuda, are small but are greater long standing beneficiaries of CDR than otherwise similar Caribbean islands. Bermuda and Hong Kong data are not reported because they are too small in size so their CDR data were set to that of the United Kingdom, their former governing country. Other Caribbean CDR notables are Trinidad & Tobago and Barbados.

4.6 Entrepreneurship and new G

The fitted *G* equation demonstrates the correlation between *G* and *C*, *D*, and *R*. The statistical correlation is indisputable. While it does not prove causation, it does rule out any suggestion that there is no relationship. It does serve as support for the causation explained earlier. In addition to sustainable wealth generation from accumulated capital, there is the recurrence of the genesis of wealth which is human capital. The accumulated capital for systematic wealth generation will not only depreciate; it will become obsolete over time. Therefore, sustainability requires the new idea innovations of entrepreneurship. Entrepreneurship is human capital (Skousen, 1990, Casalegno, Pellicelli, Civera, 2017) that at a minimum, must replace depreciation and obsolescence if new growth is to continue. The Solow (1956) production function of capital and labor is based on a stock of installed equipment, not *C* that is required for determining growth due to new innovation. Also, whereas it is presented as an aggregate production function, Ridley and Ngnepieba (2018) show definitively that there is no such thing as an aggregate production function.

The signaling of a new entrepreneurial idea requires a high signal and the low noise environment (Shannon, 1948, Romer, 1990, Gilder, 2013) of high *D* and high *R*. Technology is an outcome of intellectual activity. Therefore, as random and otherwise unsystematic as discovery may be, the genesis of wealth creation is its indirect product of the imagination of the mind and study by the mind. “Since new developments are the products of a creative mind, we must therefore stimulate and encourage that type of mind in every way possible (Carver, 1864-1943).” Low *D* low *R* countries have the characteristics of chaos, continuous putting out of fires, unsettlement of disputes, corruption and low educational attainment, etc. Entrepreneurship will avoid such countries. Indigenous entrepreneurship will migrate to high *D* high *R* countries.

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5. Conclusions

Since the company is the instrument of capitalism (business capitalization) and entrepreneurship is new company creation, expansion or innovation; and since prerequisites for investment include democracy and rule of law; one must conclude that entrepreneurship is correlated with CDR. Countries such as those of the former Soviet Union (Korovyakovskaya and Ridley, 2017), Sub Sahara Africa, South America and communities such as formerly oppressed minorities in the Unites States of America appear to be frozen in time with regards to entrepreneurship. Each of these communities has received American aid with little to show for it. The reason is that little attention has been paid to the debilitating mindset that remained after their segregation from a modernizing world. This is despite the fact that many universities have introduced entrepreneurship education to raise the capabilities of practicing managers.

To reconstruct confidence, this paper proposes a new concept (a CDR index) to show that capitalism, democracy and rule of law (CDR) constitute a joint indicator for economic success and pathway to understanding the rationale and benefits of entrepreneurship. Incontrovertible evidence shows that a country must put its CDR index above natural resources. The paper recommends incorporation of this CDR index in an appropriate integrative pedagogy for entrepreneurship education designed to raise CDR and positive entrepreneurial mindset. It also recommends that poor countries adopt a policy to raising their CDR index instead of bemoaning the lack of natural resources and location which cannot be changed.

We agree with Barro (1996) that rich countries should export democratic and other economic freedom institutions to poor countries, provided that they do so for free. Also, it must be expected that certain elements of democracy will vary in purely stylistic features. It is only important that freedom of choice and justice prevail. This is a plus sum proposition. This type of aid should be an easy decision for rich countries, because if anywhere in the world, somebody produces a product with the same quality at a lower price, or at the same price with higher quality, the world’s economic pie must increase to the benefit of both the poor and the rich countries alike.

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Appendix A

Table A1. (part 1)

Country	*G*	Capitalization	Democracy Rank	Corruption Rank	Natural resources rents (% of *G*)	Population
Argentina	22,302	25,301,170,000	53	65	3.8	43,590,400
Armenia	8,164	132,149,289	63	59	3.9	2,998,600
Australia	46,550	1,286,440,000,000	10	9	7.7	24,007,900
Austria	46,640	106,037,000,000	15	17	0.4	8,699,730
Bangladesh	3,391	26,500,000,000	68	78	3.4	159,939,000
Belgium	43,139	300,058,000,000	7	12	0.1	11,306,030
Bolivia	6,224	4,445,020,000.00	50	62	16.1	10,985,059
Botswana	17,050	4,587,518,000	34	21	3.2	2,141,206
Brazil	16,155	1,229,850,000,000	44	45	6.1	205,679,000
Bulgaria	17,926	6,625,400,000.00	39	43	2	7,202,198
Canada	44,967	2,016,120,000,000	8	8	5.2	35,985,751
Chile	23,057	313,325,000,000	19	16	16.1	18,191,900
China	13,224	3,697,380,000,000	75	61	5.6	1,375,040,000
Colombia	13,480	262,101,000,000	57	58	10.3	48,541,200
Cote d'Ivoire	3,101	8,102,600,000.00	61	68	8.4	22,671,331
Croatia	20,947	21,527,900,000.00	30	37	1.7	4,225,316
Denmark	44,625	224,856,000,000	1	1	1.7	5,707,251
Dominican Republic	14,014	140,000,000	48	67	0.5	10,075,045
Egypt	10,918	59,181,970,000.00	69	60	10.9	90,464,200
El Salvador	8,060	10,742,970,000.00	42	49	1.7	6,520,675
Estonia	27,880	2,331,962,196.50	13	18	2.8	1,311,759
Finland	40,661	158,687,000,000	2	2	1.3	5,500,146
France	40,538	1,823,340,000,000	17	19	0.1	64,513,242
Germany	46,216	1,486,310,000,000	9	10	0.2	81,459,000
Ghana	4,137	3,150,400,000.00	28	36	17.6	27,670,174
Greece	25,954	44,876,550,000.00	45	46	0.2	10,846,979
Hungary	25,019	20,760,180,000.00	29	30	0.6	9,849,000
India	5,808	1,263,340,000,000	43	53	5.9	1,284,960,000
Indonesia	10,651	396,772,000,000	52	64	7.6	258,705,000

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Table A1. (part 2)

Country	*G*	Capitalization	Democracy Rank	Corruption Rank	Natural resources rents (% of *G*)	Population
Iran	17,443	140,843,000,000	79	75	29.4	79,036,200
Ireland	51,284	109,014,000,000	11	14	0.1	4,635,400
Israel	33,136	148,436,000,000	26	24	0.4	8,463,500
Italy	35,131	480,453,000,000	25	42	0.2	60,679,836
Jamaica	8,610	6,390,479,000	35	51	1.4	2,723,246
Japan	37,519	3,680,980,000,000	16	13	0	126,810,000
Jordan	11,971	26,967,480,000.00	60	34	1.9	9,531,712
Kazakstan	24,108	23,542,600,000.00	78	70	31.5	17,670,900
Kenya	3,099	14,773,500,000.00	70	79	3.4	47,251,000
Korea, South	34,355	1,180,470,000,000	33	28	0	51,541,582
Kyrgyzstan	3,262	164,970,464.14	74	74	10	6,008,600
Latvia	23,793	1,114,877,589.45	32	27	2.7	1,971,300
Lebanon	18,052	10,401,100,000.00	64	73	0	5,939,993
Lithuania	27,259	3,963,704,823.10	20	25	1	2,888,582
Macedonia	13,398	559,059,534.08	49	38	3.7	2,069,172
Malawi	1,112	753,551,700.00	59	66	14	16,832,910
Malaysia	25,145	476,340,000,000	56	31	10	30,868,700
Mauritius	18,689	7,180,100,000.00	27	29	0	1,262,879
Mexico	17,950	525,057,000,000	54	63	7.7	122,273,500
Mongolia	11,919	1,292,937,288.99	31	48	33.1	3,069,300
Morocco	7,813	52,479,840,000.00	67	50	3.7	33,337,529
Namibia	10,656	1,303,200,000.00	36	33	1.9	2,324,400
Netherlands	47,960	651,004,000,000	6	7	1	16,991,200
Nigeria	6,054	56,389,260,000	62	72	15.6	186,988,000
Norway	67,166	252,950,000,000	4	4	10.7	5,213,985
Oman	43,847	30,291,300,000.00	65	40	38.8	4,370,794
Panama	19,546	12,544,000,000.00	51	57	0.5	3,814,672
Peru	11,860	102,616,700,000.00	46	54	9.7	31,488,700
Philippines	6,974	264,143,000,000	47	55	3.2	102,855,400

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Table A1. (part 3)

Country	*G*	Capitalization	Democracy Rank	Corruption Rank	Natural resources rents (% of *G*)	Population
Poland	25,247	177,730,000,000	21	22	1.8	38,484,000
Portugal	27,069	65,519,040,000.00	18	20	0.5	10,374,822
Romania	19,744	15,878,100,000.00	41	44	2.2	19,861,000
Russia	24,449	874,659,000,000	77	71	18.8	146,519,759
Saudi Arabia	52,311	373,380,000,000	72	35	46.4	32,248,200
Serbia	13,378	7,450,561,000	40	47	3.3	7,114,393
Singapore	83,066	414,126,000,000	55	6		5,535,000
Slovakia	28,279	4,610,560,000.00	24	32	0.5	5,424,058
Slovenia	29,867	6,474,850,000.00	22	26	0.3	2,069,762
South Africa	13,094	612,308,000,000	38	41	9.2	54,956,900
Spain	33,835	995,095,000,000	23	23	0.1	46,423,064
Sweden	46,219	560,526,000,000	3	3	1.1	9,851,017
Switzerland	58,149	1,079,020,000,000	5	5	0	8,306,200
Thailand	15,579	382,999,000,000	66	56	4.6	65,246,562
Trinidad and Tobago	32,170	15,165,380,000	37	52	34.4	1,349,667
Turkey	19,698	308,775,000,000	58	39	0.6	78,741,053
Uganda	1,939	7,294,133,434.37	71	76	13	34,856,813
Ukraine	8,681	20,711,371,700.24	73	77	9.7	42,774,605
United Kingdom	39,826	3,019,470,000,000	12	11	1	65,097,000
United States	54,370	18,668,300,000,000	14	15	1.3	322,916,000
Vietnam	5,656	32,552,900,000.00	76	69	10.4	91,700,000

G (PPP, constant international$ for 2014, reported by the IMF) http://www.imf.org/external/data.htm
Population http://data.worldbank.org/indicator/SP.POP.TOTL
Capitalization (US$ mundi) http://www.indexmundi.com/facts/indicators/CM.MKT.LCAP.CD/rankings
Democracy rank http://democracyranking.org/wordpress/rank/democracy-ranking-2014/
Corruption rank https://www.transparency.org/research/cpi/
Total natural resources (% of *G*) http://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS
Democracy rank & corruption rank for Bermuda set to that for United Kingdom as the governing country
Democracy rank & corruption rank for Hong Kong set to that for United Kingdom as the recent & last governing country
Barbados (high CDR) and Equatorial Guinea (high *G*) are too small for attention by the reporting agencies.

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Appendix B

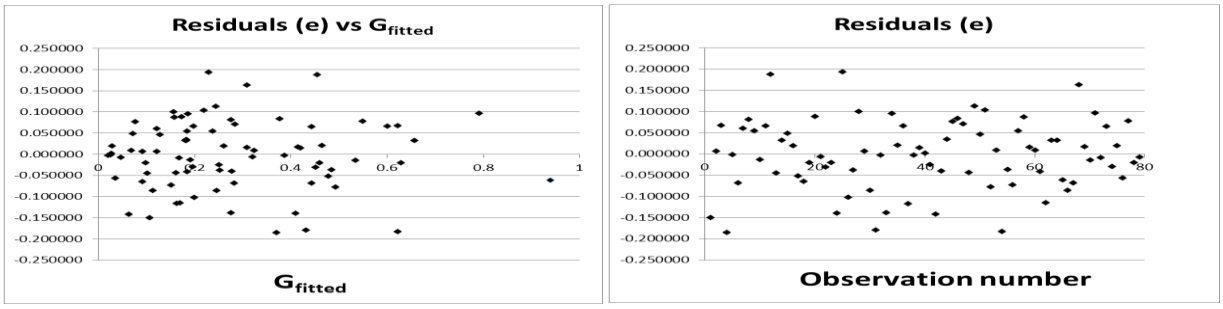

Figure B1. Plot of residuals vs. fitted values of *g* and observation number

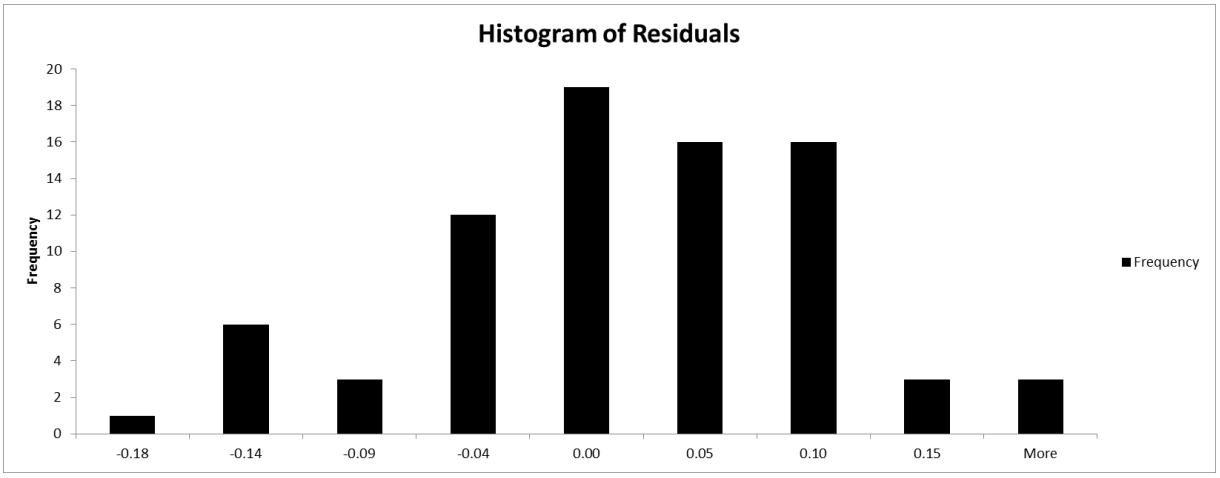

Figure B2. Histogram of residuals

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CHAPTER 7

Capitalism/Democracy/Rule of law Interactions and Implications for Entrepreneurship and per capita real gross domestic product adjusted for purchasing power parity

Reference: Ridley (2020).

An interactive CDR *index combines the degree of capitalism, democracy and rule of law associated with a particular country. In previous work, depictions of the* CDR *index and its implications for gross domestic product were based on approximate trends. No formal measurements were made. This paper presents a formal measurement of the* CDR *index based on published country market capitalization, rankings in democracy, and rankings in corruption, taking into account the effect of interactions. Consistent with the principle of parsimony, the* CDR *index explains per capita real gross domestic product adjusted for purchasing power parity (G) with only three variables. We show that G is a function of the* CDR *index as evidence that a national policy should focus on raising a country's* CDR *index, whether or not it is resource rich. Countries with a low* CDR *index fare poorly in wealth even when they are rich in natural resources. While the importance of capitalism, democracy and rule of law appear to remain elusive to economically unsuccessful countries, governments do have access to the means for raising them exogenously.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship

JEL: E02, P16

Introduction

The concept of a CDR index that combines the degree of capitalism (*C*), democracy (*D*) and rule of law (*R*) associated with a particular country, was first introduced in Ridley (2016) and Ridley, Davis and Korovyakovskaya (2017). In that work, the CDR index was considered for how it reflected on mindset toward entrepreneurship and community economic transformation (Ridley, et. al., 2008). It was argued that countries that neglected the need for either capitalism, democracy, or the rule of law, have lower gross domestic product. Furthermore, until there is a change in that mindset, entrepreneurship does not succeed. This is despite massive natural resources. All depictions of CDR and its implications for per capita real gross domestic product adjusted for purchasing power parity (*G*) were based on approximate trends. This paper presents a formal measurement of the CDR index based on published country market capitalization, ranking in democracy, and ranking in corruption (Goel, Mazhar and Nelson, 2016, Czap and Nur-tegin, 2012, see also Couttenier and Toubal, 2017, López, et. al., 2017).

Rule of law reflects government effectiveness indicators such as the prevention of theft, the protection of property rights and contracts, the control of corruption, regulatory quality, political stability and absence of violence, access to justice and efficient court proceedings, the status and role of legal professionals, administration of justice and management of courts. With

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the exception of corruption, these variables are complicated constructs, the details of which are not understood by the average investor. Despite their presence, rules can be broken and corruption can persist. And, everybody has a strong perception of corruption, when and where it exists. It is this perception that informs their willingness to invest time, money and effort. Precise breakdowns and measurement are impossible. But, it is generally agreed which countries are more or less corrupt. Therefore, despite what might have been small differences in component scores, the country ranking can be the same. In this paper, the transparency international corruption perception index is chosen to represent the opposite of rule of law. We investigate the individual relationships between *G* and capitalism as measured by market capitalization, *G* and democracy as measured by country democracy ranking, and *G* and rule of law as measured by country rule of law ranking, ceteris paribus. Democracy ranking is a proxy for new pathway creations that connect human capital thoughts, ideas, imagination and creativity. Rule of law ranking is a proxy for stability that attracts capital.

It is not uncommon for national policy to focus on the discovery of natural resources. However, this research reveals that the relationship between *G* and the CDR index is undeniable, irrespective of a shortage or abundance of natural resources. Countries with a low CDR index fare poorly in *G* even when they are rich in natural resources. Natural resources can exacerbate the social ill effects of little or no democracy and injustice due to little or no rule of law (Norman, 2009; Frankel, 2012). So much so that countries are better off embracing a national policy that focuses on raising their CDR index. There are also benefits associated with diversifying from natural resources (Cullen, 2017).

Different economic schools of thought suggest different determinants of economic growth. Classical and neo-classical economics favor only market forces of demand and supply, producer's urge for profit maximization and consumers' motive of utility maximization. Keynesian economics criticizes the classical school for its sole reliance on market forces and for ignoring recessions and the possibility of market failure due to factors such as the savings paradox. It favors government interventions via fiscal and monetary policy formulation and implementation to restore the competitiveness of the market. Institutional economics emphasizes the impact of institutions via various socio-economic cultures (Hamilton,1919, Hodgson, 2000). Schumpeter (1911, 1928, 1954) was the first to present a model that includes entrepreneurship. Micro combinations and suggestions for their aggregation into industries were offered by Houthakker (1955). The fixed proportions production function was proposed by Leontief (1906-1999). Solow (1956) suggested that growth be determined by an aggregate production function of capital and labor, where capital is the stock of installed equipment. But, said capital is not the same as C that is assigned to entrepreneurship. The measure of market capitalization assumes that investors act rationally and without bias, and current value is discounted future earnings, thereby taking into account the impact on *G* in current and all subsequent years. Therefore, the Solow (1956) model is not useful for determining growth due to entrepreneurship. Whereas the Solow model is presented as an aggregate production function, Ridley and Ngnepieba (2018) show definitively by mathematical proof that there is no such thing as an aggregate production function. They show that under certain abstract configurations of production units, an aggregate production function that is equivalent to the sum of individual production units is theoretically possible. But, these configurations are limited, restrictive and short of a miracle, most unlikely to occur in practice. It is a fallacy of composition (Cohen and Harcourt, 2003). In this paper, we take an interdisciplinary approach, combining elements of neo classical (capitalism) and institutional economics (democracy and rule of law) to explain *G*.

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Significance and Purpose of this research

All wealth is shown to originate in human capital of ideas and imagination. The mean square error parameter estimator for a Cobb-Douglas type function $G=\alpha_0 K^{\alpha_K} L^{\alpha_L} e$, where the fixed part of capital stock (*K*) and labor (*L*) are complementary, and e is random error associated with uncertainty, yields well-known high correlations between actual and fitted values. But, this function cannot account for new wealth creation from human capital represented in *C*, and *C* and *L* are not complementary anyway. Exogenous catalysts *D* and *R* augment *C* but are not complementary and $G=\beta_0 C^{\beta_C} D^{\beta_D} R^{\beta_R} \epsilon$, where ϵ is random error, yields very low correlations. On the other hand, this paper proposes $G=\beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \varepsilon$, where ε is random error, includes an interaction term, and yields very high correlations, irrespective of government spending, natural resources, country size, location, culture, and other commonly held beliefs. A negative coefficient β_{CDR} resolves prior conflicting research on the relationship between *G* and *D*. It exhibits ideal ordinary least squares (OLS) properties of parameter significance with no unwanted correlations. No structural equations, two stage least squares (2SLS) or instrumental variables (IVs) are required for efficient prediction of *G*. The macro-economic *C*, *D*, *R* and micro-economic *K*, *L* derivations of *G* are reconciled into a single mathematical function∎

The remainder of the paper is organized as follows. "Literature review" is a literature review of determinants of economic growth, with a focus on scholarly work that analyzed capitalism, democracy, and rule of law as individual determinants of economic growth. "The *CDR* index" discusses data and construction of the CDR index. "Graphical Analysis" and "Maco-economic Statistical analysis" contain graphic and regression analyses. A vexillological chart is used to identify countries. "Parametric Global Invariance" and "Entrepreneurship" relate the macro-economic cross country statistical model findings to parametric global invariance, and entrepreneurship. "Reconciling the Macro- and Micro-economies" reconciles the macro and micro economic models. "Conclusions" contains concluding remarks and suggestions for future research.

Literature Review

Galor and Ashraf (2013) hypothesized that economic development is determined by characteristics of genetic diversity. High genetic diversity in Africa and low genetic diversity in native America are associated with low development. Medium genetic diversity in Asia, Europe and American settlers is associated with high development. However, very large differences in wealth between Western and Eastern Europe, between Japan and China and between North Korea and South Korea suggest that genetics leaves much unexplained (see Acemoglu, Johnson and Robinson, 2005 for an account of a natural experiment represented in the two Koreas divide only by the 38th parallel and their institutions, no other variables). Faria, et. al. (2016) found that institutional effects from learning and developing human capital can outweigh genetic effects. We argue that if genetic inheritance manifests itself as human capital that is passed on through knowledge and skills by nature and nurture, then such capital is transportable between countries. Like all capital, human capital tends to travel from undemocratic lawless countries to democratic law abiding countries where it is applied to the generation of wealth. In any case, even if a country is immutably stuck with less than maximal talent, it should still focus on raising its CDR index to maximize its own *G*.

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Economic freedom

In a more progressive approach, six Liberty Fund conferences from 1986 to 1994 introduced the economic freedom of the world index (EFW) that distinguishes economic freedom from political freedom. The Heritage Foundation (1995-2016) publishes the economic freedom index designed to track advancement in economic freedom, prosperity, and opportunity to promote these ideas (see also Gwartney, et. al. 1999, Scully and Slottje, 1991, O'Driscoll et al., 2001, Hanke and Walters, 1997, Messick, 1996, Hall and Lawson, 2014). This index is calculated from 50 independent variables that are grouped into 10 major factors. The variables are equally weighted, masking their relative importance as to where to apply effort to raise the index. The original index did not incorporate property rights of rule of law. Gwartney and Lawson (2003), Leblang (1996) and Keefer and Knack (1997) suggested the inclusion of rule of law. Lau and Lam (2000) suggested using variable weights to construct an economic freedom ranking that minimizes disagreements among countries. Still, some of the 50 endogenous variables are difficult to improve, and some are impossible to improve exogenously because there is no mechanism available via governing national policy intervention. To the extent that the index is unmanageable, it is only descriptive. More important, it is not designed to predict *G* (de Haan and Sturm, 2000). Other advocates of maximal economic freedom and minimal fiscal government spending (intervention in market forces of supply and demand) include Hayek (1944), and even more so Friedman (2002). On the other hand, advocates of fiscal government spending include Keynes (1936) and Samuelson and Nordhaus (2009). There is also the crowding out investment by government debt (Traum and Yang, 2015, Alfonso and Sousa, 2012). In this paper, the $G=f(C, D, R)$ model is unaffected by government spending and does not include it.

Political freedom

With regards to political freedom, Przeworski and Limongi (1993) reviewed 18 studies on various data samples ranging from 1949 to 1992 on the question of democracy and economic growth (see Adelman and Morris, 1967, Dick, 1974, Huntington and Dominguez, 1975, Weede, 1983, Kormendi and Meguire, 1985, Kohli, 1986, Landau, 1986, Sloan and Tedin, 1987, Marsh, 1988, Pourgerami, 1988, Scully, 1988, 1992, Barro, 1989, Grier and Tullock, 1989, Remmer, 1990, Pourgerami, 1991, Helliwell, 1992). The findings were split equally between yes and no, and no findings at all (see Barro (1996), Przeworski and Limongi (1997) for more on democracy). Therefore, the conclusion of the review was that the answer is as yet unknown. In this paper we uncover and clear up what we think is the reason for the confusion by presenting a statistical cross country regression model that includes both a positive democracy term and a negative interaction term that contains democracy. The signs are easily explained as a positive democracy effect and negative friction between capitalism, democracy, and rule of law, where all three make significant contributions to explaining G. When the interaction term is omitted the estimated coefficient of democracy becomes insignificant like in the prior above-mentioned research.

Parsimony

Everything should be made as simple as possible, but not simpler. In this paper, we will show that the parsimonious CDR index requires only 3 variables to explain most of *G*. The coefficients in CDR are optimal global constants that are weighted by country *C*, *D* and *R* to maximally explain and predict *G*. Since these variables are fewer, and are more easily understood and accessible, it is easier to raise them via exogenous governing national policy. To the extent that they are manageable, the index is prescriptive.

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Related concepts and theories

CDR is entirely consistent with the information theory (Shannon, 1948) of capitalism analogy (Gilder, 2012, 2013, 2016) and the principle that wealth is essentially knowledge and creativity and therefore entrepreneurship (see also Skousen, 1990). Therefore, growth in wealth is learning and G can rise immediately once knowledge is acquired through the process of learning to the extent that mindset changes for the better (see also Faria, et. al., 2016). It took a little more than two hundred years to achieve current massive and dominant wealth in Western Europe and the United States of America. But, having done so and now that we have this knowledge, the entire world can change in what should be at most, the time it takes to raise one generation through institutions of school and higher education. To ignore this possibility is to waste time or money (see Gilder, 2012, 2013, 2016 on the time-money equivalence enigma). The CDR index model is also consistent with the theory of dead capital (de Soto, 2000) in so far as it must lower the value of the CDR index.

The CDR Index

An empirical scientific approach requires that we break economic variables into their simplest elements for which we have data. That way, their marginal, several and joint impacts on *G*, ceteris paribus, can be determined. We define a capitalist as a person who seeks to deploy personal effort in such a way as to maximize the benefit to him or herself. This includes all rational human beings (Smith 1776, 2010). We define capitalism as the mechanism for capital formation. It is achieved through the limited liability company (Micklethwait and Wooldridge, 2003). Ridley and Davis (2009) reminded us that the company is one of the inventions with great impact on our lives. The earliest modern limited liability law was enacted by the American State of New York in 1811. The English unlimited liability Joint Stock Act of 1844 was followed by the limited liability act of 1855. The American State of Pennsylvania introduced the limited partnership association law in 1874. The German limited liability firm law was introduced in 1892. We define the company as the instrument of capitalism. Before capitalism, circa the turn of the 19th century and the Industrial Revolution, all people were poor. The few exceptions were pre 17th century feudal lords, and beneficiaries of the 17th century Amsterdam stock exchange, the Dutch and English East India Companies that held sway over trade, and certain skilled artisans. The feudal method for acquiring wealth was to seize property at the point of a sword. No wealth was created by the seizure method. It merely moved wealth from the meek and physically weak to the wrong and physically strong. In addition to the creation of the company, the 1662 King Charles II of England grant of charter for the Royal Society to study science provided a great force of innovational support for the Industrial Revolution. The confluence of capitalism, democracy, rule of law, the company, and science staged an environment for the disambiguation that created a perfect storm and the start of the Industrial Revolution. It could have happened anywhere in the world if and where these conditions might have prevailed (Murrell, 2017, Langlois, 2017, Deakin, et. al., 2017, Gagliardi, 2017). The outcome was previously unsurpassed economic growth and English hegemony that spread to the neighborhood of Western Europe and the descendant United States of America.

Democracy and the rule of law are demanded by shareholders if they are to invest in companies. It is also demanded by employees for them to offer their labor and creativity willingly. These mechanisms were followed by the creation of vast wealth. Some countries have created more wealth than others. The high wealth countries have practiced capitalism, democracy

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and the rule of law more than their low wealth counterparts. To study this, let us denote capitalism by *C*, democracy by *D*, and the rule of law by *R*. Then, we can compare *G* with *C*, *G* with *D* and *G* with *R*.

Next, consider a CDR index = *f*(C, D, R) that combines the degrees of capitalism, democracy and rule of law practiced in a country. The CDR index comprises the CDR sum (CDRs: a weighted average of the coefficients of *C*, *D* and *R*) and the CDR product (CDRp: a weighted product of $C \cdot D \cdot R$). We illustrate the wealth effects by graphing *G* versus *C*, *D*, *R* and CDR for various countries. We also regress *G* on CDRs and CDRp to determine if there are synergistic interaction effects.

Finally, we compare the wealth effects of CDR and natural resources (*N*) derived from per capita total natural resources rents. We expect that *N* can improve the economic success of a country. Therefore, we are interested in the effect of CDR on improving wealth over and above natural resources. However, it is well known that natural resources can have positive or negative effects on wealth, depending on some prevailing economic conditions (Auty, 1993, Sachs and Warner, 2001, Ross, 2001, Sala-i-Martin and Subramanian, 2003, Humphreys, 2005, Wadho, 2014, Ridley, 2017b). Consider for example the Dutch disease paradox (Ebrahim-zadeh, 2003). When a country discovers a natural resource such as oil, it must almost invariably contract with an international company that has the expertise to extract the oil. When the oil enters the international market, the country's currency is upwards revalued. Its currency is strengthened. The higher currency value reduces the country's other exports. The net impact may be no increase in total exports and no increase in *G*. The net impact on *G* could also be positive and negligible or even negative. The contraction of manufacturing may have a negative impact on sustainable growth in the medium to long run and increases the exposure of the country to fluctuations in the resource prices. There are also numerous social ill effects that can arise with a negative impact on *G* (Hirschman, 1958, Seers, 1964). For example, widespread loss of non-oil related jobs, disruption, dislocation, and social crisis. Therefore, in addition to the direct wealth effect of CDR, we are interested in the extent to which CDR can have the indirect result of offsetting or otherwise fighting the Dutch disease, and root anti *C*, *D* and *R* social diseases.

Ordinarily, the regression coefficients in a *G*=*f*(*C*,*D*,*R*) economic model would simply be weights and *G* would be a weighted average of *C*, *D* and *R*. However, the weights would be impossible to interpret in any meaningful way. The model would not provide a reference from which *G* can be estimated outside of the data sample. That is, a model that is estimated in any one year would not apply to subsequent years. This problem is overcome by creating a constant global index from the combination of the model parameters and weights *C*, *D*, and *R*. That is, a CDR index. To do this, we standardize the variables such that they are always on or between 0 and 1, as defined below, and the model parameters become scale factors. The model is given in the section on statistical analysis.

Definitions

Capitalist	Person seeking to deploy personal effort to maximize benefit to himself
Capitalism	Mechanism for capital formation
Company	Instrument of capitalism
g	= (*G*-lowest *G*)/(highest *G*-lowest *G*)
G	= Per capita real gross domestic product adjusted for purchasing power parity (change in per capita wealth = G less consumption, depreciation and obsolescence)
C (Capitalism)	= (per capita capitalization-lowest per capita capitalization)/ (highest per capita capitalization - lowest per capita capitalization)
D (Democracy)	= (lowest democracy rank-democracy rank)/ (lowest democracy rank- highest democracy rank)
R (Rule of law)	= (lowest corruption rank-corruption rank)/ (lowest corruption rank- highest corruption rank)
N (Natural resources)	= (per capita total natural resource rents-lowest per capita total natural resource rents)/

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(highest per capita total natural resource rents- lowest per capita total natural resource rents).
These transformations standardize the variables and ensures upper and lower bounds on $0 \leq g, C, D, R, C \cdot D \cdot R, N \leq 1$.
Data for these standardized variables are listed in Table 1. The corresponding source data are listed in the Appendix 1 and in a *supplementary spreadsheet*. Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries.

Table 1. Sample of standardized variables for twenty one countries

COUNTRY	FLAG	*G*	CAPITALISM *C*	DEMOCRACY *D*	RULE OF LAW *R*	CDR index	Natural Resources *N*	Population
Argentina		22,302	0.004468	0.563758	0.420000	**0.181082**	0.020286	43,590,400
Barbados		16,365	0.121405	-	-	**0.185749**	0.002742	285,000
Bermuda		52,347	0.176028	0.919463	0.926667	**0.429702**	0	65,024
Botswana		17,050	0.016493	0.744966	0.846667	**0.311675**	0.013060	2,141,206
Brazil		16,155	0.046029	0.657718	0.646667	**0.287549**	0.023589	205,679,000
Canada		51,964	0.431279	0.946309	0.946667	**0.542581**	0.055973	35,985,751
Chile		23,057	0.132584	0.865772	0.893333	**0.405450**	0.088860	18,191,900
China		13,224	0.020699	0.194631	0.460000	**0.162475**	0.017727	1,375,040,000
Equatorial Guinea		36,785	-	-	-	-	0.474612	757,014
Hong Kong		55,097	0.866107	0.919463	0.926667	**0.774077**	0	9,849,000
India		5,808	0.007568	0.664430	0.560000	**0.229991**	0.008203	1,284,960,000
Jamaica		8,610	0.018064	0.738255	0.560000	**0.250757**	0.002885	2,723,246
Japan		37,519	0.223451	0.899329	0.920000	**0.455681**	0	126,810,000
Nigeria		6,054	0.000000	0.395973	0.246667	**0.112169**	0.022607	186,988,000
Norway		67,166	0.373455	0.979866	0.973333	**0.501459**	0.172033	5,213,985
Poland		25,247	0.035551	0.852349	0.833333	**0.334834**	0.010878	38,484,000
Russia		24,449	0.045953	0.127517	0.253333	**0.144630**	0.110027	146,519,759
Singapore		83,066	0.575954	0.516779	0.960000	**0.828618**	0	5,535,000
Taiwan		46,036	0.246115	0.805369	0.833333	**0.481109**	0	23,476,640
Trinidad & Tobago		32,170	0.086497	0.724832	0.560000	**0.320134**	0.264904	1,349,667
United States		54,370	0.445029	0.912752	0.906667	**0.571583**	0.016919	322,916,000

Data sources

G (PPP, constant international$ for 2014, reported by the IMF) http://www.imf.org/external/data.htm
Population http://data.worldbank.org/indicator/SP.POP.TOTL
Note: A caveat associated with capitalization is that it only includes publicly traded stocks. Therefore, this measure understates the degree of capitalism in a country.
Barbados (high CDR) and Equatorial Guinea (high *G*) are too small for attention by the reporting agencies.
Purchasing power parity (PPP) is used to correct for the effect of currency exchange rate.
Nigeria is the least capitalized country in the list giving it a standardized *C* value of zero.
Bermuda, Hong Kong, Japan, Singapore and Taiwan have no reported natural resources and an N value of zero.
CDR index=$1.53C+0.14D+0.23R-1.21C \cdot D \cdot R$ where the coefficients are calculated below in the statistical analysis.

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Graphical Analysis

Table 1 shows data for twenty-one countries. Any more would create clutter. These countries were selected to illustrate contrast between high and low income, CDR and population size, and for diversity of population characteristics of physical appearance, history and culture (Table 3). They are all over the map. Each of the below bubble charts is plotted for these data. The sizes of the bubbles depict population: diameter is proportional to the square root of population. Figures 1,2,3,5 for G vs *C*, *D*, *R* and *N* cannot be interpreted separately because the other variables are changing, but they do indicate that they should be included in any model to explain *G*.

G vs Capitalism

The relationship between *G* and capitalism is shown in Figure 1. *G* increases with capitalism. This relationship is stronger than for *G* and natural resources shown in Figure 5.

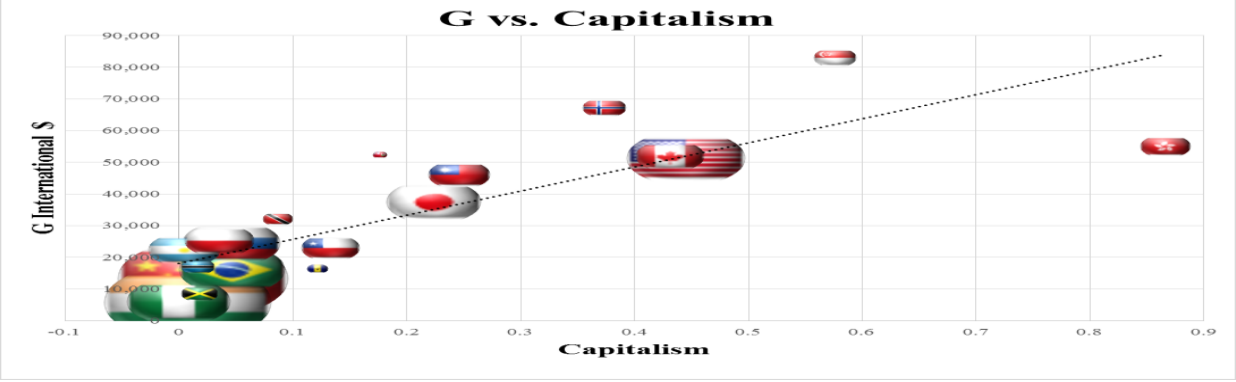

Figure 1. Year 2014 *G* vs Capitalism for 79 countries (line). Bubble size (21 countries) is the square root of population.

G vs Democracy

The relationship between *G* and democracy is shown in Figure 2. *G* increases with democracy. This relationship is stronger than for *G* and natural resources shown in Figure 5. Barbados and Equatorial Guinea are not reported and their democracy was estimated for this graph.

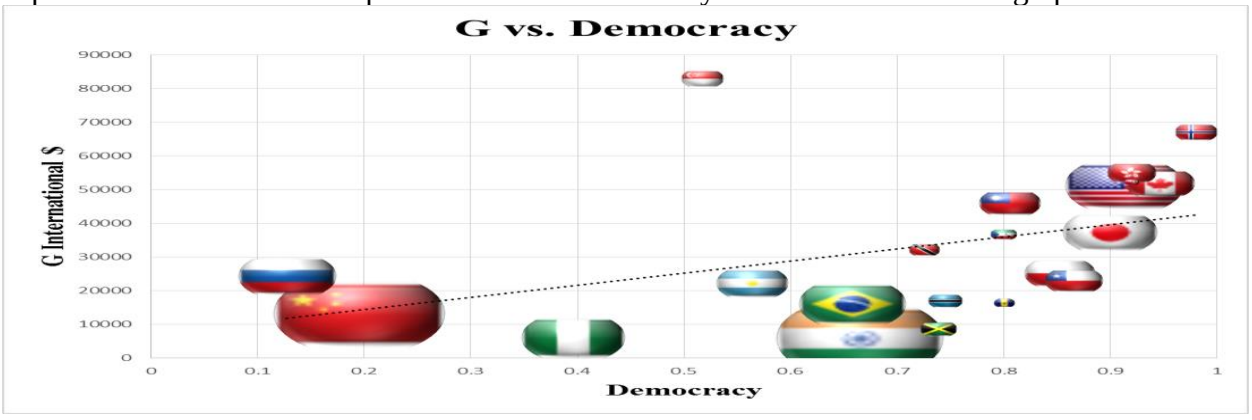

Figure 2. Year 2014 *G* vs Democracy for 79 countries (line). Bubble size (21 countries) is the square root of population.

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G vs The Rule of Law

The relationship between *G* and the rule of law is shown in Figure 3. *G* increases with the rule of law. This relationship is stronger than for *G* and natural resources shown in Figure 5. Barbados and Equatorial Guinea are not reported and their Rule of Law was estimated for this graph.

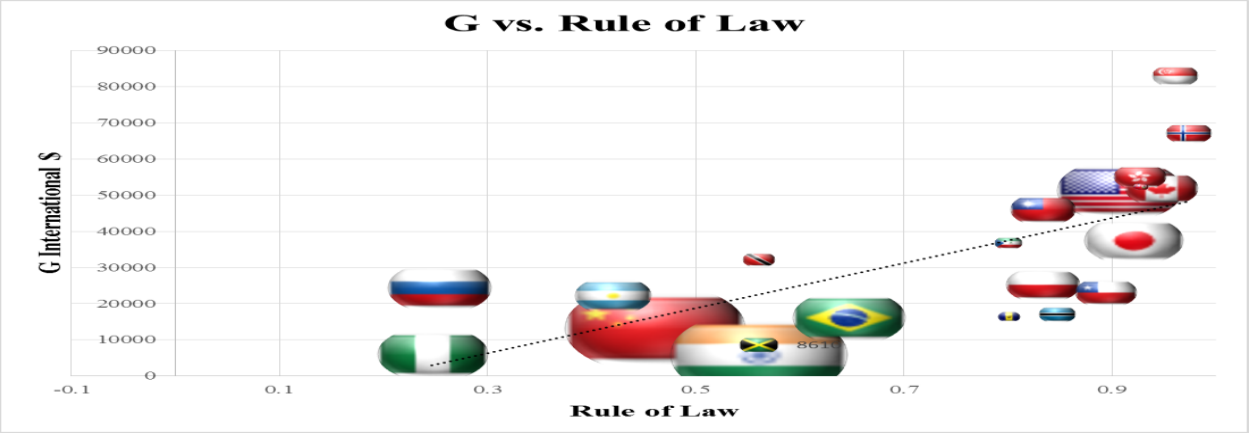

Figure 3. Year 2014 *G* vs Rule of Law for 79 countries (line). Bubble size (21 countries) is the square root of population.

G vs The CDR Index

The relationship between *G* and the CDR index (calculated later in Table 2) is shown in Figure 4. G increases with the CDR Index. This relationship is stronger than for *G* and *C*,*D*,*R* separately as shown in Figures 1-3, and is much stronger than for *G* and natural resources shown in Figure 5. Equatorial Guinea is not reported and their CDR was estimated for this graph.

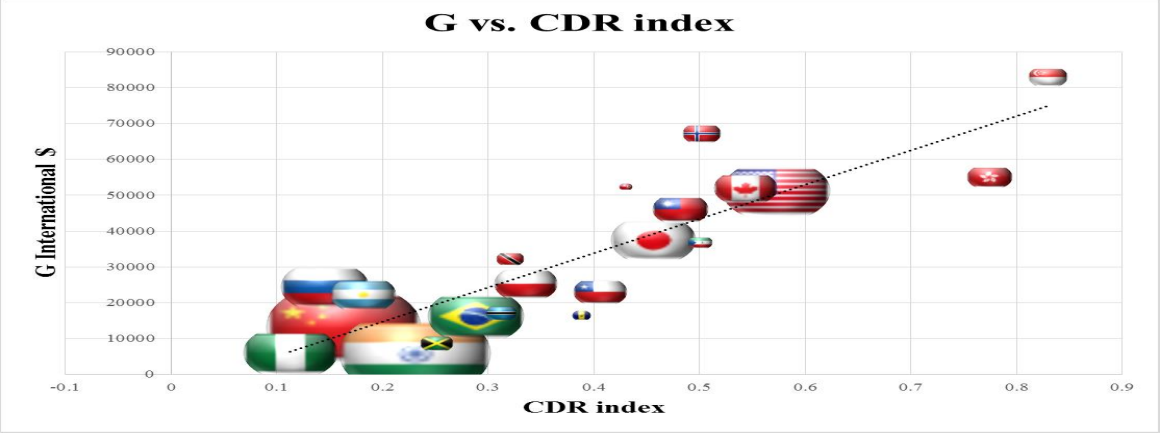

Figure 4. Year 2014 *G* vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population.

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G vs Natural resources

The relationship between *G* and natural resources is shown in Figure 5. Compared to CDR, any increase in *G* with natural resources is negligible. Despite evidence to the contrary, it is easy to mistakenly conclude that economic development is attributable to natural resources, not CDR. Bermuda, Hong Kong, Japan, Singapore and Taiwan have negligible natural resources.

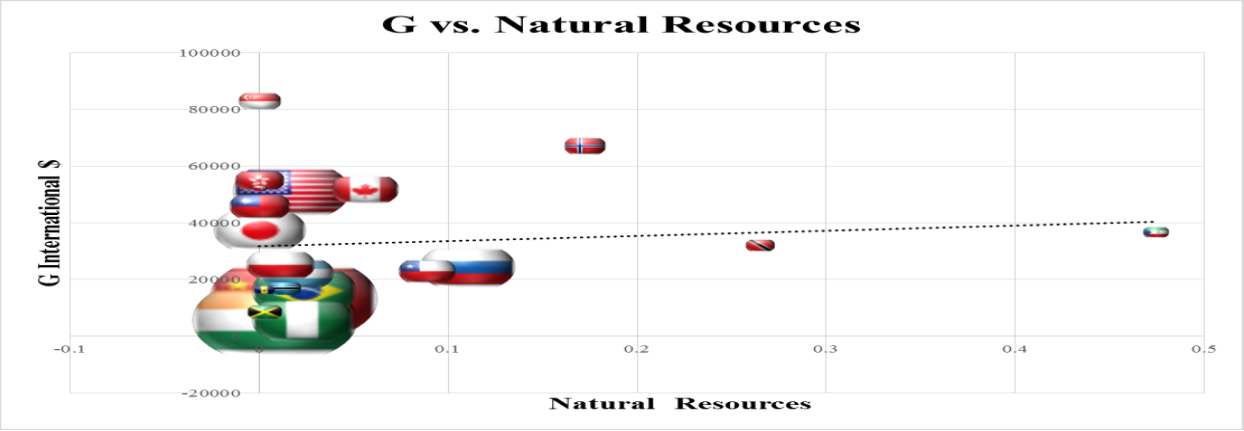

Figure 5. Year 2014 *G* vs Natural Resources for 79 countries (line). Bubble size (21 countries) is the square root of population.

Comparison of selected Countries

The United States of America, Western Europe and Japan are avid practitioners of capitalism, democracy and the rule of law, and they are prominent and dominant economic world leaders. What is so remarkable is that this is in spite of the fact that Japan is oil free. Two other examples are Hong Kong and Singapore. A few tiny oil rich principalities and micro nations also enjoy high G. The super abundance of oil combined with small population numbers in the denominator of their G calculation may have some distortional effect tending to skew the ratio upwards. Still, much of the economic success is due to effective governance and management of national affairs.

One example of effective governance is Norway, a high CDR country. Unlike the oil rich countries that have low CDR indices and low *G*, Norway has high *G*. One remarkable difference is that Norway has adopted a policy of placing all revenues from oil exploitation in a national endowment. The only benefits to its citizens derive from earnings on the endowment. Another outcome of this policy is its ability to be charitable to other oil rich nations that are poverty stricken! Norway ranks very high on the percentage of *G* contributed to global charity.

Once Poland, Chile, Botswana and Equatorial Guinea adopted CDR policies, they were able to break quickly away from their respective geographic neighbors. Botswana is a poster nation for policy to raise CDR (Devarajab, Easterly and Pack, 2003). Equatorial Guinea made positive change but has a long way to go. Bermuda and Cayman Islands (not shown), themselves small, are greater long standing beneficiaries of CDR than otherwise similar Caribbean islands. Other Caribbean countries benefiting from high CDR are Trinidad & Tobago and Barbados. China has not made the switch to CDR policies and has low *G*. Russia returned to what appears to be a neighborhood invasion strategy as opposed to a CDR strategy. They entered Ukraine counter to rule of law, and despite being awash in oil and gas, their post-communist *G* collapsed once again. Russia, India and Nigeria are endowed with vast natural resources of oil, minerals, and climate. Nigerian sweet crude (less than 0.42% sulfur) is relatively high-quality oil, yet, it has turned into a sprawling pollutant in return for very little economic benefit for its citizens.

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Furthermore, as oil pollution appears, nonrenewable fixed oil assets disappear. Based on Figure 4, potential and some recent accomplishments notwithstanding, China, Brazil and India do not appear to be emerging economies. Their CDR and *G* are low. Figure 4 suggests that they should focus on policies that raise their CDR index.

Macro-Economic Statistical Analysis

Consider the following hypothesis.
H_0: *G* is not explained by the CDR index
H_1: *G* is explained by the CDR index

To test this hypothesis, consider the cross-country regression of g on *C, D, R*, the interaction variable *C·D·R*, and *N*. The error term is assumed to be random and normally distributed with a mean of zero and constant standard deviation. All variables are previously defined linear rescaling's and therefore have no effect on the statement of hypothesis.

$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} \mathrm{C \cdot D \cdot R} + \beta_N N + \varepsilon_{CDRN}$
Where the dimensionless coefficients and variable are
β_C = Coefficient of *C* in the presence of *D, R, C·D·R & N*
β_D = Coefficient of *D* in the presence of *C, R, C·D·R & N*
β_R = Coefficient of *R* in the presence of *C, D, C·D·R & N*
β_{CDR} = Coefficient of *C·D·R* in the presence of *C, D, R & N*
β_N = Coefficient of *N* in the presence of *C, D, R & C·D·R*,
ε_{CDRN} ~ random, normally distributed error with a mean of zero and constant standard deviation, not explained by *C, D, R, C·D·R & N*.

Table 2: OLS Regression Results

Coefficient	Estimate	|t|		Correlation (r) with fitted errors, F ratio and R^2_{adj} for different independent variables included in the regression model			
			Variable	r	F ratio	R^2_{adj}	
β_0	0.00	0.08	All	5.43×10^{-16}	81.0	0.83	0.83
β_C	1.53	6.60	C	5.41×10^{-16}	66.3	0.59	0.77
β_D	0.14	1.69	D	-2.50×10^{-16}		0.05	
β_R	0.23	2.60	R	-0.63×10^{-16}		0.10	
β_{CDR}	-1.21	4.50	C·D·R	4.39×10^{-16}		0.03	
β_N	0.38	5.60	N	10.1×10^{-16}	5.67	0.06	0.06

The source data contains data for 150 countries. Of these, 71 countries have at least one value missing for at least one of the variables. Excluding them leaves 79 complete observations. The results of the regression analysis are given in Table 2. The constant term (intercept) is zero. If there is no *C, D, R* and *N*, then there is no *G*. That is, there are no other variables that are relevant to *G* (see also the residuals analysis in Figure 6). The estimated model is $\hat{g} = 1.53C + 0.14D + 0.23R - 1.21 \cdot C \cdot D \cdot R + 0.38N$ to two decimal places, where ^ denotes estimated or fitted value. *G* can be estimated from $\hat{G} = \hat{g}$ (highest *G*-lowest *G*)+lowest *G* where highest *G*=83,066 and lowest *G*=1,112.

Concisely stated, the estimated country CDR index is the vector inner product (dot product) of the global constant [1.53 0.14 0.23 -1.21] and the country [*C D R C·D·R*]. Or, the

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CDR index = CDRs index + CDRp index. The CDRs sum index = 1.53*C* + 0.14*D* + 0.23*R*. That is, a country CDRs index = 1.53, 0.14 and 0.23 weighted by its country *C*, *D* and *R* and summed. The CDRp product index = -1.21·*C*·*D*·*R*. That is, a country CDRp index is the product of -1.21 and its *C*, *D* and *R*.

Correlation

Starting with 79 observations, from which the sample mean, and the parameters for 5 independent variables are estimated, we are left with 73 degrees of freedom for error. All regression coefficients are significantly different from zero at a level of significance of 10% (|t statistic| > $t_{0.1,73}$=1.67). The coefficient of multiple determination, adjusted for degrees of freedom due to the number of independent variables in the full model, R^2_{adj} = 0.83. That this, 83 percentage of the variation in *G* is explained by the model (one might be interested to know that while *D* and *R* augment *C*, they *C*, *D* and *R* are not complementary, and the results of fitting a log linear model $g = \beta_0 C^{\beta_C} D^{\beta_D} R^{\beta_R} N^{\beta_N} \varepsilon_{CDRN}$, where the $\beta's$ are output elasticities, is the very low value of R^2_{adj}=0.36). The F ratio = 81 > $F_{0.01,5,73}$=3.28 indicates that at a level of significance of 1%, the model is a good fit to the data. There is only a 1% chance of reaching this conclusion erroneously. If only *C, D, R, C*·*D*·*R* are included in the model, R^2_{adj} = 0.77. The F ratio=66.3 > $F_{0.01,4,73}$=3.58 indicates that the CDR model, is a good fit at a 1% level of significance. The coefficients of partial determination add to the total of 0.83, indicating that the independent variables are not correlated. Therefore, we reject H_0 and conclude that *G* is explained by the CDR index. The intangible CDR and the tangible *N* are logically unrelated. They are orthogonal. If only *N* is included in the model, R^2_{adj} = 0.06. The CDR contribution to explaining variation in *G* is 0.77/0.06≅13 times the contribution from *N*. That is, the combined capitalism, democracy and rule of law is a much greater contributor than natural resources.

Causation

This research demonstrates irrefutable statistical correlation between *G* and *C*, *D* and *R*. However, we are mindful that correlation does not dictate causation. Therefore, we rely on all the prior research that explains why *C*, *D*, and *R* are necessary to promote *G*. Our contribution is the unique parsimony of the model and a new index. The analysis of residuals below shows that there are no other systematically varying variables that are missing from the model.

The greatest contribution to explaining statistical variations in *G* is *C* with R^2_{adj} = 0.59. However, without security from rule of law, investment and therefore capitalization would be greatly curtailed. Foreign direct invest would almost certainly vanish. The only possibility would be investment of the East India Company type, wherein the rule of law was imported by their appointed private portable army of enforcers. That methodology, invade and seize, shifted wealth from India to the company but it did not create new wealth. If anything, it was a net destroyer of wealth. Suffice it to say that the logically most important causal factor influencing *C* and therefore *G*, is indirectly, the rule of law. Investors will also demand democracy, especially as it applies to their voting rights as shareholders. Democracy also taps into human knowledge capital and cognition (Altinok and Aydemir, 2017). Hence the indirect causal influence of *D* on *G*.

As a psychological matter, one person one vote democracy is a right that inspires the best in human participation and relentless determination to succeed. The lowliest citizen voter is as powerful as the billionaire. As an intellectual matter, democracy incorporates the knowledge of all interested parties. Like *C* and *R*, this is a positive contribution from *D* to *G*. But, the expression of democracy by some individuals is as emotional as the expression of democracy by

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others is logical. In a proportional representation democracy where 51 percent carries the day, 49 percent disagree with the installed leadership. Many people will disagree with many of the established laws and capital deployment decisions. Due to these frictions, the negative coefficient of the interaction between *C*, *D*, and *R*; CDRp will reduce the *G* that might otherwise have been attained from CDRs had there been no friction. Excessive democracy can delay decision making unnecessarily. Excessive regulation can limit efficient options unnecessarily. Such is the nature of mankind and democracy.

The direction of causation is clearly obvious. Capital is made up of two components namely exogenous entrepreneurial human capital of imagination and creativity, and endogenous capital stock. Capital stock is fixed capital comprised of knowledge, machines, computers, recordings, etc. Initially, prior to the existence of capital stock, exogenous *C* is converted to *G* of goods and services which are available for consumption. Any decision to reinvest some fraction of *G* in capital stock, which is subject to depreciation and obsolescence, is exogenous. It is not automatically proportional to the level of *G* produced and cannot be predicted from *G*. To the extent that some capital stock accumulates, it will contribute to the creation of G at equilibrium, prior to its complete depreciation and obsolescence. The capital stock component is not an undesirable endogenous element. It contributes to *G*. Any attempt to remove it via a 2SLS instrument will only reduce the efficiency of the CDR model as a predictor of *G*. However, endogeneity due to capital stock within *C* may bias the estimate of β_C. To guard us against that, a consistent 2SLS estimate of β_C can be obtained. Like La Porta, 1999, consider legal origin, latitude or absolute distance from the equator (d_i) and ethnolinguistic fractionalization as IVs for *C*. We assume that these IVs are uncorrelated with the errors in the OLS model. It turns out that only d_i is statistically significant (*t*=3.77). The significant estimated 1st stage least squares regression that includes d_i is

$$\hat{C}_i = 0.04 - 0.07d_i - 0.16D_i + 0.22R_i + 1.11C_i \cdot D_i \cdot R_i - 0.02N_i.$$
$$|t| = (3.20) \quad (3.77) \quad (4.64) \quad (6.43) \quad (27.11) \quad (0.61) \qquad R^2_{adj}=0.94$$

The estimated 2nd stage least squares regression for estimating g from exogenous $\hat{C}_i$ is

$$\hat{g}_i = 1.30\hat{C}_i + 0.12D_i + 0.28R_i - 0.98\beta_{\hat{C}DR} \cdot \hat{C}_i \cdot D_i \cdot R_i + 0.39N_i.$$
$$|t| = (2.66) \quad (0.88) \quad (1.95) \quad (1.88) \quad (4.45) \qquad R^2_{adj}=0.74$$

The coefficient (-0.07) of d_i implies that exogenous entrepreneurship capital ($\hat{C}_i$) decreases the further a country is from the equator. We offer no causation for this, but note that as latitude increases, vegetation decreases and so does life, the source of human capital. Still, it is not important to our main objective here. After purging endogenous capital stock from *C*, the coefficient of capital changes from the inconsistent biased OLS estimate of 1.53 to the consistent estimate of 1.30. In the case of entrepreneurship only, there could be as few as one person involved in decision making and democracy would not be significant (t=0.88). In the case of capital stock, there are more likely to be many decision makers involved and democracy would be significant (t=1.69). The amount of negative friction (-1.21) associated with the $C_i \cdot D_i \cdot R_i$ interaction when capital includes capital stock is greater than the amount of negative friction (-0.98) associated with the $\hat{C}_i \cdot D_i \cdot R_i$ interaction when capital is only entrepreneurship.

The loss of efficiency in the 2nd stage least squares model as a predictor of *G* is the difference in R^2_{adj} of 0.83-0.74=0.09 per unit or 9%. This is the contribution from capital stock. The contribution of total capital to $R^2_{adj} = .59$. So entrepreneurship is about (59-9)/9~6 times as important for *G* as is capital stock from old ideas that occurred earlier. This is also consistent with and illustrated by the speed with which countries that adopted CDR policies (Chile, Poland,

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Hong Kong, Singapore) attracted human capital new ideas, thereby experiencing increases in *G* relative to their neighbors who would have had to rely on capital stock from old ideas.

In the CDR paradigm, *D* and *R* are options that can be selected. Human beings and political leaders can and do make choices. There is no intrinsic mass genetic trait or wisdom requiring the maintenance of a corrupt tradition. Regardless of *G*, a nation can independently make a conscious decision to implement *D* and *R*, jointly or severally. Furthermore, D and R are freedom variables and Gwartney, Holcombe and Lawson (2004, 2006) showed the direction of causation to be from EFW to GDP. Once the decision to implement is made, the creation of market capital in *C* for investment in human capital ideas will initiate the *G* creation process. *G* is the effect of *C*, *D*, and *R*. Still, in case of any endogeneity in *D*, we considered legal origin, latitude and ethnolinguistic fractionalization as 2SLS IVs for democracy. But, they were all found to be first stage insignificant. As it turns out, when the geographic variable latitude is included in the OLS model, it does contribute 4% to R^2_{adj}, raising it to an impressive almost 90%. But, like N, it is negligible and is not under government decision making control. A country cannot move to gain from latitude or natural resources and must focus on raising its CDR index. Recognize also that while there are many factors related to *C*, *D* and *R*, they are subsumed in *C*, *D* and *R*. Most of them cannot be measured or are simply unavailable. Also, there would be no point to including correlated sub variables only to suffer a loss of degrees of freedom. So, for all practical purposes *C*, *D* and *R* are the only relevant policy variables. This is consistent with Acemoglu, Johnson and Robinson (2005) on the impact of institutions.

The CDR model is biased due to endogeneity in the capital stock in *C*. Purging capital stock from *C* leaves the exogenous entrepreneurial capital $\hat{C}$. So, with all exogenous variables the 2SLS estimator ĈDR model parameters are by definition best linear unbiased estimators (blue). This paper is the first to compute the value of imagination and creativity. It is also the first to decouple entrepreneurial capital from capital stock.

Economic Interpretation

The marginal contributions to the mean in g (denoted by E[g]) from *C*, *D*, and *R* are the partial derivatives $\partial E[g]/\partial C = \beta_C + \beta_{CDR} \cdot D \cdot R$, $\partial E[g]/\partial D = \beta_D + \beta_{CDR} \cdot C \cdot D$, $\partial E[g]/\partial R = \beta_R + \beta_{CDR} \cdot C \cdot D$, respectively, for different fixed values of $D \cdot R$, $C{\cdot}R$, and $C \cdot D$. The products $D \cdot R$, $C{\cdot}R$ and $C \cdot D$ are all products of fractions and are therefore small. But, they are all positive. Therefore, the negative values for $\beta_{CDR} \cdot D \cdot R, \beta_{CDR} \cdot C \cdot R, \beta_{CDR} \cdot C \cdot D$ imply that $\partial E[g]/\partial C < \beta_C$, $\partial E[g]/\partial D < \beta_D$ and $\partial E[g]/\partial R < \beta_R$.

Based on the above definition of capitalism, *C*, *D* and *R* are independent of each other. Initially, *C* is at equilibrium. Any new disequilibrium investment component of *C* is exogenous. *C*, *D* and R each contribute to *G* per the CDR index, where *D* and *R* are independent catalysts for *C*. *R* attracts *C*. *D* releases knowledge (exodidactic). As catalysts, *D* and *R* facilitate the functioning of *C* but do not take part in the *G* creating process in which the elements of *C* interact. At the end of the process, *D* and *R* remain unchanged, intact and available for the next cycle of the process. As the process repeats via continual reinvestment, wealth builds in the form of assets, including knowledge, minus loss due to depreciation and obsolescence (Janssen, Claus and Sauer, 2016). There is no loss of *D* or *R*. They provide economic benefits, with no harmful side effects. Spin offs include social equilibrium, less crime, investor confidence, and fighting the Dutch disease (exosocial). Since *D* and *R* are exogenous catalysts, beyond the comprehensive interaction of interest: *C*·*D*·*R*, other than minor spurious statistical effects, possible subsidiary

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interaction effects *C·D*, *C·R* and *D·R* are meaningless and irrelevant. When these subsidiary interactions are included in the regression model their coefficients are statistically insignificant.

In summary $\beta_C + \beta_{CDR} \cdot D \cdot R$ is the marginal return on domestic market capitalization. It is the maximum marginal return on gross invested capital derived from publicly traded stocks. If all stocks were publicly traded, C would be larger, and $\hat{\beta}_C$ would be smaller. Hence, $\hat{\beta}_C \leq \beta_C$. The marginal utility of democracy is $\beta_D + \beta_{CDR} \cdot C \cdot R$, and the marginal utility of rule of law is $\beta_R + \beta_{CDR} \cdot C \cdot D$. The marginal loss due to interactive friction is always a negative number (β_{CDR}<0).

Unexplained G

Only 17% variation in *G* is not explained by the regression model. It is possible that this could be accounted for by various excluded variables. Since *C* only includes capitalization from publicly traded stocks, one such excluded variable could be capitalization via all other business investments. If all capitalization could be measured and included, it is possible that capitalism would explain even more of the variation in *G*. Also, human intellectual knowledge capital is not explicitly included. The residuals from the regression model (e=g_{fitted}-g) vs g_{fitted} and observation number are plotted in Figure 6. There is no heteroscedasticity or correlation between the residuals e and any of the independent variables (all r's have an order of magnitude of $10x10^{-16}$). There is no reason to think that alphabetic order would have any pattern. Still, the Durbin Watson statistic DW=2.0, indicating no pattern in the order of observations or any other variable such as climate or geography that could be incidentally related to order. The histogram (not shown) is bell shaped and a chi-square goodness of fit test with 7 degrees of freedom and 5% level of significance, $\chi^2 = 2.891 < \chi^2_{7,0.05} = 14.067$ indicates that the residuals are normally distributed. No need to involve IVs is indicated. Therefore, we assume that the regression is an apt model. This outcome is because the investment component of *C*, and *D* and *R* are all exogenous.

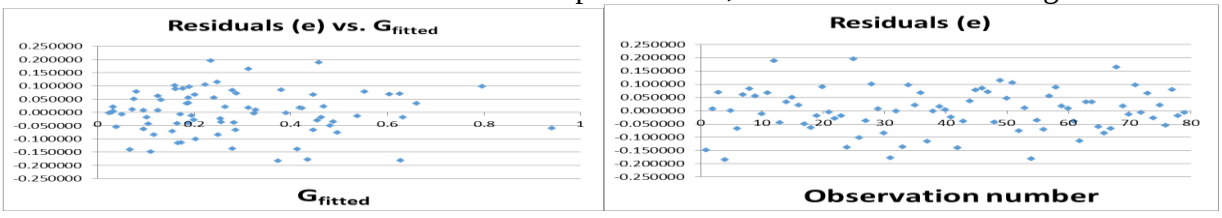

Figure 6. Plot of residuals vs. fitted values of g and observation number

Prediction of G

G can be estimated from the CDR index as follows:

$\hat{G}$ = (1.53*C* + 0.14*D* + 0.23*R* -1.21·*C·D·R*+ 0.38*N*) (highest *G*-lowest *G*) + lowest *G*.

Parametric Global Invariance

The parameter β_C is the global expected value. In the limit as $R^2_{adj} \to 1$, $\hat{\beta}_C \to \beta_C$, and the global average $\hat{\beta}_C$ becomes the same for all countries. The same is true for all parameters in the model. Therefore, if the CDR index is imputed to global constants, then it must be that the *G* creating process is the same in all countries. This may appear counterintuitive. The traditional view is that developed countries own more efficient means of production. But, the high R^2_{adj} of 0.83, and

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aptness of the model illustrated by Figure 6, such that the constants do in fact explain all systematically varying *G*, and the only errors are entirely random, not attributable to any between country variations, imply equality of efficiency after adjustments for the country factors of productivity. Differences in human skills are absorbed into capital. One way of thinking about global invariance is that when a country is 'perceived' to have better means of production, it attracts more capital and vice versa. It is the higher capital (not the process) that is responsible for the higher *G*. The same is true of perceptions of democracy and rule of law. All that is required is to attract capital to a country and direct it to the best democratic and rule of law abiding industries. For that, human knowledge, socialization skill, and the ethos are remarkably efficient (Harari, 2015, Gomes and Sprott, 2017). The avoidance of rent seeking activities is more difficult. Irrespective of geographic location, technology functions according to fixed laws of science (Kuhn, 2012). In that sense, the world is flat and parametrically globally invariant. The CDR model was re-estimated for different years from 2008-2016 and the parameter estimates were similar (See Appendix 2). To the extent that this explanation is not entirely satisfying, we invoke the axiom of the Adam Smith invisible hand.

Global invariance explains why some former low *CDR* low *G* countries have able to transform themselves to high *CDR* high *G* countries in just a few years, while their geographic neighbors with low CDR remain poor (see "Comparison of selected countries"). For example, Poland, Chile, Hong Kong, Singapore, and South Korea went from poverty to wealth in just a few decades. Given the global approximately equal and constant coefficients of the CDR model, all that remained was for them to raise their *D* and *R* through national governance, and thereby attract and build *C* via excellent science, technology, engineering and mathematics in their schools and universities, for deployment throughout industry and commerce. There is one caveat regarding the specific parameters in this study. Even if the parameters were global invariant in a previous era, their values may have been different from these post Industrial Revolution values since that revolution was unlike any other before it (Harari, 2015).

Entrepreneurship

The CDR index model has established that the intangibles are what create wealth and that natural resources are negligible if not problematic. It follows from the above economic interpretation that *D* and *R* provide the positive effect of social equilibrium, but that new wealth is related to the positive effect of disequilibrium caused by new ideas, innovation and creativity, and therefore entrepreneurship as deployed through *C*. Knowledge is about the past. Entrepreneurship is about the future. Consider the context of information and equilibrium theory (Gilder, 2013, Romer, 1990) depicted in Figure 7 (best practices assumed). *D* and *R* are exogenous tools that provide a stable low noise information channel through which high signal to noise ratio information can be transmitted and subsequently detected. By themselves, they produce no information. Without them the channel is abundant with noise that drowns out new information. Consider a system at equilibrium. Entrepreneurship is an exogenous element of new surprisingly large information and disequilibrium due to the discovery of natural resources (*N*) and new ideas (ε). It is detected as information from the low noise channel and becomes an exogenous element of *C*. A *G* creating process begins with the additional *C*. At the end of the process, in the absence of any new entrepreneurship, the economy settles back to equilibrium, at a new and higher level of *C*. Such is the enigmatic wealth maintenance positive equilibrium positive *G* disequilibrium CDR benefit.

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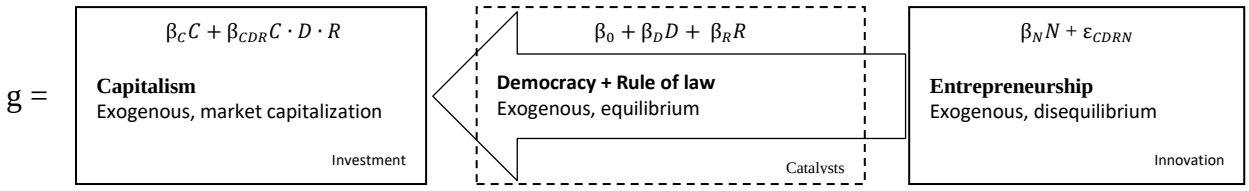

Figure 7. Democratic law-abiding entrepreneurial *G* creating process.

To illustrate the implications for entrepreneurship and instant wealth, consider a coastal community where extreme tidal activity occurs annually. The community has a staple diet of chicken meat. Every year there is sufficient flooding to kill all chickens by drowning. This of course creates a severe life-threatening food shortage. To continue in this way is to do business as usual, year after year. No entrepreneurship. In an act of entrepreneurship, the chicken farmer recognizes that while chickens drown, ducks float. The chicken farmer switches from chickens to ducks and the entire community is lifted out of poverty. There is no change in natural resources, one hundred percent of the increase in wealth comes from an idea of a creative mind, and the change takes place in the short period of time required for duck incubation, gestation, and maturity.

In a second example, consider the dead capital in the poor countries described by de Soto (2000). Capital is inaccessible due to lack of property identification and recordation, and the concomitant inability to enforce property rights. In an act of entrepreneurship a new company could dedicate its resources to a nationwide project to survey all the land, title the property and record the deeds. We proffer that the release of capital would exceed total foreign aid, this element of rule of law would inspire foreign direct investment, and there would be an unprecedented rise in *G* (see also McCloud and Kumbhakar, 2012). All this in short order.

The above two examples require modest levels of education to understand. Now, consider an example that is steeped in science. Knowledge from only a few years ago on US dependency on crude oil, the threat of rising energy prices and fragile political relationships with oil producing enemy states, signaled that natural resources are finite and life, the way we know it is soon to end. Business as usual tells us that, without a doubt, no alternatives exit. Then, an act of entrepreneurship discovers how to apply the physical and chemical processes of vertical drilling, horizontal drilling, hydraulic fracturing, retorting and pyrolysis for extracting oil and natural gas from shale. In relatively short time, the United States of America is self-sufficient and a potential exporter of oil and natural gas. This example involves natural resources. But the shale resource was unrecognizable without scientific knowledge.

Discussion

Those of a socialist persuasion may express concerns regarding the rapaciousness of capitalism. Compared to its socialist counterpart, it is described as unsuitable for civilized conduct. We do not propose capitalism in the absence of democracy and the rule of law. Power corrupts and absolute power corrupts absolutely (Dalberg-Acton, 1907). Like any other tool or instrument, unregulated capitalism is subject to abuse. However, a company that produces low quality or overpriced products will not remain in business. Companies that grow in size and wealth do so because they provide products and services that people want and benefit from. Both democracy and rule of law are social mechanisms. But, they are completely unrelated to the socialism of wealth redistribution. If per capita government spending (not to be confused with government

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expenditure as a percentage of *G*) and population size are included in the model, their coefficients are not significant and there is no increase in R^2_{adj}. Government taxes and expenditures merely cancel. Any *G* benefits from economies of scale due to country size are absorbed into capitalization that is already included in the model. The upshot of all this is that the relationships in Figures 1-6 are independent of the size of or the visible characteristics of the people in a country. That is, as the chart is traversed, there is no systematic change in the size of the bubble. As counterintuitive as it may seem to a certain mindset, the primary factors for economic development are not natural resources. The epistemological position is that economic success is dependent on the institution of policy to adopt and engineer a high CDR index.

Further to the CDR index, we recognize that wealth derives from ownership of the means of production. Even the measure of natural resources studied here is of wealth that has been derived from their extraction and conversion into productive assets, an activity of capitalism. It does not include resources in the ground for which no value has been created. Technology as a means of production is an intellectual outcome. Therefore, wealth creation is an indirect product of the imagination of the mind and study by the mind. "Since new developments are the products of a creative mind, we must therefore stimulate and encourage that type of mind in every way possible (Carver, 1864-1943)."

The notion of wealth creation through intellectual productivity supports the theory of plus sum capitalism. That is, if anywhere, through raised CDR, somebody produces products at a lower price with the same quality or produces better quality at the same price; the total economic pie must increase for the benefit of all, both rich and poor. Therefore, rich countries should promote and aid poor countries to raise their CDR.

Reconciling the Macro- and Micro-Economies

Wealth begins in the imagination and creativity of the mind as human capital. Capitalism is a macro-economic measure by market capitalization as an expression of confidence in human capital. Market capitalization is the discounted value of all future earnings from products that are expected to be created from human capital. Therefore, it takes into account current and all future years. Assuming perfect *D* and *R*, then simultaneous with the appearance of human capital is an increase in market capitalization. Simultaneous with the distribution of market capital to investee companies, said products are created in individual micro-economic units of production that employ physical capital and labor.

In general, consider *m* countries, *i=1,2,3,..m*, where country *i* contains n_i production units. The *i*th country *G* estimate is $\hat{G}_i$=$\hat{g}_i$(highest *G*-lowest *G*) + lowest *G*, where in equilibrium, $\hat{g}_i = f(C_i, D_i, R_i) = \hat{\beta}_C C_i + \hat{\beta}_D D_i + \hat{\beta}_R R_i + \hat{\beta}_{CDR} C_i \cdot D_i \cdot R_i$. Production of $\hat{G}_i$ is obtained from the sum of n_i micro-economic production units. Consider a deterministic Cobb-Douglas function v_{ij}=$f(K_{ij}, L_{ij})$ applied to the *j*th unit of production in the *i*th country, where K_{ij} is capital obtained by the investment of the fraction f_{ij} of $\hat{G}_i$, L_{ij} is the matching quantity of physical labor in person-hours per annum, and v_{ij} is the annual value of production. Assume that the value of wages paid to labor is W_{ij}. All labor is identical in nature and functionality. This operating definition of homogenous labor is consistent with the original theory of comparative advantage (Ricardo, 1817). Any human differences due to knowledge, experience and skills are transferred into production capacity of capital stock. Assuming constant returns to scale, then v_{ij}=$A_{ij} K_{ij}^{\alpha_{ij}} W_{ij}^{1-\alpha_{ij}}$, where A_{ij} is the total factor productivity and α_{ij} and 1-α_{ij} are output

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elasticities of capital and labor respectively. The total monetary value of production for country *i* is given by

$$\sum_{j=1}^{n_i} v_{ij} = \sum_{j=1}^{n_i} A_{ij} K_{ij}^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}} = \sum_{j=1}^{n_i} A_{ij} (f_{ij} \hat{G}_i)^{\alpha_{ij}} W_{ij}^{1-\alpha_{ij}}.$$

The global monetary value of production of all *m* countries is therefore

$$\sum_{i=1}^{m} \sum_{j=1}^{n_i} A_{ij} (f_{ij} \hat{G}_i)^{\alpha_{ij}} W_{ij}^{1-\alpha_{ij}}.$$

Or, substituting for $\hat{G}_i$,

$$\sum_{i=1}^{m} \sum_{j=1}^{n_i} A_{ij} \left\{ f_{ij} [f(C_i, D_i, R_i)(\text{highest } G - \text{lowest } G) + \text{lowest } G] \right\}^{\alpha_{ij}} W_{ij}^{1-\alpha_{ij}}.$$

Conclusions

This paper calculates the Ridley (2016) CDR index that captures the level of practice of capitalism, democracy and rule of law (CDR) in a country and estimates its impact on economic success as measured by G. Prior to the development and practice of CDR, practically all people were poor. Subsequently, countries that practice these have become rich and countries that do not, have remained relatively poor. This and the perfectly random residuals from the *G=f*(*C,D,R,N*) regression model (no other decision variables matter), show that *D*, *R* and *N* are exogenous. Furthermore, since *D* and *R* are never consumed in the *C* to *G* wealth creation process, and their form does not change, then *D* and *R* are exogenous catalysts. *R* attracts *C* and *D* creates additional pathways for ideas of imagination and creativity to deploy *C* in the creation of more *G* than would otherwise be created. From this study of 79 large, small, rich and poor countries, the estimated country CDR index = CDRs sum index + CDRp product index = 1.53*C* + 0.14*D* + 0.23*R* -1.21·*C*·*D*·*R*. The impact of the CDR index is approximately 13 times the impact of natural resources on variation in *G*. This astonishing finding is that intangible assets are many times more impactful than the tangible assets. Enough to leave an anticapitalist nonplussed. Also astonishing is that in decoupling entrepreneurial capital from capital stock for the first time, entrepreneurial human capital of imagination and creativity contributes 6 times as much to *G* as does

capital stock. Still, this is not so surprising when we think about the journey from the silk road to silicon valley (Garten, 2016), see also Gordon(2016), and the enormous wealth and philanthropy generated by companies such as General Electric, International Business Machines, Intel, Microsoft, Apple and now Google, all completely unrelated to natural resources.

Underdeveloped and developing countries, especially communities with a paucity of entrepreneurial exposure and experience, due to historical economic oppression and segregation from a modernizing world, will benefit from raising their CDR index. Examples include formerly oppressed minorities in the United States of America, former communist soviet countries like Russia (Korovyakovskaya and Ridley, 2017b) and those constituting the Commonwealth of Independent States (CIS), sub-Sahara Africa, South Asia and South America. But, they must focus on enhancing their institutions of capitalism, democracy and rule of law.

Capitalism should be further enhanced through the practice of entrepreneurship, as that is where innovative products of the mind intersect to create wealth. If wealth is produced in the mind, then if the activity and scope of the mind are unlimited (Lotto, 2017), then the amount of wealth that is possible is unlimited: a pathway from American exceptionalism to routine world-wide economic success. At no time should any country sacrifice capitalism, democracy or rule of law, despite or in spite of its holding in natural resources. Indeed, the ill effects of natural resources via the Dutch disease and or social ills can be offset by raising its CDR index.

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Furthermore, raising its CDR index can enhance the positive effects of natural resources. Because the phenomenon of mindset of assumptions, methods, or notions held by a group of people is so established that it creates a powerful incentive to continue to adopt or accept prior behaviors, choices, or tools, it is often difficult to counteract its effects upon analysis and decision making processes. It's not what one doesn't know that gets one into trouble. It's what one knows for sure that just isn't so. The mindset that neglects self-reliance and the components of the CDR index must be reversed through early education and exposure to entrepreneurship. Since the company is the instrument of capitalism (business capitalization) and new company creation, expansion or innovation is entrepreneurship; and since democracy and rule of law are prerequisites for investment; it follows that CDR and entrepreneurship are positively correlated. Considering the potential of institutional economics (see for example Hamilton, 1919, North, 1991, Acemoglu, Johnson and Robinson, 2005 and Gilder, 2012, 2013, 2016), future research on institutional design (Koltai and Muspratt, 2017, Acs, et. al, 2016, Feldman, 2014, van Praag and van Stel, 2013, van Hornel, et. al., 2017, Nurunnabi, 2017) for the purpose of raising CDR is recommended.

Appendix 1

Table 3. Sample source data for twenty one countries

COUNTRY	CAPITALIZATION US $	DEMOCRACY RANK	CORRUPTION RANK	TOTAL NATURAL RESOURCES (% of G)
Argentina	25,301,170,000	66	88	3.8
Barbados	4,494,777,000	-	-	0.7
Bermuda	1,486,900,000	13	12	0
Botswana	4,587,518,000	39	24	3.2
Brazil	1,229,850,000,000	52	54	6.1
Canada	2,016,120,000,000	9	9	5.2
Chile	313,325,000,000	21	17	16.1
China	3,697,380,000,000	121	82	5.6
Equaitorial Guinea	-	-	-	-
Hong Kong	1,108,130,000,000	13	12	0.7
India	1,263,340,000,000	51	67	5.9
Jamaica	6,390,479,000	40	67	1.4
Japan	3,680,980,000,000	16	13	0
Nigeria	56,389,260,000	91	114	15.6
Norway	252,950,000,000	4	5	10.7
Poland	177,730,000,000	23	26	1.8
Russia	874,659,000,000	131	113	18.8
Singapore	414,126,000,000	73	7	0
Taiwan	750,586,000,000	30	26	0
Trinidad & Tobago	15,165,380,000	42	67	34.4
United States	18,668,300,000,000	14	15	1.3

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Appendix 2

The year 2014 CDR model was re-estimated using annual samples from 2008 to 2016 and a panel of 9 years from 2008 to 2016. The results are in Table B (student t statistics are in brackets). Prior to 2008, capitalization data were not available for all countries. The OLS parameter estimates from the CDR models are approximately constant for 9 years. They converge in the forward direction of time. Constancy and convergence of the parameter estimates demonstrates model stability and consistency. Even if there is some bias, the model will yield useful stable predictions. The 2008-2016 panel data pooled OLS estimates are similar to the individual year estimates. The between fixed effects parameter estimates are almost identical to the OLS estimates. The random effects generalized least squares (GLS) are based on the inclusion of a variance covariance error matrix. However, these error variances are estimated from residuals from the OLS model because the true errors are unobservable and therefore unknown. By definition then, the corresponding coefficient of multiple determination is unity as calculated. The parameter estimates are almost identical to the OLS estimates. These results imply that there are no fixed effects or random effects that are a source of concern. Some two hundred and forty years after Smith (1776) announced an inquiry into the nature and causes of the wealth of nations, the cause is found to be capitalism, democracy and rule of law, and the CDR model places economics on a sound scientific footing.

Table 4. CDR model annual and panel data parameters for 9 years.

	YEAR	*Bc*	*Bd*	*Br*	*Bcdr*	*Bn*	R^2_{adj}
Annual OLS	2016	1.53 (6.07)	0.14 (1.56)	0.24 (2.61)	-1.25 (-4.26)	0.33 (4.30)	0.81
	2015	1.53 (6.07)	0.14 (1.61)	0.24 (2.56)	-1.23 (-4.19)	0.35 (4.63)	0.82
	2014	1.53 (6.60)	0.14 (1.69)	0.23 (2.60)	-1.21 (-4.50)	0.38 (5.60)	0.83
	2013	1.51 (6.34)	0.14 (1.73)	0.23 (2.59)	-1.15 (-4.19)	0.39 (5.67)	0.84
	2012	1.52 (6.21)	0.16 (1.80)	0.22 (2.41)	-1.16 (-4.08)	0.42 (5.90)	0.83
	2011	1.53 (6.21)	0.16 (1.80)	0.22 (2.40)	-1.16 (-4.08)	0.42 (5.90)	0.83
	2010	1.56 (6.09)	0.18 (1.95)	0.21 (2.16)	-1.19 (-4.00)	0.42 (5.82)	0.83
	2009	1.57 (5.47)	0.22 (2.14)	0.21 (1.96)	-1.13 (-3.39)	0.48 (6.11)	0.82
	2008	1.52 (5.20)	0.23 (2.13)	0.22 (2.01)	-1.09 (-3.20)	0.50 (6.02)	0.82
PANEL 2008-2016	POOLED OLS	1.54 (18.16)	0.17 (5.59)	0.23 (7.10)	-1.18 (-11.98)	0.42 (16.93)	0.83
	BETWEEN FIXED EFFECTS	1.54 (6.11)	0.17 (1.86)	0.23 (2.40)	-1.18 (-4.03)	0.41 (5.63)	0.83
	RANDOM EFFECTS GLS	1.51 (474.10)	0.13 (63.23)	0.25 (129.75)	-1.12 (-263.09)	0.40 (395.32)	1.00

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CHAPTER 8

General theory of economics: CDR supply side scientific growth law unveiled

Reference: Ridley (2018a).

The capitalism (C), democracy (D) and rule of law (R), CDR *global invariant hypothesis was previously demonstrated for year 2014 cross country per capita real gross domestic product adjusted for purchasing power parity (G). Consistent with the principle of parsimony, the* CDR *index explained G with only these three variables. This paper re-estimates the model for the last 22 years of available data. The result is model parameters that are a set of global time invariant constants. These constants constitute the global time invariant* CDR *index defined by the vector inner (dot) product of the global constants and country C, D, R and C·D·R. This establishes the* CDR *global time invariant hypothesis. Based on the unitary entrepreneurship elasticity of G, the theoretical optimal reinvestment in capital stock is validated by empirical gross fixed capital formation. Together, these place economic growth on a scientific basis.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship
JEL: E02, P16

1. Introduction

Before explicitly revealing various features of the avant garde CDR supply side economy, it bears reviewing how strictly demand sided the common view of economic equilibrium is. There are three traditional ways to determine gross domestic product (GDP) for a specified period. One is the market value of all domestic expenditures made on final goods and services, including consumption expenditures, investment expenditures, government expenditures, and net exports. Another is a tally of income earned by all the factors of production in an economy including the wages paid to labor, the rent earned by land, the return on capital in the form of interest, entrepreneurial profits, indirect business taxes and depreciation, and net foreign factor income. Another is the net product or value added. But, these demand side calculations can only be performed after the fact. They assume that a capital stock of facilities that produce final goods and services just exist somehow, do not have to be created, and that economics are concerned with how the goods are produced, distributed, exchanged and consumed. In reality, all such capital must have been previously created. Its only source must be human capital ideas of imagination and creativity, otherwise known as entrepreneurship. Entrepreneurship is expressed as quanta of new information that if noticed, can be converted to tangible wealth in terms of goods and services. The traditional economic thought process is designed on the Malthusian (1798) assumption of scarce resources. But, since Malthus, the world has seen massive population growth, undeterred by resources. It is as if each person brings their own wealth into the world (Simon, 1981).

If economics is currently a science, it is one of descriptive forensic postmortem. Even then, the extant literature is not in uniform agreement of that which has already occurred, or in general, how the various economies of the world got to be where they are currently. Traditional economics does not appear to have prescriptive ability.

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As it turns out, *G* can be estimated ahead of time from the postulated CDR index. The CDR index is a blend of *C*, *D* and *R*, where *C* is measured by total market capitalization, and *D* and *R* are country rankings. The ability to predict demonstrates that high CDR countries will be relatively wealthy and low CDR countries will be relatively poor. Therefore, it establishes the importance for a country to raise its CDR. The CDR index was presented for year 2014 data (Ridley, 2017a, 2017b, 2017c). The model was constructed from global invariant parameters. Therefore, it will estimate *G* for any country. The purpose of this paper is to present the CDR model for years other than 2014. We show that in addition to being parametrically global invariant, the CDR index is also time invariant. That is, the CDR hypothesis is shown to be universally true, as is expected in any law of science. We also calculate the total and marginal contributions to *G* from entrepreneurship. From the marginal contribution, we obtain the unitary entrepreneurship elasticity and the optimal reinvestment in capital stock.

We proffer that a well learned poor society can skip steps within the technology silo travelled by wealthy countries. For example, they can skip whale oil and go straight to subterranean crude oil and gas. They can skip oil and gas and go straight to nuclear power. They can skip land line communications and go straight to mobile cell phone technology. But, to gain wealth, they cannot skip the organizational steps of the CDR law. This is now obvious from all the failed attempts by rich countries to help impecunious countries by way of loans, charity, and transfer of technology. What rich countries need to do is help poor countries develop their institutions of democracy and rule of law. This will increase their CDR index and *G*. This is more difficult than it first appears because much of the creation of rich country institutions and property rights were accomplished by trial and error. And, many poor countries have developed a debilitating mindset of distrust for capitalism (Ridley, 2016, Ridley, Davis and Korovyakovskaya, 2017, Korovyakovskaya and Ridley, 2017). Poor countries would do better to recognize that CDR is not rapacious capitalism but capitalism in the presence of democracy and rule of law, consistent with the moral sentiments of Adam Smith(1759, 2006). Also, it would help greatly to reduce their angst if poor people would recognize that every rational human being is a capitalist (Smith, 1776, 2000) who deploys his personal effort so as to maximize his benefit. Should a capitalist who is also an entrepreneur become very rich he can only consume a tiny fraction of the products that he makes. The remainder is consumed by others who might otherwise be less well off. Entrepreneurs devote so much time to risk taking, inventing, and devising ways to manufacture high quality products cheaply so as to be affordable by others, they drastically reduce their own leisure time. The labor-saving products that they develop create leisure time for others. That is, entrepreneurship is an act of giving. Instead of worthless envious worrying about equality of income, one should be thankful for all the numerous jobs created and the equality of consumption that rich countries make possible.

CDR is the mechanism that functions through the limited liability company (Micklethwait and Wooldridge 2003) and requires a number of historical institutions, laws and events. At the behest of English barons in search of rights, English King John offered Magna Carta in 1215. English King Charles II granted the Royal Charter of 1662 for the study of science. Smith (1776, 2000) recognized the mechanism of division of labor that creates surplus capital. The limited liability law of 1811 was enacted by the American State of New York, soon followed by English and German limited liability laws. These set the stage for the perfect storm that led to the English industrial revolution. It could have happened anywhere in the world where the prevailing conditions were to accumulate. As it turned out, it happened in England on or between 1760 and 1840. Since then, it's Western European neighboring countries and their United State of America (USA) settlers and immigrants have never been the same. Whether they

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realized it or not, they adopted CDR policies and amassed tremendous wealth (Figure 1). At the time of this writing, their economic acceleration is its greatest, while poverty persists elsewhere. There are no records and no blueprints on how it was done or how to repeat it from the beginning (de Soto, 2000). Still, as best we can tell, wealth comes from human capital. And, each human being brings his or her wealth into the world. Therefore, it is in the positive sum self-interest of rich countries to help raise all country CDR indices so that people in poor countries can also expand the world's wealth and stability for the benefit of all.

Democracy is a mechanism for exploring a wider and larger set of options and forming consensus through discussing and weighting. Even if it were true that the variance of genes is different for different sub populations of human beings, then in the case of more variance, even greater intensity of democracy is required to arrive at the optimal consensus. As the internet enables coordination of individual knowledge throughout the economy, democratic countries only grow richer. But, the internet cannot create democracy where it does not already exist.

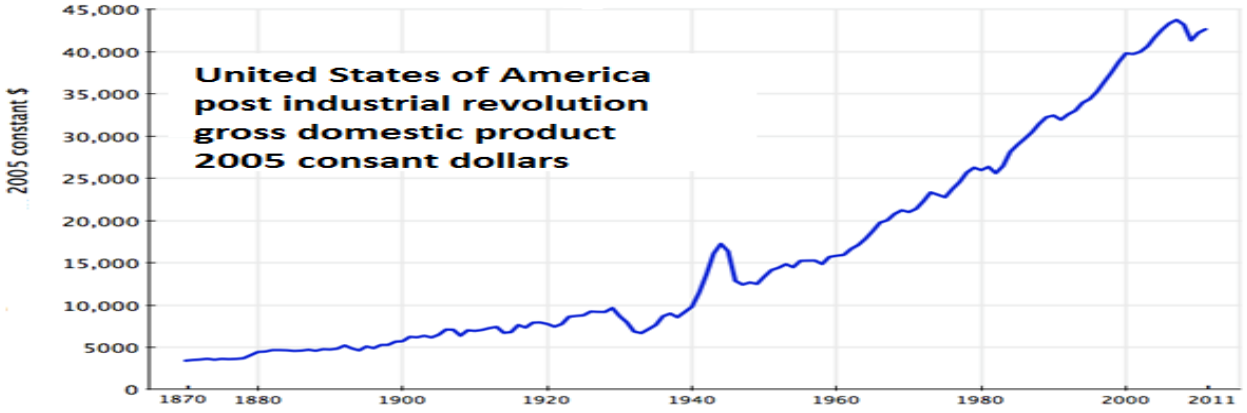

Figure 1. U.S. Department of commerce, Bureau of Economic Analysis, gross domestic product after the industrial revolution of 1760 to 1840 shows massive creation of wealth. Previously, mercantilism and colonialism transferred wealth but did not create wealth.

The remainder of the paper is organized as follows. Section 2 introduces the mystery of wealth creation. Section 3 discussed the structure of the CDR model. Section 4 discusses the estimation and global application of the CDR model. Section 5 compares the relative importance of entrepreneurship and capital stock to *G* generation. Section 6 illustrates the marginal returns on *C*, *D* and *R*. Section 7 illustrates the entrepreneurship elasticity of *G*. We end with some conclusions in section 8. Because of the absence of explicit definitions in the extant literature for concepts such as capitalist, capitalism, entrepreneurship and other consequential terminologies, defining nomenclature in Appendix AA.

2. How supply side wealth is created

Wealth begins in the imagination and creativity of the mind as a human capital idea (Figure 2). Inventions are often considered irrelevant by the many persons who do not see their applications. Indeed, many of the applications will not have been invented as yet. Ideas that arise in the minds of the few may not arise in the minds of the many. Recall the supply side remark by Steve Jobs (1955-2011) that "A lot of times, people don't know what they want until you show it to them." And, Henry Ford's (1863-1947) alleged "If I had asked people what they wanted, they would

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have said faster horses." Therefore, the demand side of an economy can only act on existing products, and it cannot be the source of wealth. Division of labor (Smith, 1776, 200) may create surplus capital but it is not the source of wealth. It is an idea, just like *C*, *D* and *R*. All three of these come from the human brain, the same place that all wealth comes from. To help understand this consider the journey from the silk road to Silicon Valley (see Garten, 2016, Gordon, 2016), and the enormous wealth and philanthropy produced by high technology companies: IBM, GE, Intel, Microsoft, Apple and Google, etc., that are unrelated to natural resources and manufactured goods. Knowledge related to ideas can be taught to other human beings via educational institutions, adding to human capital stock. This division of human capital (researchers, trainers and trainees), in so far as the application of the related knowledge spreads to other human beings and programmable storage devices, creates surplus wealth. Surplus wealth is also created when two or more ideas combine directly to stimulate yet another idea.

CDR is a supply side concept. It expands the supply and types of products and services that are available. It comes from the creation of affordable products, not from the demand for products. Affordable products create their own demand (Smith, 1776, 2006). The supply side is not necessarily top down. It can be bottom up. For example, consider a trash can cleaner. All around the world trash cans were and still are emptied and cleaned by workers. In 1950, Harry Wasylyk and Larry Hansen invented the garbage bag at home. They thought to place a plastic bag in the trash can, then, collect the bag with the trash deposited inside it. They simply tied the bag at the top, collected the trash bag, and replaced it with a new one. The job changed from cleaning to simply collecting. This is an idea that started at the bottom, saved time and effort, thereby creating surplus wealth. This wealth generating change was supplied by the imagination and creative idea of the lowly home trash collector. As more people were taught the idea, the division of human capital created surplus wealth (Ridley, 2017b). In the late 1960's, the bag traveled up the corporate ladder to Union Carbide where it was manufactured. The demand for bags and the demand for plastic increased.

Capitalism is a macro-economic activity measured by market capitalization as an expression of confidence in human capital. Market capitalization is the discounted value of all future earnings from products that are expected to be created from human capital. Therefore, it takes into account current and all future years. Assuming perfect *D* and *R*, then simultaneous with the appearance of human capital (brain) is an increase in market capitalization. Simultaneous with the distribution of market capital to investee companies, said products are created in individual micro-economic units of production that employ capital stock and corporeal physical labor (brawn). This operating definition of homogenous labor is consistent with the original theory of comparative advantage (Ricardo, 1817).

A production function $Q=f(K,L)$ relates physical units of inputs to physical units of outputs from a single machine. Therefore, there can be no such thing as a macroeconomic function when the inputs are different types of items, or outputs are different types of items, or outputs are made by different constructs. Furthermore, there is the fallacy of composition that we can simply jump from microeconomic conceptions to an understanding of production by society as a whole (Cohen and Harcourt, 2003, Ridley and Ngnepieba, 2018). For this reason it might be that $G=f(C,D,R)$ which is defined in the aggregate is a better standalone starting point for the conceptualization of aggregate *G*. Then, since we will already know *G*, we do not need an aggregate production function. However, it is assumed here that there exists a macroeconomic domain that maps homeomorphically into microeconomic domains (Ridley and Ngnepieba, 2018). Still, it is only under specific conditions related to elasticities in the Cobb-Douglas function that capital will be preserved under this mapping. And, these conditions are impossible

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to arrive at in practice. To make seemingly appropriate comparisons, all physical and chemical, etc., inputs and outputs are simply converted to economic value in terms of monetary units. After conversion to monetary units, q=*f*(*k*,*w*) can be integrated over any region of the economy with no loss of accuracy.

Consider the total value of ideas as measured (estimated) by market capitalization (*C*), inclusive of current ideas and former ideas that led to the formation of capital stock (*K*) as measured by fixed capital investment adjusted for depreciation and obsolescence plus skills and knowledge taught to others (see also Day, 2016). That is, the total value of innovation from entrepreneurship is *C*-*K*. *K* is measured by the sum of the book value of installed fixed capital and salaries paid to skilled and educated administrative and professional employees. The value of labor can be measured by wages (*W*) paid to unskilled hourly workers.

In general, consider *m* countries, *i=1,2,3,..m*, where country *i* contains n_i microeconomic production units. Production of G_i is obtained from the sum of n_i micro-economic production units. Consider a deterministic Cobb-Douglas function $v_{ij}=f(k_{ij},w_{ij})$ applied to the jth unit of production in the *i*th country, where k_{ij} is existing capital stock plus capital stock obtained by the investment of the fraction f_{ij} of G_i, w_{ij} is the matching physical labor, and v_{ij} is the annual value of production. All labor are identical in nature and functionality. Any human differences due to knowledge, experience and skills are transferred into the production capacity of capital stock. Assuming constant returns to scale, then $v_{ij}=A_{ij}K_{ij}^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}$, where A_{ij} is the total factor productivity and α_{ij} and 1-α_{ij} are output elasticities of capital and labor respectively. The total monetary value of production for country *i* is given by

$$\sum_{j=1}^{n_i} v_{ij}=\sum_{j=1}^{n_i} A_{ij}K_{ij}^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}=\sum_{j=1}^{n_i} A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}.$$

The global monetary value of production for all *m* countries is therefore

$$\sum_{i=1}^{m}\sum_{j=1}^{n_i} A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}.$$

CONCEPTUAL WEALTH New human capital Ideas of imagination & creativity	**BRAIN**	**Supply side unveiled.** Every human being brings his or her own wealth into the world. Market capitalization is the discounted value of all future earnings from products that are expected to be created from human capital. When human capital of imagination and creativity occurs, market capitalization expands to match. Said capital is attracted to rule of law. Democracy optimizes the conversion of capital to G. Production of goods and services takes place in micro-economic units. The outcome is wealth that can be consumed and capital stock that can be reinvested.	
Market capitalization C=new human capital + capital stock (formerly human capital)		**BRAWN**	
Macroeconomic potential $G_i = f(C_i, D_i, R_i)$	Capital distribution process $k_{ij} = f_{ij}G_i$	Microeconomic production process $f(k_{ij}, w_{ij})$	REALISED WEALTH country aggregate $\sum_{j=1}^{n_i} A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}$

Figure 2. Methods of accounting for *G* in a perfect environment of democracy and rule of law.

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3. Structures of CDR

Endogenous variables: The genesis of all wealth is imagination and creativity of the human mind. *C* is capital that comprises human capital of ideas from entrepreneurs and endogenous accumulated capital stock that was generated from investments in prior ideas, less depreciation and obsolescence. *C* is measured by the value of outstanding shares of stock sold on the capital markets. *C* is utilized in the *C* to *G* conversion. Some fraction of said *G* may be reinvested in capital stock. The decision and the fraction to reinvest are random and exogenous. Therefore, the amount reinvested is not predictable by *G*. Nevertheless, even after depreciation and obsolescence, the remainder can accumulate and become part of subsequent *C* and *G* generation. Said capital stock comprises fixed installed capital less depreciation and obsolescence, plus skills and knowledge acquired from entrepreneurs and taught to others. It is interesting to learn how much capital is new human capital and how much is residual capital stock. In this paper we use 2SLS with latitude as an instrumental variable to separate exogenous entrepreneurial new human capital from endogenous accumulated capital stock.

Exogenous variables: The part of *C* that is human capital of ideas from entrepreneurs is exogenous. *D* is the exogenous catalyst that creates new pathways for connecting, generating, extracting and combining ideas from human capital to generate *G*. Surowiecki (2005) explains how the wisdom of crowds can yield a superior decision compared to that of any one member, even when that member is a superior individual. The direction of causation is obviously from *D* to *G*. Furthermore, *D* and *R* reflect economic freedom, and Gwartney, Holcombe and Lawson (2004, 2006) used Granger (1969) testing to show the direction of causation to be from and economic freedom of the world (EFW) to GDP. *R* is the exogenous catalyst of governance that recognizes property rights and discourages corruption (Goel, Mazhar and Nelson, 2016, Czap and Nur-tegin, 2012). In this study the reverse of corruption was chosen to represent *R*. It is a ranking of countries (the Transparency International graphic in Figure A.1. depicting corruption speaks volumes). *R* encompasses property rights, an important feature for economic growth (McCloud and Kumbhakar, 2012). Country rankings based on corruption correspond inversely to country rankings based on property rights. Therefore, the reverse of corruption ranking captures property rights. But, property rights are a complex legal proposition that the average person might not fully understand. On the other hand, the concepts of fairness and justice versus corruption are intuitive.

The catalysts *D* and *R* perform a role similar to that suggested by Baron J. J. Berzelius in 1835 to describe the property of substances that speed up or slow down chemical reactions without being consumed in them. *D* and *R* are heterogeneous exogenous catalysts because they exist in different structures from each other and from capital and *G*. That way they can remain robust and incorruptible by the *G* production that they facilitate. The human capital component of the process is what is now commonly referred to as entrepreneurship.

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4. The Global Time Invariant CDR model

To determine the relative contributions of *C*, *D*, *R* and natural resources (*N*), we standardize the variables to guarantee upper and lower bounds of $0 \leq g, C, D, R, C \cdot D \cdot R, N \leq 1$ as follows:

g	= (G -lowest G)/(highest G -lowest G)
C (Capitalism)	= (per capita capitalization-lowest per capita capitalization)/ (highest per capita capitalization - lowest per capita capitalization)
D (Democracy)	= (lowest democracy rank-democracy rank)/ (lowest democracy rank- highest democracy rank)
R (Rule of law)	= (lowest corruption rank-corruption rank)/ (lowest corruption rank- highest corruption rank)
N (Natural resources)	= (per capita total natural resource rents-lowest per capita total natural resource rents)/(highest per capita total natural resource rents- lowest per capita total natural resource rents).

Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries.
These transformations are all one hundred percent reversible.

The ordinary least squares (OLS) model is $g_i = \beta_0 + \beta_c C_i + \beta_d D_i + \beta_r R_i + \beta_{cdr} C_i \cdot D_i \cdot R_i + \beta_n N_i + \varepsilon_i$, where *i* represents the *i*th country, the coefficients and variables are dimensionless, and the errors ε_i are random and normally distributed with zero mean and constant standard deviation. We regress g on *C*, *D*, *R*, and *N* to obtain the *i*th country estimated g as follows.

Year 2014: $g_i = 1.53C_i + 0.14D_i + 0.23R_i - 1.21C_i \cdot D_i \cdot R_i + 0.38N_i$

$|t| =$ *(6.60)* *(1.69)* *(2.60)* *(4.40)* *(5.59)*

R^2_{adj} =83%

Partial corrections: 59% 5% 10% 3% 6%

where g_i is the per unit G_i and G_i can be estimated from $G_i = g_i$ (highest G_i-lowest G_i) + lowest G_i. Click for source data.
Other possible subsidiary interaction effects such as *C·D*, *C·R* and *D·R* were tested and found not to be statistically significant.

The variation in *G* that is explained by the model is 83%. The remaining 17% is due to unpredictable events such as natural disasters like hurricanes and earth quakes. Additionally, non-publicly traded stocks are not included because there are no data on their capitalization. The largest factor in explaining *G* is *C* (59%). This model shows that contrary to commonly held belief, natural resources contribute only 6% to *G*. *C*, *D* and *R* contribute about (59+5+10+3)/6=13 times. This is in addition to the Dutch disease or natural resources curse they are known to cause (Auty, 1993; Frankel, 2012; Humphreys, 2005; Norman, 2009; Peach and Starbuck, 2011; Sachs, 2001; Sala-i-martin, 2003; van der Ploeg, 2011; Wadho, 2014). Ridley (2017b) gives a didactic account of how Jamaica lost its currency to the bauxite natural resource curse. The *C*, *D* and *R* components have positive coefficients and are significant per the student t statistic. The coefficient of the $C_i \cdot D_i \cdot R_i$ interactive term is significant but negative. The negative value is due to friction in the decision-making process permitted by a democratic process. It reduces *G* from the theoretical maximum possible value that would be attainable if the decision makers were in perfect agreement. Any disagreement must subtract from the theoretical optimal contribution. If there were perfect agreement and the agreement was the best possible decision, then the contribution from the interaction could neither be positive nor negative and

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must be zero. When government spending is added to the regression model (not shown), its coefficient is not significant and there is no change in R^2_{adj}.

Other growth models such as that of Solow (1956) are based on installed capital stock and cannot capture entrepreneurial capital. Prior studies of data from 1949 to 1988 such as those by Adelman and Morris (1967), Barro (1996), Dick (19740), Grier and Tullock (1989), Helliwell (1992), Huntington and Dominguez (1975), Kohli (1986), Kormendi and Meguire (1985), Landau (1986), Marsh (1988), Pourgerami (1988, 1991), Przeworski and Limongi (1993, 1997), Remmer (1990), Scully (1988, 1992), Sloan and Tedin (1987) and Weede (1983) excluded the interactive term, which inter alia, explains why the significance of D gave mixed results and was hitherto not captured. Also, economic freedom advocated by Friedman and Friedman, 1980, Friedman, 2002, Gwartney, Holcombe and Lawson, 1999, Gwartney and Lawson 2003, Heritage Foundation, 1995-2016, Sowell, 2015, Rand, 1961, reduced government and the empowerment of people, are consistent with the CDR model. Economic freedom appears to be working for GDP (Gwartney, Lawson and Hall, 2015). But, Gwartney, Holcombe and R. Lawson's (2006) model that uses the EFW index yielded an R^2_{adj} =52.5%, considerably lower than the 83% obtained from the CDR index reported in this paper.

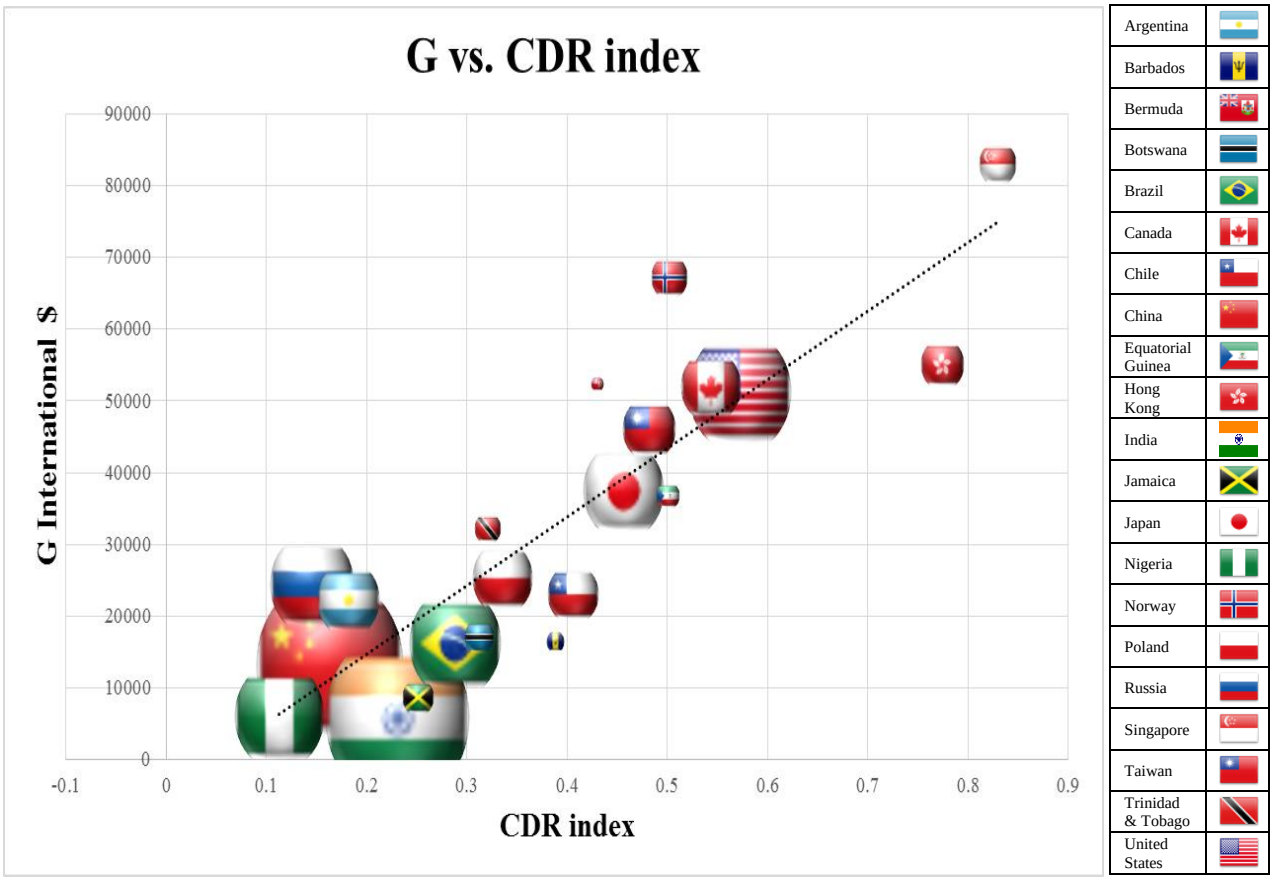

Fig 3. Year 2014 *G* vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population.

The CDR model may be applied to the global prediction of *G* (Figure 3). The high correlation between CDR and *G* is made obvious from the graph. The regression line is for 79 countries for

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which there are complete data and that represent almost all of the world's population. In addition, the graph shows *G* bubbles for twenty one countries selected for variety in natural resources, government spending, country size, location, culture and physical characteristics of the population. As the graph is traversed from one end to the other, there is no systematic change in bubble size (population size). The high natural resource countries, namely Russia, Nigeria, Brazil, India to mention just a few have low CDR and *G*. The low natural resource countries, namely Singapore, Hong Kong, Taiwan, Bermuda, Japan to name a few have high CDR and high *G*. As noted earlier government spending has no effect on *G*. Government spending and its source of funds which are taxes, appear to cancel. The countries on the graph are from all over the map, and there is no indication that geographic location, culture and appearance of the population makes any difference. Sowell (2015) speculated that geography might play a role but that is not supported here. The only exception is the preponderance of Western Europe and USA in the high *G* category. It is true that they exist in temperate climate zones, but so do low CDR Eastern Europe and Russia. The unique feature that Western Europe and USA have in common is high CDR. The high cross country R^2_{adj} of 83% and the straight line relationship between the countries and the CDR index establishes that the CDR model is global invariant.

To investigate the time invariance of the CDR model, the CDR model is re-estimated for different year g's from 1995 to 2016. The results are shown on Table 1 and Figure 4. The B′s are used in place of $\widehat{\beta}'s$ since they are the closest to the available characters in the legend of the chart. The *Bo*′s (not shown) are all zero. For the last seven years from 2010 to 2016 the parameter estimates are nearly identical. For earlier years they are also similar. For all practical purposes the parameter estimates are the same and are therefore time invariant.

Table 1. CDR model OLS parameters for 22 years.

YEAR	*Bc*	*Bd*	*Br*	*Bcdr*	*Bn*	R^2_{adj}
2016	1.53	0.14	0.24	-1.25	0.33	0.81
2015	1.53	0.14	0.24	-1.23	0.35	0.82
2014	1.53	0.14	0.23	-1.21	0.38	0.83
2013	1.51	0.14	0.23	-1.15	0.39	0.84
2012	1.52	0.16	0.22	-1.16	0.42	0.83
2011	1.53	0.17	0.22	-1.16	0.42	0.83
2010	1.56	0.18	0.21	-1.19	0.42	0.83
2009	1.57	0.22	0.21	-1.13	0.48	0.82
2008	1.52	0.23	0.22	-1.09	0.50	0.82
2007	1.62	0.22	0.20	-1.23	0.44	0.82
2006	1.66	0.24	0.20	-1.27	0.49	0.82
2005	1.72	0.25	0.19	-1.33	0.52	0.82
2004	1.73	0.26	0.19	-1.32	0.53	0.82
2003	1.77	0.29	0.18	-1.33	0.55	0.81
2002	1.77	0.32	0.19	-1.26	0.56	0.81
2001	1.77	0.33	0.17	-1.23	0.64	0.81
2000	1.78	0.30	0.17	-1.24	0.63	0.81
1999	1.81	0.31	0.16	-1.27	0.65	0.81
1998	1.81	0.32	0.15	-1.25	0.74	0.81
1997	1.83	0.27	0.15	-1.32	0.68	0.82
1996	1.85	0.27	0.14	-1.31	0.73	0.81
1995	1.84	0.27	0.14	-1.29	0.75	0.81

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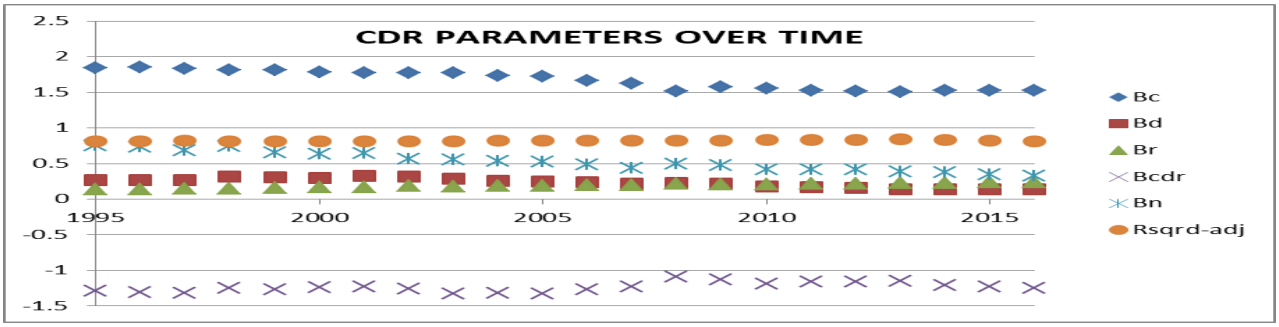

Figure 4. CDR model OLS parameters for 22 years

5. New human capital versus old capital stock from prior human capital.

We wish to decouple exogenous and endogenous capital. This can be accomplished by purging the endogenous capital from the total capital, leaving only exogenous capital. La Porta, 1999, considered legal origin, latitude and ethnolinguistic fractionalization as 2SLS instrumental variables (IVs). The only one of these that could be relevant to C_i is latitude. We fitted the 2SLS models as follows. Click for source data.

The OLS model is

$$g_i = \beta_0 + \beta_c C_i + \beta_d D_i + \beta_r R_i + \beta_{cdr} C_i \cdot D_i \cdot R_i + \beta_n N_i + \varepsilon_i,$$

$$\hat{g}_i = \mathbf{1.53} C_i + 0.14 D_i + 0.23 R_i - 1.21 C_i \cdot D_i \cdot R_i + 0.38 N_i.$$

$|t|$ = (6.6) (1.69) (2.60) (4.40) (5.59) $\boldsymbol{R^2_{adj}}$**=0.83**

The 1st stage least squares model is

$$C_i = \alpha_l L_i + \alpha_d D_i + \alpha_r R_i + \alpha_{cdr} C_i \cdot D_i \cdot R_i + \alpha_n N_i + \xi_i,$$

where the instrumental variable is latitude (L_i).

The estimated 1st stage least squares model is

$$\hat{C}_i = 0.04 - 0.07 L_i - 0.16 D_i + 0.22 R_i + 1.11 C_i \cdot D_i \cdot R_i - 0.02 N_i.$$

$|t|$ = (3.20) (**3.77**) (4.64) (6.43) (27.11) (0.61) R^2_{adj}=0.94

The 2nd stage least squares model where C_i is replaced by $\hat{C}_i$ is

$$g_i = \beta_0 + \beta_{\hat{c}} \hat{C}_i + \beta_d D_i + \beta_r R_i + \beta_{\hat{c}dr} \hat{C}_i \cdot D_i \cdot R_i + \beta_n N_i + \epsilon_i.$$

The estimated 2nd stage least squares model for estimating g from exogenous new idea human capital entrepreneurship ($\hat{C}_i$) is

$$\hat{g}_i = \mathbf{1.30} \hat{C}_i + 0.12 D_i + 0.28 R_i - 0.98 \hat{C}_i \cdot D_i \cdot R_i + 0.39 N_i.$$

$|t|$ = (2.66) (0.88) (1.95) (1.88) (4.45) $\boldsymbol{R^2_{adj}}$**=0.74**

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The results are summarized in Table 2.

Table 2: 2SLS Regression Results

1st stage least squares Regressand is *C* R^2_{adj}=0.94				**2nd stage least squares Regressand is g** R^2_{adj}=0.74		
Coefficient	Estimate	$\lvert t \rvert$		Coefficient	Estimate	$\lvert t \rvert$
α_0	0.04	3.27		β_0	0.00	0.02
α_l	-0.10	3.77		$\beta_{\hat{c}}$	1.30	2.66
α_d	-0.16	4.64		β_d	0.12	0.88
α_r	0.22	6.43		β_r	0.28	1.95
α_{cdr}	1.11	27.11		$\beta_{\hat{c}dr}$	-0.98	1.88
α_n	-0.02	0.61		β_n	0.39	4.45

Since Cov(L_i, ξ_i) $= 0$ by construction, $\hat{C}_i$ is endogenous if and only if the structural error ε_i and reduces form error ξ_i are correlated such that Cov(ε_i, ξ_i)≠0. Consider the regression of ε_i on ξ_i: ε_i=ρξ_i+e_i, where ρ= Cov(ε_i, ξ_i)/Var(ξ_i) and Cov(L_i, e_i) $= 0$. Substituting into the above OLS model for ε_i,

$$g_i = \beta_0 + \beta_c C_i + \beta_d D_i + \beta_r R_i + \beta_{cdr} C_i \cdot D_i \cdot R_i + \beta_n N_i + \rho\xi_i + e_i.$$

If we knew ξ_i we could calculate the OLS estimate for ρ and perform a t test for significance. Unfortunately we do not know ξ_i. Still, following the approach by Hausman (1978, 1983), replacing ξ_i with $\hat{\xi}_i$ from the above estimated 1st stage least squares model,

$$g_i = \beta_0 + \beta_c C_i + \beta_d D_i + \beta_r R_i + \beta_{cdr} C_i \cdot D_i \cdot R_i + \beta_n N_i + \rho\hat{\xi}_i + e_i.$$

The result of the t test is that $\rho \neq 0$ and that C_i is endogenous. After capital stock is purged from C_i the correlation with ε_i is negligible: Corr($\hat{C}_i, \hat{\varepsilon}_i$) $= -0.05$.

The coefficient of L_i is significantly different from zero ($\lvert t \rvert$=3.77), supporting the requirement that L_i be correlated with C_i. The OLS stochastic error is unobservable, so we can only assume that the requirement that L_i is uncorrelated (or negligible) with ε_i prevails. Note however that the coefficient is negative (-0.07), implying that the exogenous capital decreases the further a country is from the equator. No causation is posited for this but as latitude increases, vegetation decreases, and so does life, the source of human capital. Still, it is not important to our main objective here. As it turns out, when latitude is included in the OLS model, it does contribute R^2_{adj} =0.04. But, like N, it is negligible and is not under government decision making control. A country cannot move to gain from latitude or natural resources and must focus on raising its CDR index. When the endogenous capital stock is purged from *C*, the coefficient of capital changes from 1.53 to 1.30, implying that entrepreneurship contributes 100(1.30/1.53)=85% to *G* generation and capital stock contributes 100(1.53-1.3)/1.53=15% to *G* generation. That is, new ideas contribute about 85/15~6 times as much as capital stock from old ideas. The amount of negative friction (-1.21) associated with the $C_i \cdot D_i \cdot R_i$ interaction when capital includes capital stock is less than the amount of negative friction (-0.98) associated with the $\hat{C}_i \cdot D_i \cdot R_i$ interaction when capital is only entrepreneurship. In the case of entrepreneurship only, there could be as few as one person involved in decision making and democracy would not

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be significant ($|t|$=0.88). In the case of capital stock there are more likely to be many decision makers involved and democracy would be significant ($|t|$=1.69).

The 2nd stage least squares model is a less efficient predictor of *G* by the difference in R^2_{adj} of 0.83-0.74=0.09 per unit or 9%. The contribution of total capital to $R^2_{adj} = .59$. So, this shows that new ideas are about (59-9)/9~6 times as important for economic growth as is capital stock from old ideas from a previous time. That is, it shows how rapidly capital stock declines from depreciation and obsolescence. Resting on our laurels is the wrong policy. Inheritance, when unenhanced, lasts only a short time. This is consistent with what we know that seventy percent of rich families lose their inheritance by the second generation. And, ninety percent lose it in three generations (Taylor, 2018). This is also consistent with and illustrated by the speed with which countries that adopted CDR policies (Chile, Poland, Hong Kong, Singapore) attracted human capital new ideas, thereby experiencing increases in *G* relative to their neighbors who would have had to rely on capital stock from old ideas.

This declining stock observation could be extended to the case of welfare. All rich countries have the problem of what to do about the indigent. With what appears to be an accumulation of capital stock, it is so unseemly that a rich country should be defined by its poor. The solution to date has been to institute minimum wage laws that put unqualified persons out of work, followed by welfare for the unemployed, paid for out of the apparent capital stock. But, welfare recipients cannot contribute to new idea generation for the simple reason that they are not engaged in the capital to *G* conversion process. Their payments from capital stock are not unlike inheritances, or the taxing thereof that accelerates its depletion. This is despite the potential 6 to 1 ratio from their potential contribution versus capital stock. Minimum wage workers may not be qualified to work in research and development. But, consider a negative income tax government wage supplement that places workers in jobs where their experience just does not justify them being hired. In addition to working, numerous small contributions of ideas on how to improve their job will occur in all kinds of ways and at times that are highly unpredictable. These are the kinds of ideas that only workers are likely to see, thereby making them eminently qualified in that sense. The negative income tax wage supplement could pay for itself from these micro innovations. Then, in about six months to a year the worker may become worth what the government defines as a living wage, and the employer will be willing to pay said wage with no need for any supplement (Ridley, 2017c).

The above section on the structures of CDR explains why D and R are heterogeneous exogenous catalysts and therefore cannot in theory be endogenous. Still, D was tested for endogeneity using legal origin, latitude and ethnolinguistic fractionalization as 2SLS IVs for democracy. But, their regression coefficients were all found to be first stage insignificant.

The revised 2SLS parameters estimated for years 1995 – 2016 are given in Table 3. To demonstrate that the revised model has all exogenous regressors, a plot of the time variant parameter estimates is shown in Figure 5.

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Table 3. CDR model 2SLS parameters for 22 years.

YEAR	*Bc*	*Bd*	*Br*	*Bcdr*	*Bn*	R^2_{adj}
2016	1.32	0.12	0.29	-1.04	0.34	0.72
2015	1.32	0.13	0.28	-1.02	0.36	0.73
2014	1.30	0.12	0.28	-0.98	0.38	0.74
2013	1.22	0.11	0.29	-0.87	0.40	0.75
2012	1.21	0.12	0.29	-0.85	0.43	0.75
2011	1.21	0.12	0.29	-0.85	0.43	0.75
2010	1.29	0.15	0.27	-0.92	0.42	0.74
2009	1.30	0.19	0.27	-0.87	0.48	0.75
2008	1.15	0.17	0.30	-0.73	0.45	0.74
2007	1.41	0.20	0.25	-1.04	0.37	0.75
2006	1.52	0.23	0.22	-1.16	0.49	0.74
2005	1.69	0.26	0.20	-1.34	0.52	0.74
2004	1.84	0.33	0.17	-1.43	0.56	0.74
2003	1.84	0.33	0.17	-1.43	0.56	0.74
2002	1.89	0.36	0.17	-1.43	0.56	0.74
2001	1.94	0.37	0.15	-1.44	0.63	0.75
2000	1.99	0.35	0.13	-1.50	0.62	0.75
1999	2.09	0.38	0.10	-1.60	0.64	0.75
1998	2.10	0.39	0.10	-1.59	0.73	0.73
1997	2.15	0.35	0.09	-1.68	0.68	0.75
1996	2.20	0.36	0.08	-1.71	0.72	0.75
1995	2.20	0.36	0.07	-1.69	0.74	0.75

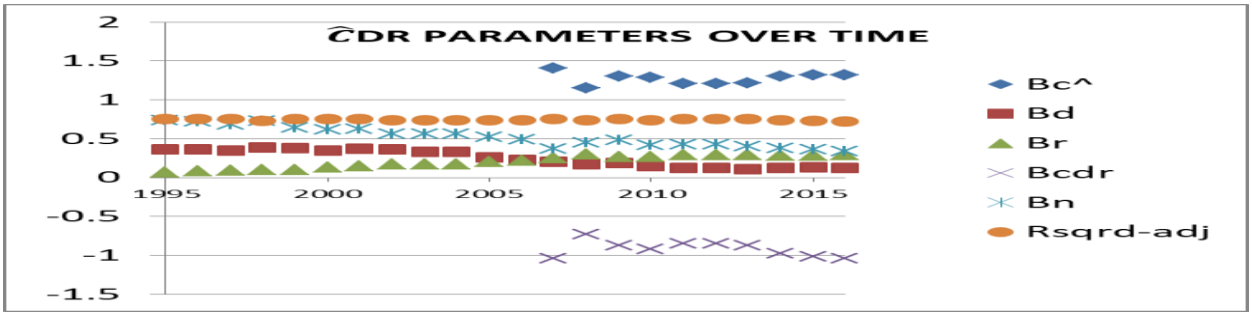

Figure 5. ĈDR model 2SLS parameters for 22 years

Consistency in the estimator of a parameter requires that the sampling distribution of the estimator becomes increasing concentrated around the population value as the sample size increases. In this case, as the sample goes from 2016 to 2016 – 2015 to 2016-2014 to 2016-2013, and so on. The Bd, Br and Bn parameter estimates from the CDR and ĈDR models are approximately constant for 22 years. They converge in the forward direction of time. The Bc and Bcdr estimates are approximately constant for the most recent 10 years. Prior to 2008, capitalization data were not available for all countries. So capitalization was held constant. Therefore, Bc and Bcdr increased in absolute value as *G* was decreasing, going back in time and

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capitalization was held constant. Constancy and convergence of the parameter estimates demonstrates model stability and consistency. In the case of the ĈDR model, it demonstrates that endogenous capital stock K was purged from total capital $C=\hat{C}+K$ to leave only exogenous entrepreneurship human capital $\hat{C}$. So, if the ĈDR model contains only exogenous regressors, the 2SLS parameter estimates must be best linear unbiased (blue) estimators. So the 2SLS parameters estimates are unbiased. The CDR data came from a real-life uncontrolled experiment, but the 2SLS process yields a global time invariant ĈDR scientific law. Even if there were some bias, the model would yield useful stable predictions. Some two hundred and forty years after Adam Smith (1776) announced an inquiry into the nature and causes of the wealth of nations, the cause is found to be capitalism, democracy and rule of law, and the ĈDR model places economics on a sound scientific footing.

6. Total and Marginal Contribution to g

The following analysis of total and marginal contributions is based on the revised 2SLS regression model. The total country i contribution is $\hat{\mathrm{g}}_i = 1.3C_i + 0.12D_i + 0.28R_i - 0.98C_i \cdot D_i \cdot R_i$. The marginal contributions to the mean in $\hat{\mathrm{g}}_i$ (denoted by $\mathrm{E}[\hat{\mathrm{g}}_i]$) from C_i, is the partial derivative $\partial E[\hat{\mathrm{g}}_i]/\partial C_i = 1.3 - 0.98D_i \cdot R_i$, for different fixed values of $D_i \cdot R_i$. The product $D_i \cdot R_i$ is a product of fractions and is therefore small but positive. Therefore, the negative values for $-0.98D_i \cdot R_i$ implies that $\partial E[\hat{\mathrm{g}}_i]/\partial C_i < 1.3$.

Consider the scenario where a fraction f_i of $\hat{\mathrm{g}}_i$ is reinvested in capital stock, such that

$$\hat{\mathrm{g}}_i = 1.3(\hat{C}_i + f_i\hat{\mathrm{g}}_i) + 0.12D_i + 0.28R_i - 0.98(\hat{C}_i + f_i\hat{\mathrm{g}}_i) \cdot D_i \cdot R_i.$$

Then,

$$(1 - 1.3f_i + 0.98f_i \cdot D_i \cdot R_i)\hat{\mathrm{g}}_i = 1.3\hat{C}_i + 0.12D_i + 0.28R_i - 0.98\hat{C}_i \cdot D_i \cdot R_i.$$
$$\hat{\mathrm{g}}_i = (1.3\hat{C}_i + 0.12D_i + 0.28R_i - 0.98\hat{C}_i \cdot D_i \cdot R_i)/(1 - 1.3f_i + 0.98f_i \cdot D_i \cdot R_i)$$

And, the marginal return on entrepreneurial capital $(\hat{C}_i)$ is

$$\partial E[\hat{\mathrm{g}}_i]/\partial \hat{C}_i = (1.3 - 0.98D_i \cdot R_i)/(1 - 1.3f_i + 0.98f_i \cdot D_i \cdot R_i).$$

The marginal utilities of *D* and *R* are

$$\partial E[\hat{\mathrm{g}}_i]/\partial D_i = \frac{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)(0.12 - 0.98\hat{C}_i \cdot R_i) - (1.3\hat{C}_i + 0.12D_i + 0.28R_i - 0.98\hat{C}_i \cdot D_i \cdot R_i)(0.98f_i \cdot R_i)}{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)^2}$$
$$\partial E[\hat{\mathrm{g}}_i]/\partial R_i = \frac{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)(0.28 - 0.98\hat{C}_i \cdot D_i) - (1.3\hat{C}_i + 0.12D_i + 0.28R_i - 0.98\hat{C}_i \cdot D_i \cdot R_i)(0.98f_i \cdot D_i)}{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)^2}$$

Simplifying,

$$\partial E[\hat{\mathrm{g}}_i]/\partial D_i = \frac{0.12 - 0.156f_i - 0.98\hat{C}_i \cdot R_i - 0.2744f_i \cdot R_i^2}{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)^2}$$
$$\partial E[\hat{\mathrm{g}}_i]/\partial R_i = \frac{0.28 - 0.364f_i - 0.98\hat{C}_i \cdot D_i - 0.1176f_i \cdot D_i^2}{(1-1.3f_i+0.98f_i \cdot D_i \cdot R_i)^2}$$

The following will omit the country i notation and apply the same fraction to all countries. The total contribution to g and marginal contribution from $\hat{C}$ for three different fractions of

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reinvestment in capital stock $f = 0, 0.1, 0.2$ are plotted in Figure 6a and 6b. In each case, g increases with *C*=*D*=*R* until *C*=*D*=*R* is approximately 0.75 then it declines. The post peak decline in g is due to the interaction effect of $\hat{C} \cdot D \cdot R$ which can only be zero or negative. The peak g is 0.85 when there is no reinvestment. Higher peaks in g occur when the fraction reinvested is 0.1 and 0.2. This implies that division of human capital creates surplus g. The marginal return on $\hat{C}$ falls with increasing *D* and *R*. Higher marginal returns occur when the fraction reinvested is 0.1 and 0.2. The difference in marginal return due to fraction reinvested is least when *D* and *R* is highest. Note that in reality there will be depreciation and obsolescence in capital stock that reinvestment must surpass. Click for source data.

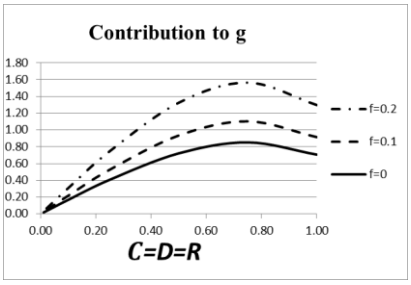

Fig 6a. Total contributions to g.

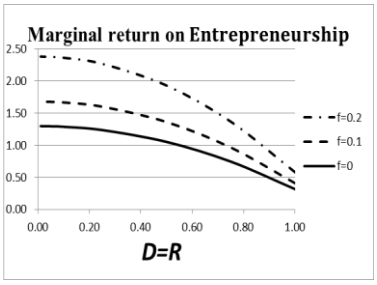

Fig 6b. Marginal contribution to g.

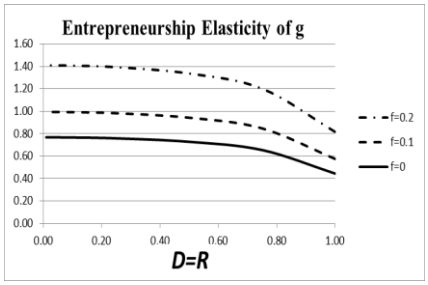

Fig 6c. Entrepreneurship elasticity of g.

7. Entrepreneurship capital elasticity of g

The entrepreneurial capital ($\hat{C}$) elasticity of g is defined from the percentage change in g in response to a 1% change in $\hat{C}$, ceteris paribus. This point elasticity can be investigated directly from the marginal return on $\hat{C}$. That is, from $(\hat{C}_i/\hat{g}_i)\partial E[\hat{g}_i]/\partial \hat{C}_i$. From figure 6c, in general, as *D* and *R* increase, the elasticity of g falls. When there is no reinvestment (*f*=0), g is always inelastic. As the reinvestment fraction increases to *f*=0.1 and 0.2, the elasticity increases. If a unitary elasticity of 1.0 can be obtained for some combination of these variables, such that g is maximum, then the policy suggested is to reinvest about 10% when *D* and *R* are between 0 and 0.5. As *D* and *R* increase from 0.5 to 0.9, increase the fraction of reinvestment in like manner to about 20%. As *D* and *R* increase from 0.9 to 1.0, the fraction of reinvestment should be increased to about 25%. Assuming uniform distribution across countries, the average is about 10%+(25-10)%x0.5=17.5%. Adding 3.5% for depreciation and obsolescence brings this number up to 21%. This is consistent with the World Bank report of 21% for year 2014 worldwide average gross fixed capital formation (GFCF). GFCF does not include book value recovery of depreciation for tax purposes, but it does include actual replacements. Neither one of these includes capital stock investment in training to develop knowledge and skills. Therefore, we proffer that the theoretical g=*f*(*C*,*D*,*R*) function is validated by the empirical GFCF.

8. Conclusions

The CDR model is a global time invariant scientific law. The law governs the mechanism by which human capital is converted to wealth for bifurcation into consumption and capital stock for future investment. The unitary capital elasticity of *G* provides an optimal policy guide for the CDR and reinvestment strategy that maximizes *G*. The contribution to *G* from intangible *C*, *D*

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and *R* is about thirteen times that from tangible natural resources. The contribution from entrepreneurship is about six times that from capital stock. If the source of wealth is indeed the human mind, then if entrepreneurial imagination and creativity are unlimited (Lotto, 2017), then wealth is unlimited (Ridley, 2017a). Each human being brings his or her own wealth into the world. Ideas are the natural born enemy of the way things are. For only change can usher in new wealth. Sometimes it is the people who no one imagines anything of who do the things that no one can imagine (Moore, 2004). If wealth were fixed, each child could only contribute to the impoverishment of everybody else. The phenomenal wealth creation by the countries that have implemented CDR policies commensurate with population increases there, is proof that there is no such impoverishment. A country that knows where it is going will not get far. A country willing to create an entrepreneurial environment of risk taking and investment in the unknown may experience unlimited growth.

In the mystery of capital, Hernando de Soto (2000) implied that capital is hidden in land assets that can be acquired by titling through the property rights feature of rule of law. In reality, such a combination of assets and titles will remain barren in the absence of ideas. It will fall short of being working capital. Property is collateral that can be used to obtain financial capital. But, the true source of wealth is really the human capital of imagination and creativity of the mind. The remainder of the human being is physical labor. Human capital is contained in total capital measured by market capitalization. Wealth is realized through CDR. Rule of law attracts capital and democracy deploys it optimally to generate wealth contribution as measured by *G*. Assuming perfect democracy and rule of law, hence high signal to noise ratio channels of new quanta of entrepreneurial information, market capital expands and shrinks to match expansion and shrinkage in entrepreneurial imagination and creativity. Only a small number of sui generis people will be entrepreneurs. What the CDR model suggests is that an entrepreneurial environment is required such that when the entrepreneur does come along their message gets heard and acted on. Also contained in market capitalization may be capital for which fungible property based collateral is pledged. The capital that is deployed to appropriate units of production is converted to *G*. *G* is generated from CDR, independently of natural resources, government spending, country size, location, culture, and physical characteristics of the population. The human capacity for ideas (human capital and entrepreneurship), and the virtues of democracy and rule of law are all that are required. Even if certain limiting human characteristics or natural resources were obstacles in some nations, CDR is salutary to economic development in terms of making the best of what is possible. As countries adopt policies that decrease CDR, their *G* falls. Such is the mystery of poverty. As countries adopt policies that increase CDR, their *G* increases. Such is the mystery of wealth. This is as far as science can take us (Ball, 2012). Counting on the next random invention is a leap of faith.

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Appendix A

World Corruption

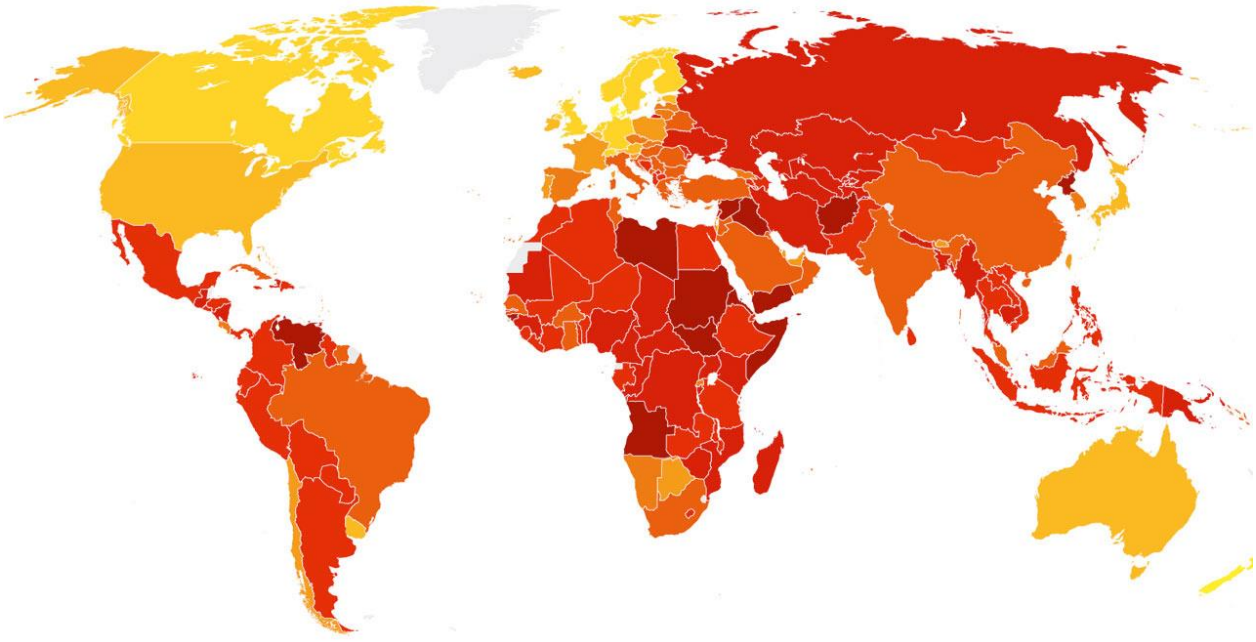

Figure A.1. Corruption Perceptions Index 2016. Lighter color less corruption. Darker color more corruption. Visit www.transparency.org/cpi for more information

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CHAPTER 9

Decoupling Entrepreneurship Capital from Capital Stock

Reference: Ridley and Khan (2019).

Per capita real gross domestic product adjusted for purchasing power parity (G) is parsimoniously explained by capitalism (C), democracy (D) and rule of law(R). G is estimated from a CDR *index equal to the vector inner (dot) product of global invariant parameters [1.53 0.14 0.23 -1.21] and country specific [C D R C·D·R]. The data are for year 2014 and 79 countries that represent practically all people in the world. C is measured by total capitalization then split into human capital of entrepreneurship imagination and creativity and capital stock of knowledge, machines, computers, training, recording devices etc. The contribution of entrepreneurship to G is found to be 6 times that of capital stock.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship

JEL: E02, P16

1. Introduction

The idea of explaining per capita real gross domestic product adjusted for purchasing power parity (*G*) by capitalism (*C*), democracy (*D*) and rule of law(*R*) was introduced by Ridley (2016) and Ridley, Davis and Korovyakovskaya (2017). But, no formal measurements were made. Ridley (2017b) presented a parsimonious model *G=f*(*C,D,R*) based on published country market capitalization as the measure of capitalism, ranking in democracy, and ranking in rule of law (Goel, Mazhar and Nelson, 2016; Czap and Nur-tegin, 2012, see also Couttenier and Toubal, 2017, de Soto, 2000). Ridley (2017b) used an ordinary least squares (OLS) model based on year 2014 data for 79 countries that represent practically all people in the world. This paper goes further using two stage least squares (2SLS) to decouple the human capital ideas of imagination and creativity from capital stock of human knowledge, machinery, recording and computing devices, etc. This is the first time that this decoupling of capital has been performed. It is also the first time that an estimate of the value of ideas has been computed.

Unlike the Solow (1956) growth model of capital stock and labor, *C* is measured from the sum of entrepreneurship capital and capital stock and assumes that investors act rationally and without bias. Its current value is discounted future earnings for current and all subsequent years. Capitalism is the mechanism for capital formation and the company is the instrument of capitalism (Micklethwait and Wooldridge, 2003). We define a capitalist as a person who seeks to deploy personal effort in such a way as to maximize the benefit to him or herself. This includes all rational human beings (Smith 1776, Young, 2016). Democracy ranking reflects the ability of citizens to freely select government and corporate leadership, and invest capital. It is a proxy for new pathways that connect human capital ideas of imagination and creativity. Rule of law is the enforcement of contracts and discouragement of corruption. It is a proxy for stability that attracts capital. This research finds that the intangible factors of *C*, *D* and *R* greatly outweigh the tangible factor of natural resources (*N*). Furthermore, natural resources can contribute to corruption in the absence of democracy and rule of law (Norman, 2009; Frankel, 2012). This suggests that countries may do better to embrace a national policy that focuses on raising their *C*, *D* and *R*.

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Different economic schools of thought suggest different determinants of economic growth. However, the consensus is that institutions reflected in *D* and *R* play a significant role (Acemoglu, Johnson and Robinson, 2005; Hamilton,1919; Hodgson; 2000, North; 1991). The literature appears to be settled on the impact of *R*. But, there is considerable debate over the role of *D*. In a review of several studies on data from 1949 to 1992 (see Adelman and Morris, 1967; Dick, 1974; Huntington and Dominguez, 1975; Weede, 1983; Kormendi and Meguire, 1985; Kohli, 1986; Landau, 1986; Sloan and Tedin, 1987; Marsh, 1988; Pourgerami, 1988; Scully, 1988, 1992; Barro, 1989; Grier and Tullock; 1989, Remmer, 1990; Pourgerami, 1991; Helliwell, 1992), the findings of Przeworski and Limongi (1993) were split between positive, negative and no effect. But, none of those studies include an interaction $C{\cdot}D{\cdot}R$ term. The *C, D, R*, model does include an interaction term. The result is a positive democracy effect and negative friction between capitalism, democracy, and rule of law, where all three make significant contributions to explaining *G*. These will be explained further in the section on the regression model. Regarding the direction of causation, *D* and *R* are the same type as economic freedom of the world (EFW) variables, and Gwartney, Holcombe and Lawson (2004, 2006) showed the direction of causation to be from EFW to *G*.

The remainder of the paper is organized as follows. Section 2 is a global cross-sectional regression analysis. Section 3 shows a corresponding vexillological chart that easily identifies countries. Section 4 reconciles the macro and micro economic models of *G* and production. Section 5 contains concluding remarks and suggestions for future research.

2. Regression analysis

The OLS regression model is defined as

$$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \beta_N N + \varepsilon$$

where the parameters and variables are dimensionless under linear transformation as follows

g	= (*G* - lowest *G*)/(highest *G*-lowest *G*)
C (Capitalism)	= (per capita capitalization-lowest per capita capitalization)/ (highest per capita capitalization-lowest per capita capitalization)
D (Democracy)	= (lowest democracy rank-democracy rank)/ (lowest democracy rank-highest democracy rank)
R (Rule of law)	= (lowest corruption rank-corruption rank)/ (lowest corruption rank-highest corruption rank)
N (Natural resources)	= (per capita total natural resource rents-lowest per capita total natural resource rents)/ (highest per capita total natural resource rents-lowest per capita total natural resource rents).
ε	= normally distributed zero mean constant standard deviation random error.

These transformations standardize the variables and ensures upper and lower bounds on $0 \le g, C, D, R, C \cdot D \cdot R, N \le 1$.
Democracy and corruption are rank ordered, where the highest =1 and the lowest = the number of countries.
Data for these standardized variables are listed in a *supplementary spreadsheet*. ***Click here to download supplementary source data.***

Data sources

G (PPP, constant international$ for 2014, reported by the IMF)	http://www.imf.org/external/data.htm
Population	http://data.worldbank.org/indicator/SP.POP.TOTL
Capitalization (US$ mundi)	http://www.indexmundi.com/facts/indicators/CM.MKT.LCAP.CD/rankings
Democracy rank	http://democracyranking.org/wordpress/rank/democracy-ranking-2014/
Corruption rank	https://www.transparency.org/research/cpi/
Total natural resources (% of G)	http://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS

Democracy rank & corruption rank for Bermuda was set to that for United Kingdom as the governing country
Democracy rank & corruption rank for Hong Kong was set to that for United Kingdom as the recent & last governing country
Barbados (high CDR) and Equatorial Guinea (high G) are too small for attention by the reporting agencies.

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There are 150 countries for which 79 contain complete data for the regression. The degrees of freedom for error are 79-5-1=73. The results of the regression analysis are given in Table 1. The zero intercept implies that g is zero when *C, D, R* and *N* are zero and that there are no other relevant variables. The estimated model is $\hat{g}$ =1.53*C*+0.14*D*+0.23*R*-1.21·*C·D·R*+0.38*N*. That is, g is estimated from the vector inner (dot) product of global invariant parameters [1.53 0.14 0.23 -1.21] and country specific [*C D R C·D·R*]. For convenience this will be referred to as the CDR index. *G* can be estimated from $\hat{G}$= $\hat{g}$ (highest *G*-lowest *G*)+lowest *G* where highest *G*=83,066 and lowest *G*=1,112.

All regression coefficients in the OLS model are significantly different from zero at a level of significance of 10% (|t statistic| > $t_{0.1,73}$=1.67). The coefficient of multiple determination R^2_{adj} = 0.83. That this, 83 percentage of the variation in g is explained by the model. The F ratio = 81.03 > $F_{0.01,5,73}$=3.28 indicates that at a level of significance of 1%, the model is a good fit to the data. The greatest contributor to explaining g is *C* with a contribution of 59%. *D, R* and $C \cdot D \cdot R$ contribute 5, 10 and 3% respectively for a total of 18%. In the *C, D, R* paradigm, *D* and *R* are heterogeneous exogenous catalysts that facilitate the conversion of *C* to g. *D* and *R* do not take place in the operation, do not get used up, but remain unchanged at the end. Because they are unchanged, they must be heterogeneous and exogenous from *C*. The function of *R* is to create stability that attracts *C*. The function of *D* is to create additional pathways for connecting ideas on how to deploy *C* effectively. The negative coefficient associated with the interaction term $C \cdot D \cdot R$ represents friction due to differences in ideas that are almost certain to occur in a democracy. If there were perfect agreement and the agreement was the best possible decision, the decision could not be bettered and the coefficient would be zero. The partial contribution from *N* is a negligible 6%. The intangibles *C, D* and *R* contribute (83-6)/6~13 times as much as natural resources. This is a most surprising result.

Finally, the fitted errors from the model were examined and exhibited no patterns. They did not show any correlation with $\hat{g}$. They passed a chi squared goodness of fit test for normality at a 5% level of significance.

Entrepreneurship versus capital stock

In the *C, D, R* paradigm, *C* is measured by total market capitalization. *C* is measured from the sum of exogenous human capital ideas also known as entrepreneurship, and endogenous capital stock. *C* is converted to the production of goods and services. Some production is consumed and some is reinvested in capital stock. Capital stock is residual skill, stored knowledge from teaching ideas to other persons, and reinvestment in fixed capital less depreciation and obsolescence (Janssen, Claus and Sauer, 2016). The endogenous capital stock in *C* will bias the coefficient of *C* in the OLS model. Like La Porta, et. al. 1999 did elsewhere, we use latitude or absolute distance from the equator (d) as an instrumental variable for *C* to obtain a consistent estimate. Latitude is assumed to be correlated with *C* and uncorrelated with the errors in the OLS model. The results are given in Table 1. In the 1st stage least squares regression d is statistically significant (t=3.77). In the estimated 2nd stage least squares regression the consistent estimate of the coefficient of *C* is 1.30 and R^2_{adj}=0.74. The reduction in R^2_{adj} is 0.83-0.74=0.09 per unit or 9%. This was the contribution from capital stock. The contribution of total capital to R^2_{adj} is 0.59. So, the contribution from entrepreneurship is about (0.59-0.09)/0.09~6 times as much as capital stock from old ideas that occurred earlier.

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Table 1. OLS and 2SLS Regression Results

OLS		2SLS			
		1st stage least squares with latitude (*d*) as instrumental variable for *C*		2nd stage least squares	
Fitted equation for $\hat{g}$		Fitted equation for $\hat{C}$		Re-Fitted equation for $\hat{g}$	
Variable	Estimated coefficient	Variable	Estimated coefficient	Variable	Estimated coefficient
Intercept	0.00 (0.08)	Intercept	0.04 (3.27)	Intercept	0.00 (0.02)
C	1.53 (6.69) [0.59]	*d*	-0.10 (3.77)	$\hat{C}$	1.30 (2.66)
D	0.14 (1.69) [0.05]	*D*	-0.16 (4.64)	*D*	0.12 (0.88)
R	0.23 (2.60) [0.10]	*R*	0.22 (6.43)	*R*	0.28 (1.95)
C·D·R	-1.21 (4.40) [0.03]	*C·D·R*	1.11 (27.11)	$\hat{C}$·*D·R*	-0.98 (1.88)
N	0.38 (5.59) [0.06]	*N*	-0.02 (0.61)	*N*	0.38 (4.45)
R^2_{adj}	0.83	R^2_{adj}	0.94	R^2_{adj}	0.74
F ratio	81.03	F ratio	272.58	F ratio	46.64

Note: Student |t| coefficients are in parentheses (). Partial correlations are in parentheses []

3. Vexillological chart

The relationship between *G* and the CDR index is shown in the vexillological chart in Figure 1. In additional to the regression line, bubbles and flags are used to identify 21 of the 79 countries by name and size, selected for their contrast in population size, location, climate, wealth, natural resources, history and culture. They line up remarkably well.

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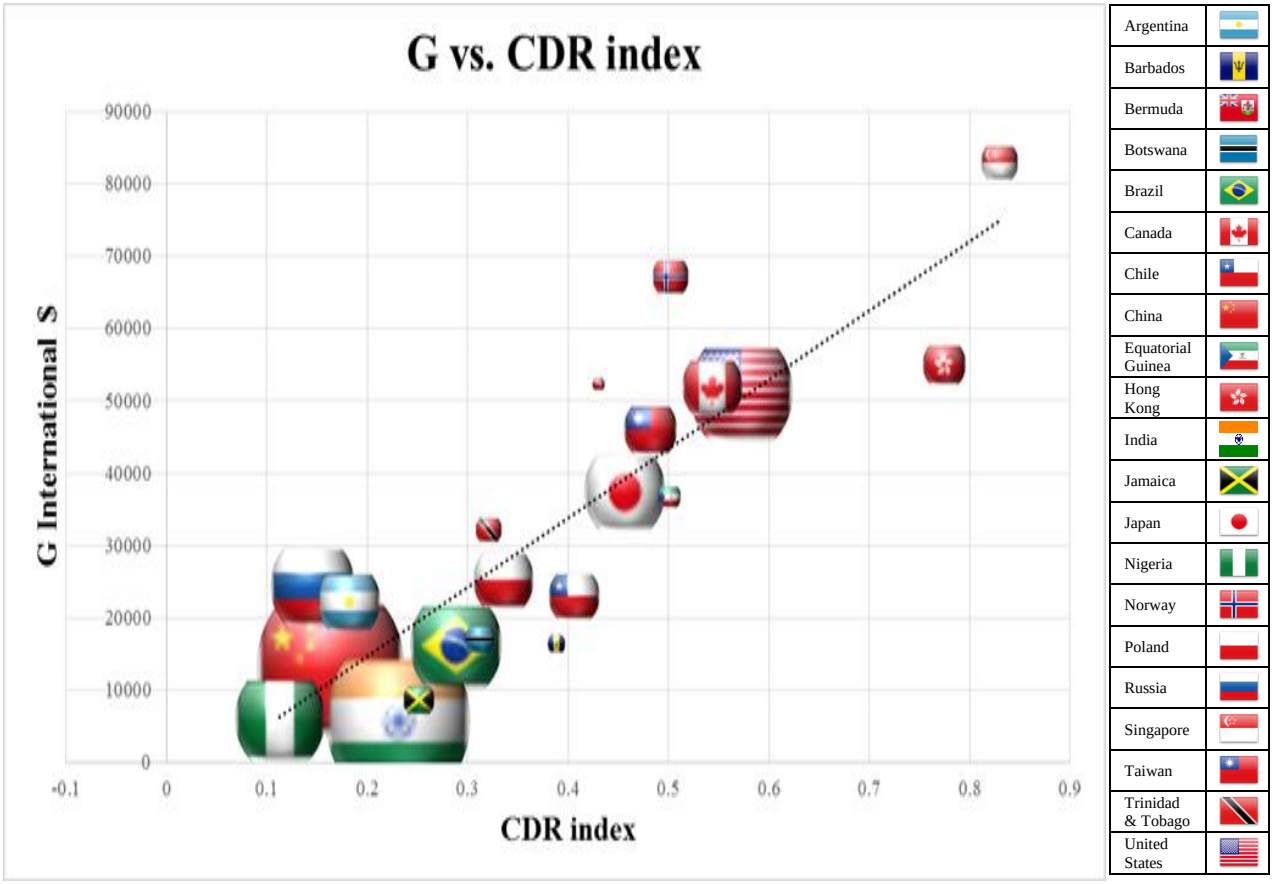

Figure 1. Year 2014 G vs CDR index for 79 countries (line). Bubble size (21 countries) is the square root of diameter

4. From Intangible Wealth to Tangible Wealth

Simultaneously with the distribution of C to investee companies, products are created in individual micro-economic units of production that employ physical capital and labor. In general, consider m countries, $i=1,2,3,..m$, where country i contains n_i production units. The ith country estimate is $\hat{G}_i=\hat{g}_i$(highest G-lowest G) + lowest G, where in equilibrium, $\hat{g}_i = f(C_i, D_i, R_i) = \hat{\beta}_C C_i + \hat{\beta}_D D_i + \hat{\beta}_R R_i + \hat{\beta}_{CDR} C_i \cdot D_i \cdot R_i$. Production of $\hat{G}_i$ is obtained from the sum of n_i micro-economic production units. Consider a deterministic Cobb-Douglas function $v_{ij} = f(f_{ij}\hat{G}_i, L_{ij})$ applied to the jth unit of production in the ith country, where existing capital stock K_{ij} is replaced by capital obtained by the investment of the fraction f_{ij} of $\hat{G}_i$, L_{ij} is the quantity of physical labor, and v_{ij} is the annual production. All labor is identical in nature and functionality. Any human differences due to knowledge, experience and skills are transferred into production capacity of capital stock. Assuming constant returns to scale, then $v_{ij}=A_{ij}(f_{ij}\hat{G}_i)^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}}$, where A_{ij} is the total factor productivity and α_{ij} and 1-α_{ij} are output elasticities of capital and labor respectively. The total production for country i is given by

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$$\sum_{j=1}^{n_i} v_{ij} = \sum_{j=1}^{n_i} A_{ij} (f_{ij} \hat{G}_i)^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}}.$$

The global production of all *m* countries is therefore

$$\sum_{i=1}^{m} \sum_{j=1}^{n_i} A_{ij} (f_{ij} \hat{G}_i)^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}}.$$

Or, substituting for $\hat{G}_i$,

$$\sum_{i=1}^{m} \sum_{j=1}^{n_i} A_{ij} \{f_{ij} [f(C_i, D_i, R_i)(\text{highest } G - \text{lowest } G) + \text{lowest } G]\}^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}}.$$

5. Conclusions

The high R_{adj}^2 of 83% in the straight line linear *C*, *D*, *R* regression model, the complete randomness in the residuals (not shown), and the overall aptness of the model suggest that the conversion of *C* to *G* occurs with approximately the same efficiency across the world. That is, the *C* to *G* conversion process is global invariant. The 17% of *G* that is not explained by the model may be due to the absence of private capital that is not publicly traded. Private capital data will never be available, so we must proceed with the data that are available. The conversion process is governed by the laws of natural science (Kuhn, 2012). What are commonly thought of as differences in productivity between countries are actually differences in their ability to attract *C*. Countries that rank high in *R* attract more *C*. Countries that have raised their CDR index have increased their *G* markedly. The intangible CDR index is approximately 13 times more important than natural resources for raising *G*. Entrepreneurship is approximately 6 times more import than capital stock. That and global invariance explains why some former low CDR index low *G* countries like Singapore, Hong Kong and Bermuda have been able to transform themselves to high CDR index high *G* countries in just decades, while their geographic neighbors with low CDR index remain poor. The policy implication of this finding is that low *G* countries should focus on raising their CDR index by effectuating higher levels of *D* and *R* rather than lamenting over geography and natural resources that cannot be changed. Future research may reveal how best to improve *D* and *R* to attract and deploy *C* effectively.

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CHAPTER 10

GDP forecasting by CDR composition

Reference: Ridley (2018c).

It has been established that the parsimonious capitalism, democracy, rule of law (CDR) *model is a global time invariant model for the estimation of real gross domestic product adjusted for purchasing power parity (G). This new scientific discovery may be used to estimate G for any year in which a country market capitalization (C), democracy ranking (D), rule of law ranking (R), and the highest and lowest values of G amongst all countries are known. This scientific growth model is used to construct a forecasting model for G from its* CDR *composition.*

Keywords: Forecasting; Gross Domestic Product; Capitalism; Democracy; Rule of Law.

1. INTRODUCTION

Prior to the Ridley (2017a,b) CDR model the Solow (1956, 1957) growth model was the best estimator of output from which gross domestic product (GDP) could be obtained. That model is based on an adaptation of the Cobb-Douglas model $Q=f(K,L)$ in which K is fixed capital and L is labor. It does not account for entrepreneurial capital and must come up short of explaining the total variation in GDP. Whereas it is presented as an aggregate production function, Ridley and Ngnepieba (2018) show definitively that there is no such thing as an aggregate production function. Also L varies depending on quality due the level of associated skill. That is, it departs from the Ricardo (1817, 1821) definition of homogenous labor in which each unit must be the same. The Solow model is not global invariant and not time invariant. Therefore, it must be estimated separately for each country and re-estimated for each year. Knowing K and L for any one country does not say anything about G in another country or in a different year.

Gwartney and Lawson (2003) and Gwartney, Holcombe and Lawson (2006) advocate economic freedom as good for economic growth. That research produced the economic freedom of the world (EFW) index. But, the GDP=f(EFW) model yields only R^2_{adj} = 52% compared to R^2_{adj} = 83% for the CDR model.

A fundamental principle for time series analysis and forecasting is to recognize that an historical variable that is to be forecast may comprise components that change over time but not all in the same way. For that reason, where possible, the variable should be decomposed into its component variables. Or, its components can be identified together with the relatively weights that they contribute. Each component variable should be forecast separately and subject to the rules that apply to it. The component forecasts can then be integrated by a weighted average to obtain the forecast of the aggregate variable of interest.

This paper explores the possibility of using the CDR growth model to forecast real gross domestic product adjusted for purchasing power parity (G). In the CDR model, the components of G are capitalism measured by total market capitalization (C), degree of democracy measured by country democracy ranking (D) and degree of rule of law (R) measured by the opposite of country ranking in corruption. Rule of law reflects the enforcement of property rights and various laws related to the achievement of justice. The relationship of these components to G is global time invariant. Global time invariance permits the estimation of G for any year in which country

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C, *D* and *R*, and the highest and lowest values of *G* amongst all countries are known for the forecast year. This can be the basis for the partial construction of a forecast for *G*. Forecasts for *C*, *D* and *R* must be made independently of *G*. Unlike *C*, *D* and *R*, Natural resources (*N*) and latitude equal to the absolute distance from the equator (*d*) are independent of government policy. The appellation CDR derives from the fact that only *C*, *D* and *R* can be shaped by government policy. However, *N* and *d* do contribute to *G*, albeit surprisingly very little. In the interest of forecasting accuracy, they can be included in the CDR model. Their inclusion will not affect the property of global time invariance.

2. THE CDR GROWTH MODEL

Definitions:
Entrepreneurship *is the process of starting a business, typically a startup company offering an innovative product, process or service.*
Capitalist *is a person who deploys his or her personal capital so as to maximize his or her own benefit and includes all rational people.*
Real gross domestic product adjusted for purchasing power parity (G) *is the net product or value added that equates to standard of living.*
Capitalism (C) *is the mechanism for the collection and assembly of capital, measured by total market capitalization that reflects entrepreneurship capital and capital stock.*
Democracy (D) *is the private work force idea participation and periodic election of public representatives, and catalyst for the process of generating G from C.*
Rule of law (R) *is the reverse of corruption, the protection of shareholder and other property rights, and catalyst for the attraction of C.*

> ***Corruption*** *is the abuse of entrusted power for private gain and can be classified as grand, petty and political, depending on the amounts of money lost and the sector where it occurs.*
> ***Property (rights)*** *is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged.*

From Appendix BB the CDR statistical model for GDP is

$$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \beta_N N + \varepsilon$$

where all variables are standardized by linear transformation to ensure upper and lower bounds on $0 \leq g,C,D,R,C \cdot D \cdot R,N \leq 1$. Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries. Note that *N* can be dropped for policy making, leaving just CDR. Hence the appellation "CDR." Although *N* contributes only 6% to explaining variations in g it is included for the purpose of accuracy in the estimation of GDP.

The ordinary least squares (OLS) model for the *i*th country is

$$\hat{g}_i = 1.53C_i + 0.14D_i + 0.23R_i - 1.21C_i \cdot D_i \cdot R_i + 0.38N_i. \qquad R^2_{adj}=0.83$$

(***Click here to download supplementary source data***)

Concisely stated, the estimated country CDR index is the vector inner product (dot product) of the global constant [1.53 0.14 0.23 -1.21] and the country [*C D R C·D·R*]. Or, the CDR index = CDRs index + CDRp index. The CDRs sum index = 1.53*C* + 0.14*D* + 0.23*R*. That is, a country CDRs index = 1.53, 0.14 and 0.23 weighted by its country *C, D* and *R* and summed. The CDRp

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product index = -1.21·*C*·*D*·*R*. That is, a country CDRp index is the product of -1.21 and its *C*, *D* and *R*.

The coefficients are global time invariant. Any country can choose a policy to raise or lower the levels of democracy and/or the levels of rule of law. Achieving such changes may be difficult in practice but it quite possible. Such change was demonstrated by South Korea where the economy went from ashes to enviable in just 50 years. They cannot choose the natural resources. But, the natural resources can change in some systematic way for various reasons. For example, seasonality, gradual depletion, etc.

Democracy and rule of law are catalysts. Rule of law attracts capital and democracy creates new pathways that permit the optimal deployment of capital. At the end of the process where capital is converted to g, the catalysts are unchanged by the process. They are the same as they are at the beginning of the process. They are available for reuse as the process continues in subsequent years. Therefore, the catalysts are exogenous variables. Capital comprises exogenous entrepreneurial human capital ideas of imagination and creativity and endogenous capital stock. Capital stock comprises human knowledge and training from prior entrepreneurship, machines, computer, recording devices, etc. Some g from capital stock can be consumed and some can be reinvested. Due to the presence of endogenous capital, the coefficient of capital is subject to bias.

For additional accuracy we can include latitude as follows:

$$\hat{g}_i = 2.02C_i + 0.16D_i + 0.10R_i - 1.78C_i \cdot D_i \cdot R_i + 0.38N_i + 0.21d_i.$$

$|t|$ = (9.52) (2.19) (1.26) (-7.21) (6.67) (5.69) R^2_{adj}=0.89

(Click here to download supplementary source data)

Ridley and Khan (2019) showed how to use two stage least squares (2SLS) to remove the bias in the estimate. The 2SLS model is better for understanding the economic impact of *C* on g. But, it yields a lower R^2_{adj}=0.74. Therefore, the OLS model is a more efficient predictor of g. So, the OLS CDR function will be used henceforth.

Consider the variables changing over time *t*,

$$\hat{g}_{it} = 2.02C_{it} + 0.16D_{it} + 0.10R_{it} - 1.78C_{it} \cdot D_{it} \cdot R_{it} + 0.38N_{it} + 0.21d_{it}.$$

The strategy is to forecast C_{it}, D_{it} and R_{it} from past observation then calculate $\hat{g}_{it}$ from this equation. Note that N_{it} is constant or changes very slowly and d_{it} remains constant. The particular forecasting method is left to the analyst. However, we know from prior research that variables such as C_{it} can be cyclical and might best be forecast by spectral analysis. One such method is the Ridley (2003) and Ridley and Ngnepieba (2009) moving window spectral method.

3. CONCLUSIONS

This paper discusses forecasting *C*, *D* and *R* and using their and *N* and *d* relationship to g to predict GDP. Suggestions for future research may be to develop better data collection mechanisms for *C*, *D* and *R* to enable better forecasting models for *C*, *D* and *R*. Further decomposition of the components *C*, *D* and *R* into subcomponents might also be investigated.

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CHAPTER 11

Conservation of Capital: homeomorphic mapping from intangible aggregate macro-economic CDR space into tangible micro-economic production spaces

Reference: Ridley and Ngnepieba (2018).

The parsimonious capitalism, democracy, rule of law (CDR) *growth model is the first global time invariant cross country model. It is the first to incorporate aggregate exogenous and endogenous sources of capital into a model for converting capital to real gross domestic product adjusted for purchasing power parity. Aggregate capital is distributed to micro-economic units of production. This mapping is shown to be homeomorphic from intangible aggregate macro-economic* CDR *space into tangible micro-economic production spaces, such that under certain prescribed conditions capital is conserved.*

Keywords: CDR index, GDP, Capitalism, Democracy, Rule of Law, Entrepreneurship

1. Introduction

A number of classical, neo-classical and modern economic growth models have been presented over time. The first model to include entrepreneurship was presented by Schumpeter (1911)(1928)(1954). Solow (1956)(1957) presented a neoclassical aggregate production function that has been widely adopted by economists. His adaptation of the Cobb-Douglas (1928) production is based on fixed capital. But, it does not include human capital ideas of imagination and creativity and must come up short when accounting for the totality of capital and growth. Also, since the Solow growth model is a production function stated in the aggregate, it represents a fallacy of composition (Cohen and Harcourt, 2003). There is no such thing as an aggregate production function. There is no way around this obstacle. Houthakker (1955) discusses some micro combinations and suggestions for their aggregation into industries. Leontief (1906-1999) proposed the fixed proportions production function. The purpose of this paper is to explore aggregation to a national level. We show that under certain abstract configurations of productions units, an aggregate production function that is equivalent to the sum of individual production units is theoretically possible. But, these configurations are limited, restrictive and short of a miracle, most unlikely to occur in practice.

A better way to capture total capitalization for explaining what is responsible for economic growth is the Ridley (2016)(2017a)(2017b)(2017c), Ridley, Davis and Korovyakovskaya (2017) and Ridley and Khan (2019) CDR growth model: $g=f(C,D,R)$. It is the most recent heterodox model that shows that the way capital is converted to real gross domestic product (GDP) is the same all over the world. Essentially, the catalyst rule of law (R) attracts intangible capital (C), and the catalyst democracy (D) deploys it optimally to create tangible wealth in the form of products and services. The catalysis is as described by Berzelius (1779-1848) in that D and R speed up the C to GDP conversion process but are not themselves changed by the process. The purpose of this paper is to show how capital from the aggregate real gross domestic product adjusted for purchasing power parity (G) can be distributed to micro-economic

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production units. These provide inputs per the Cobb-Douglas micro-economic stipulation. The outputs from the micro-economic units can then be summed to obtain a correct aggregate *G*. Finally, we show that these mappings from intangible aggregate macro-economic CDR space into tangible micro-economic production spaces are homeomorphic (Weisstein, 2018) such that under certain prescribed configurations of micro-economic production units, capital is conserved.

The remainder of the paper is organized as follows. Because the CDR growth model is a heterodox model that is built on different assumptions and relationships, section 2 provides unique definitions and specifications. Section 3 provides an account of the relationship between the CDR growth model and the Cobb-Douglas function. Section 4 examines the CDR Cobb-Douglas mapping. Section 5 provides conclusions and suggestions for future research.

2. Definitions and Specifications

Definitions:

Entrepreneurship *is the process of starting a business, typically a startup company offering an innovative product, process or service.*

Capitalist *is a person who deploys his or her personal capital so as to maximize his or her own benefit and includes all rational people.*

Real gross domestic product adjusted for purchasing power parity (G) *is the net product or value added that equates to standard of living.*

Capitalism (C) *is the mechanism for the collection and assembly of capital, measured by total market capitalization that reflects entrepreneurship capital and capital stock.*

Democracy (D) *is the private work force idea participation and periodic election of public representatives, and catalyst for the process of generating G from C.*

Rule of law (R) *is the reverse of corruption, the protection of shareholder and other property rights, and catalyst for the attraction of C.*

> ***Corruption*** *is the abuse of entrusted power for private gain and can be classified as grand, petty and political, depending on the amounts of money lost and the sector where it occurs.*
>
> ***Property (rights)*** *is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged.*

The CDR growth model was created in the search for a model that accounts for the annual contribution to real gross domestic product adjusted for purchasing power parity (*G*). The objective was to create an index that can be used to calculate *G* for any year. To accomplish that the model variables *G, C, D, R* are standardized by linear transformation to ensure lower and upper bounds of 0 and 1. That way, CDR becomes an index for the estimation of G for any country by inverse transformation when the highest *G* and lowest *G* are known for the year (see Appendix BB). The CDR index is calculated from published country market capitalization, ranking in democracy, and ranking in corruption (Goel, Mazhar and Nelson (2016), Czap and Nur-tegin (2012), see also Couttenier and Toubal (2017), López, et al. (2017)).

The global time invariant model is given as follows:

$$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \beta_N N + \varepsilon$$

where all variables are standardized by linear transformation to ensure upper and lower bounds on $0 \leq g, C, D, R, C \cdot D \cdot R, N \leq 1$. Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries. Rule of law is the opposite of corruption. See Appendix BB.

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When estimated from data, we get the CDRindex=1.53*C*+0.14*D*+0.23*R*-1.21*C*·*D*·*R*+0.38*N* that comprises positive *C*, *D* and *R* effects and a negative interaction component due to friction from democracy that reduces *G* from what it might otherwise be if there were perfect agreement amongst decision contributors (***Click here to download supplementary source data***). There is only a small contribution from natural resources (*N*) in explaining the variation in g, and *N* is not a decision variable that is under the control of government. There is also the well-known Dutch disease from natural resources that can have positive or negative effects on wealth, depending on how the financial economy is managed (Auty (1993), Frankel (2012), Norman (2009), Sachs and Warner (2001), Ross (2001), Sala-i-Martin and Subramanian (2003), Humphreys (2005), van der Ploeg (2011), Wadho (2014), Ridley (2017b)). Therefore, for the purpose of this discussion it can be omitted from the model and from the appellation CDR index. The CDR model was re-estimated for years 1995 to 2016 (see Ridley, 2018) with similar results with the conclusion that it is global time invariant.

3. Integrating the CDR and Cobb-Douglas functions

In general, consider *m* countries, *i=1,2,3,..m*, where country *i* contains n_i production units. The *i*th country *G* estimate is $\hat{G}_i$=$\hat{g}_i$(highest *G*-lowest *G*) + lowest *G*, where in equilibrium, $\hat{g}_i = f(C_i, D_i, R_i) = \hat{\beta}_C C_i + \hat{\beta}_D D_i + \hat{\beta}_R R_i + \hat{\beta}_{CDR} C_i \cdot D_i \cdot R_i$. Since there is no such thing as an aggregate production function (Cohen and Harcourt, 2003), production of $\hat{G}_i$ is obtained from the sum of n_i micro-economic production units. Consider a deterministic Cobb-Douglas function $v_{ij} = f(f_{ij}\hat{G}_i, L_{ij})$ applied to the *j*th unit of production in the *i*th country, where existing capital stock K_{ij} in the $f(K_{ij}, L_{ij})$ Cobb-Douglas function is replaced by capital representing the investment of the fraction f_{ij} of $\hat{G}_i$, L_{ij} is the matching quantity of physical labor, and v_{ij} is the annual production. All labor is identical in nature and functionality. This operating definition of homogenous labor is consistent with the original theory of comparative advantage (Ricardo, 1817, 1821)). Any human differences due to knowledge, experience and skills are transferred into production capacity of capital stock. Assuming constant returns to scale, then $v_{ij}=A_{ij}(f_{ij}\hat{G}_i)^{\alpha_{ij}}L_{ij}^{1-\alpha_{ij}}$, where A_{ij} is the total factor productivity (efficiency) and α_{ij} and 1-α_{ij} are output elasticities of capital and labor respectively. The total production for country *i* is given by

$$\sum_{j=1}^{n_i} v_{ij} = \sum_{j=1}^{n_i} A_{ij}(f_{ij}\hat{G}_i)^{\alpha_{ij}}L_{ij}^{1-\alpha_{ij}}.$$

The global production of all *m* countries is therefore

$$\sum_{i=1}^{m}\sum_{j=1}^{n_i} A_{ij}(f_{ij}\hat{G}_i)^{\alpha_{ij}}L_{ij}^{1-\alpha_{ij}}.$$

Or, substituting for $\hat{G}_i$,

$$\sum_{i=1}^{m}\sum_{j=1}^{n_i} A_{ij}\{f_{ij}[f(C_i, D_i, R_i)(\text{highest } G - \text{lowest } G) + \text{lowest } G]\}^{\alpha_{ij}}L_{ij}^{1-\alpha_{ij}}.$$

When the model exponents sum to one ($\sum_{j=1}^{n_i}\alpha_{ij} = 1$), the production function is first-order homogeneous, which implies constant returns to scale. That is, if all inputs are scaled by a common factor greater than zero, output will be scaled by the same factor.

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4. Homeomorphic mapping

We now consider the case of a single country *i* containing n_i perfectly efficient (A_{ij}=1, ∀ *i,j*) production units.

$$f(\hat{G}_i) = \sum_{j=1}^{n_i} (f_{ij}\hat{G}_i)^{\alpha_{ij}} L_{ij}^{1-\alpha_{ij}}.$$

Capital comprises ineffable human capital ideas of imagination and creativity, and capital stock sourced from human capital ideas of imagination and creativity occurring in a prior time period and learning by many human beings through training. Consider capital to be derived entirely from human capital. In the Cobb-Douglas function capital and labor are interchangeable substitutes. In some applications pure labor is treated as mindless and is utilized in much the same way that machines are utilized. On the other hand, consider capital to be such that it has the potential to replace pure corporeal labor in its totality. And, as the capital increases labor decreases. Then, there is an output for input-capital-only that is equal to an output for a particular capital-labor combination. That is, the inputs can be considered to come purely from capital. Consider three hypothetical cases as follows.

Case 1.

If capital in each production unit is represented in a single machine that can perform all the functions including labor so that no labor is required, then the value of production in country *i* is given by

$$f(\hat{G}_i) = \sum_{j=1}^{n_i} (f_{ij}\hat{G}_i)^{\alpha_{ij}}, \text{ where } \alpha_{ij} = 1, \forall\ i,j,$$
$$= \sum_{j=1}^{n_i} f_{ij}\hat{G}_i$$

Since $\hat{G}_i$ is independent of *j*,

$$f(\hat{G}_i) = (\sum_{j=1}^{n_i} f_{ij})\hat{G}_i.$$

That is,

$$f(\hat{G}_i) = \theta_i\hat{G}_i \text{ where } \theta_i \text{ is constant.}$$

Therefore, f is a linear function.

Moreover, (I) f is continuous

(II) f has a continuous inverse $f^{-1}(\hat{G}_i) = \frac{1}{\theta_i}\hat{G}_i$.

Therefore, this $\hat{G}_i \in \mathbb{R}_+ \rightarrow f_{ij}\hat{G}_i \in \mathbb{R}_+$ is a homeomorphic mapping, or bicontinuous or topological isomorphism. If 100% of capital is distributed to production units then $\theta_i = 1$, and the total production from n_i units is $\hat{G}_i$ which is equal to $\hat{G}_i$ obtained from the aggregate CDR function, and capital is conserved.

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Case 2.

If capital in each production unit is represented in two machines where the first is a traditional machine and the second machine is a robot that performs the function of labor so that no labor is required, then if the capital distributed to the first machine is $r_1\hat{G}_i$ and the capital distribution to the second machine (robot) is $r_2\hat{G}_i$, then the value of production in country *i* is given by

$$f(\hat{G}_i) = \sum_{j=1}^{n_i} 2(r_{1j}\hat{G}_i)^{\alpha_{ij}}(r_{2j}\hat{G}_i)^{1-\alpha_{ij}}, \text{ where } r_{1j}+r_{2j} = f_{ij}$$

Rewriting,

$$f(\hat{G}_i) = \sum_{j=1}^{n_i} 2{r_{1j}}^{\alpha_{ij}}\hat{G}_i^{\alpha_{ij}}{r_{2j}}^{1-\alpha_{ij}}\hat{G}_i^{1-\alpha_{ij}}.$$
$$= \sum_{j=1}^{n_i} 2{r_{1j}}^{\alpha_{ij}}{r_{2j}}^{1-\alpha_{ij}}\hat{G}_i.$$

Since $\hat{G}_i$ does not depend on *j*,

$$f(\hat{G}_i) = (\sum_{j=1}^{n_i} 2{r_{1j}}^{\alpha_{ij}}{r_{2j}}^{1-\alpha_{ij}})\hat{G}_i.$$

That is,

$$f(\hat{G}_i) = \theta_i\hat{G}_i \text{ where } \theta_i \text{ is constant.}$$

Therefore, f is a linear function.

Moreover, (I) f is continuous

(II) f has a continuous inverse $f^{-1}(\hat{G}_i)=\frac{1}{\theta_i}\hat{G}_i$.

Therefore, this $\hat{G}_i \in \mathbb{R}_+ \rightarrow r_{1j}\hat{G}_i, r_{2j}\hat{G}_i \in \mathbb{R}_+$ is a homeomorphic mapping, or bicontinuous or topological isomorphism. If 100% of capital is distributed to production units such that $\theta_i = 1$, then the total production from n_i units is $\hat{G}_i$ which is equal to $\hat{G}_i$ obtained from the aggregate CDR function, and capital is conserved.

For example if $r_{1j} = r_{2j} = 0.5f_{ij}$, then $\theta_i = \sum_{j=1}^{n_i} 2(0.5f_{ij})^{\alpha_{ij}}(0.5f_{ij})^{1-\alpha_{ij}} = \sum_{j=1}^{n_i} f_{ij} = 1$.

Now, consider $r_{1j} = af_{ij}, r_{2j} = bf_{ij}$, where a,b∈ (0,1) such that $a + b = 1$. Then

$$\theta_i = \sum_{j=1}^{n_i} 2(af_{ij})^{\alpha_{ij}}(bf_{ij})^{1-\alpha_{ij}},$$
$$\theta_i = \sum_{j=1}^{n_i} 2a^{\alpha_{ij}}(1-a)^{1-\alpha_{ij}}f_{ij},$$
$$\theta_i = \sum_{j=1}^{n_i} 2a^{\alpha_{ij}}(1-a)(1-a)^{-\alpha_{ij}}f_{ij},$$
$$\theta_i = \sum_{j=1}^{n_i} 2(1-a)(a/(1-a))^{\alpha_{ij}}f_{ij}.$$

Therefore, if $2(1-a)(a/(1-a))^{\alpha_{ij}} = 1, \forall\ i,j,$

then $\theta_i = \sum_{j=1}^{n_i} f_{ij} = 1$, and

$$(a/(1-a))^{\alpha_{ij}} = 1/2(1-a),$$
$$\alpha_{ij}\ ln(a/(1-a)) = ln\ (1/2(1-a)\ ),$$
$$\alpha_{ij} = ln\ (1/2(1-a)\ )/ln(a/(1-a)).$$

Therefore, there are many combinations of r_{1j}, r_{2j} and α_{ij} in which θ_i=1 and capital is conserved.

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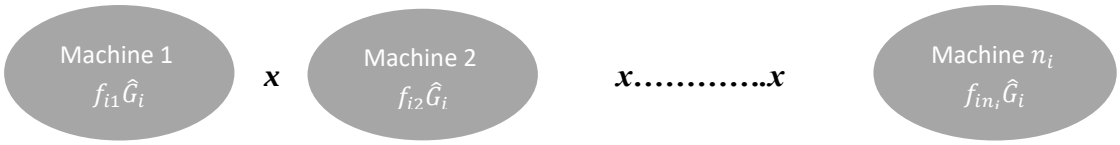
Case 3.



If capital in each production unit is represented in a single machine that can perform all the functions including labor so that no labor is required, and the production units are themselves complementary, then the value of production in country *i* is given by

$$f(\hat{G}_i) = n_i(f_{i1}\hat{G}_i)^{\alpha_{i1}}(f_{i2}\hat{G}_i)^{\alpha_{i2}} \ldots (f_{in_i}\hat{G}_i)^{\alpha_{in_i}}, \text{ where } \sum_{j=1}^{n_i}\alpha_{ij} = 1.$$

Rewriting,

$$\begin{aligned} f(\hat{G}_i) &= n_i \prod_{j=1}^{n_i}(f_{ij}\hat{G}_i)^{\alpha_{ij}}, \\ &= n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}}\, {\hat{G}_i}^{\alpha_{ij}} \\ &= n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}} \prod_{j=1}^{n_i} {\hat{G}_i}^{\alpha_{ij}} \\ &= \left(n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}}\right) {\hat{G}_i}^{\alpha_{i1}} {\hat{G}_i}^{\alpha_{i2}} \ldots {\hat{G}_i}^{\alpha_{in_i}} \\ &= \left(n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}}\right) {\hat{G}_i}^{\sum_{j=1}^{n_i}\alpha_{ij}} \\ &= \left(n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}}\right)\hat{G}_i \text{ since } \sum_{j=1}^{n_i}\alpha_{ij} = 1. \end{aligned}$$

That is,

$$f(\hat{G}_i) = \theta_i\hat{G}_i \text{ where } \theta_i \text{ is constant.}$$

Therefore, f is a linear function.

Moreover, (I) f is continuous

(II) f has a continuous inverse $f^{-1}(\hat{G}_i)=\frac{1}{\theta_i}\hat{G}_i$.

Therefore, this $\hat{G}_i \in \mathbb{R}_+ \rightarrow f_{ij}\hat{G}_i \in \mathbb{R}_+$ is a homeomorphic mapping, or bicontinuous or topological isomorphism. If 100% of capital is distributed to production units such that $\theta_i = 1$, then the total production from n_i units is $\hat{G}_i$ which is equal to $\hat{G}_i$ obtained from the aggregate CDR function, and capital is conserved.

For example, if f_{ij} are distributed equally, such that $f_{ij} = \frac{1}{n_i}\forall\, j$, then

$\theta_i = n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}} = n_i \prod_{j=1}^{n_i}(1/n_i)^{\alpha_{ij}} = n_i(1/n_i)^{\sum_{j=1}^{n_i}\alpha_{ij}} = 1.$

And, in general, if $\sum_{j=1}^{n_i}\alpha_{ij}\ln(f_{ij}) = -ln(n_i)$ then $\theta_i = n_i \prod_{j=1}^{n_i} {f_{ij}}^{\alpha_{ij}} = 1.$

Therefore, there are many combinations of f_{ij} and α_{ij} in which θ_i=1 and capital is conserved.

5. Conclusions

The CDR model gives us the basis for a unified theory for integrating the macro-economic CDR growth model into the micro-economic Cobb-Douglas production function. That is, a mapping from intangible aggregate macro-economic space into tangible micro-economic production spaces. In the particular cases studied in the paper, mapping CDR space into production spaces is homeomorphic and capital is preserved under certain prescribed combinations of the production units in the sense that the value measures of production sum to GDP. If the prescribed combinations are not present, then the aggregated values of the individual production units will

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not equate to GDP. Individual firms that construct production units operate independently of each other. So, the prescribed combinations will not exist except by some miracle. Therefore, there is no such thing as an aggregate production function.

We have seen from the CDR growth law (global time invariant CDR model) that the way in which capital is converted to gross domestic product adjusted for purchasing power parity is a universal constant. After adjusting for country factors of productivity, said capital is converted in accordance with the physical and chemical laws of the natural sciences. Like capital, the coefficients of democracy, rule of law and their interaction are global time invariant. Economic catalysis by democracy and rule of law always function the same way across the world. What makes a country more productive is its ability to attract more capital. Future research could investigate additional configurations of production functions beyond the cases presented in this paper.

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CHAPTER 12

Advances in the CDR economic theory of entrepreneurship and GDP

Reference: Ridley and Llaugel (2020).

Growth models are surveyed, beginning with Malthus and ending with the capitalism, democracy, rule of law (CDR) *model. Early models yielded changing parameters or did not explain all outcomes. The parsimonious* CDR *model is the first global time invariant cross country model. It is the first to decouple exogenous entrepreneurial human capital of imagination and creativity from endogenous human and other capital stock. That is, the first to compute the value of ideas. These properties permit computation of the theoretical optimal growth rate, and demystification of the contemporary observed mature growth rate. It permits computation of the entrepreneurship elasticity of real gross domestic product* (GDP). *Based on the unitary elasticity, the theoretical optimal reinvestment in capital stock is validated by empirical gross fixed capital formation. The global macro-economic growth model is integrated with the micro-economic production function to form a unified economic growth theory. The final outcome is an economic growth model governed by scientific law and the placement of economic growth modeling on a sound scientific footing.*

Keywords: CDR index; GDP; Capitalism; Democracy; Rule of Law; Entrepreneurship

JEL: E02, P16

1. INTRODUCTION

This paper examines the progress that have been accomplished in economic growth theories. For several centuries prior to the 20th, the registered historical aggregate GDP increased very slowly but steadily in most countries of the world. In the last century the average per capita GDP quadrupled to an average growth rate of 1.5% per year. We are interested to know the extent to which economic growth models explain and account for this phenomenon.

Classical economists like Smith (1776) considered capital formation from savings to be an important factor of economic growth. Ricardo (1817, 1821), another classical economist, stressed the important role played by technical progress. Sharipov (2015) summarized the principal theories of economic growth as follows:

Growth Concepts and Theories	Emerged
Mercantilism	15th century
Physiocracy	2nd half of 18th century
Classical Theories	1776
Innovative Growth Theory of Schumpeter	1911
Keynesian Theories	1930s
Post-Keynesian (Neo-Keynesian) Theories	1950s
Neoclassical Theories and Exogenous Theory of Solow	1950s-1960s
Endogenous Growth Theory	1980s-1990s

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Some modern theories have tried to explain causes occurring in the 19th century that set the path for the rise in GDP during the next 100 years. The theories positively correlate population growth with economic growth and rising living standards. This was particularly the case in the United States of America (USA) and most Western European countries where standard of living has outpaced population growth. Japan, South Korea, Singapore, and Hong Kong experienced similar phenomena. In all cases institutional strength is the prevalent cause of economic success. This paper reviews the salient historical theories that have attempted to explain economic growth, including the most successful CDR model. CDR theory is a mathematical demonstration that intangible human capital ideas of imagination and creativity are converted to tangible wealth in the presence of the institutional catalysts of democracy and rule of law. While we recognize that democracy and rule of law are complex and contain many components and factors, the parsimony of the CDR model is possible because said components and factors are subsumed in democracy and rule of law. For the purpose of statistical analysis, it is not necessary to include all the already correlated elements in the model.

The remainder of the paper is organized as follows. Section 2 is an historical review of economic growth. Section 3 is a review of economic growth models. Section 4 is a review of the contributions from the CDR growth model, and extensions to identify its implications for immigration and to derive a parametric formula for the theoretical optimal growth rate. Section 5 contains conclusions and recommendations for future research.

2. HISTORICAL BACKGROUND OF ECONOMIC GROWTH

Prior to the industrial revolution, there was no sustained growth in per capita GDP. There were a few sporadic increases in living standards during the Roman Empire and in China during the Song dynasty. But there was no sustained economic growth.

Unified growth theory (Galor, 2011) has attempted to explain what 19th century occurrence set some countries on a path of sustained growth. The theory suggests a fundamental change in the living standard and population growth relationship that allowed for sustained economic growth (see Figure 1). Before 1850 or thereabouts, increases in living standards appeared to lead to increases in population. Then, per the theory by Malthus (1798), population increase was followed by a fall in standard of living. However, at about 1850, England and their Western European neighbors and the USA, raised standard of living without population growth high enough to lower standard of living to previous levels. At the dawn of the 20th century, standard of living rose more quickly than population. This is referred to as the demographic transition. This pattern contradicted the Malthusian population response.

That raised the following questions for which there are no obvious answers. Was technology changing more rapidly than population was capable of keeping up? Did technology lead to the family having fewer children? What can we learn about economic growth from economic history? Economic history might help identify the origins of technological and demographic changes. Unfortunately, there are only a few examples of sustainable growth and in each case there are so many factors that may have been involved. In the case of England for example, the factors may have been any, all, or none of the following: the industrial revolution, common law, the enlightenment, canals, colonies, finance, coal, steam engines, spinning jennies and in common parlance “pure dumb luck” (see also Senna, 2013).

Regardless of the reason, we are living in a unique period of sustained economic growth. The period is long enough to tell us some things that are generally true about sustained economic growth. Consider for example the relatively short period from 1870 to 2010. Here the data are

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more reliable. This history tells us that growth rates in the USA, England and Germany are similar. They are also persistent over time with an average annual per capita growth rate of approximately 1.8%. It is as if these countries had somethings in common. It is reasonable to say that through migratory patterns, Germany and England are the two largest ethnic populations in the USA. So, it is not surprising that these three countries share some common policy making mechanism and institutions. Diffusion of institutions from England and Germany to the rest of Western Europe is a possibility. But, not to Eastern European neighbors. There are no spillover effects from England to other countries. If there were, the spill would reach beyond just ten percent of the world. It would have spilled into Eastern Europe before spilling into Japan. Japan appears to have created its own industrial revolution. Whatever happened there appears to be similar to the more recent successes in Singapore, Hong Kong and South Korea. A likely explanation is once again institutions (North, 1991). There is no reason why institutions cannot develop separately and independently.

The growth rate of approximately 1.8% observed in the developed countries is becoming as clear as it is mysterious. For example, South Korea grew rapidly beginning in1950 but is now slowing to approximately 1.8%. At the same time that some countries experience rapid growth until they converge to 1.8%, some countries experience zero or negative growth. Learning the reason could alleviate poverty around the world.

Solow (1956) explained that economies gravitate towards a balanced growth path. That the marginal return on capital rises as the economy moves farther from the balanced growth path. Output rises rapidly when an economy is relatively poor compared to its balanced growth path, then converges back towards its balanced growth path. This process can take decades. An example is Germany after World War II. Solow explains that growth converges to a finite limit as capital is accumulated and the marginal return on capital falls. While this explanation is appealing, it is only apparent for countries that were developed and experienced a setback like war. It does not speak to the case of stubborn zero or negative growth in poor countries. Are their balanced growth paths zero or negative? Neither does Solow (1956) explain how developed countries got to be rich or where 1.8% comes from.

Jones (1995a, 1995b) observed that the share of GDP going to research and development and the share of workers doing research and development have been increasing during the 20th century but the long-run growth rate remained constant. By all accounts, it appears that rate of growth is pinned down by the inherent speed of technological progress and technology progress is tied to population growth rate.

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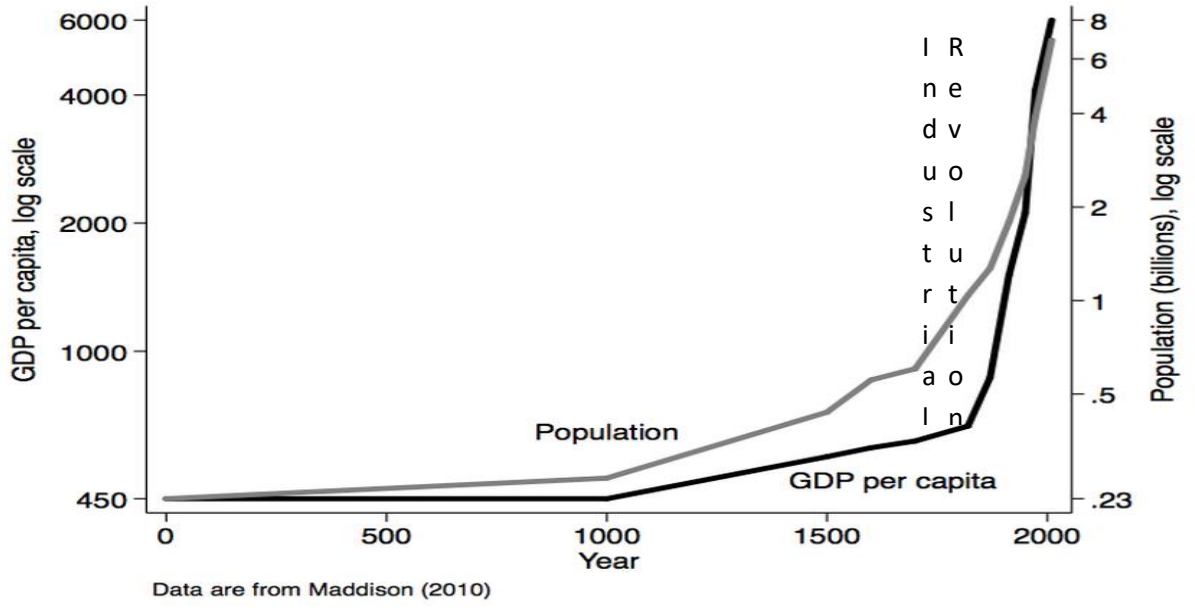

Figure 1. Global output per worker and population for 2010 years AD. For the first 1000 years both are nearly flat with no growth in per capita GDP. From 1000 to 1870, per capita GDP grew at about 0.2% annually. From 1870 to 1950, population and per capita GDP grew at about 1%. After 1950 they grew at about 1.6%.

3. CHRONONLOGICAL REVIEW OF ECONOMIC GROWTH MODELS

Models and theories of economic growth have evolved over time. From the classical to last century economists, economic growth has been attributed to different causes. Malthus (1798) was the first to propose a theory based on population explosion. He believed that inventions and higher living standards led to increases in the rate of population growth. And, population growth would lead to depletion of food and other resources. But, as growth economists go, Malthus is the dismal science advocate of neoclassical diminishing marginal property. He did not take into account that new and improved methods of farming would come to pass. It turns out that the reverse of Malthusian theory is true. Population has a positive impact on economic growth. See also Becker (1960).

Smith (1776) is associated with gain from specialization and cooperation that has indeed proved its value to growth ever since he suggested it. But it is not a complete growth model. Ricardo (1821) is associated with gain from trade. Along the way, he described labor as homogeneous. But, economists went on to violate the homogeneity rule, suggesting that there exists unskilled labor with little or no growth and skilled labor, fructified with capital that is associated with higher growth.

Schumpeter (1911) initiated of the theory of economic growth. According to him, capital accumulation was not the main driving force of economic growth. He thought that economic development was due to entrepreneurial creativity and innovation. His theory is based on the assumption of private property, a competitive buyer and seller market, and efficient financial markets. Those conditions are absent in countries that lack a democratic system.

Harrod-Domar growth models (Harrod, 1939, 1948; Domar, 1946, 1957), based on Keynesian ideas of incomplete markets attempted to demonstrate the conditions for a dynamic

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stable full employment growth. Hahn (1987) said "Neo-classical growth theory is not a theory of history. In essence it is not even a theory of growth. Its aim is to supply an element in an eventual understanding of certain important elements in growth and to provide a way of organizing one's thoughts on these matters."

The theory presented by Lewis (1954) used the term economic development instead of growth. Lewis shared the overall vision of classical economists but did not always agree with their diagnosis and methods. His model implies enlargement of the differences between countries in the short run as a condition for equalization of income levels in the long run. Lewis's theory received theoretical support from Kuznets (1955) with the "Kuznets's Curve". The association between the dynamics of economic growth and the increasing share of urban population in the total population was the work of Kuznets.

Ramsey (1928) is also associated with modern growth theory. He attempted to find the optimal saving rate for production so as to maximize consumption. But he did not find a solution. Neither did Koopmans (1965) nor Cass (1965). Solow (1956, 1957) had better luck at solving the saving question with his neoclassical growth theory. He equated saving with population growth and postulated the capital accumulation function based on investment. Solow's adaptation of the Cobb-Douglas production is based on fixed capital. It does not include human capital ideas of imagination and creativity and must come up short when accounting for the totality of growth. The Solow growth model is stated in the aggregate, but there can be no such thing as an aggregate production function (Cohen and Harcourt, 2003, see Ridley and Ngnepieba, 2018 for a mathematical proof). There is no way around this fallacy of composition. Phelps (1961) revised it to the seemingly arbitrary golden rule rate for maximum consumption. This is a version of the marginal capital condition. Setting capital price to population rate creates some other complications. Introducing Samuelson's (1958) overlapping generations (OLG) arrangement into the neo-classical model is another possibility to solve the saving puzzle, but in the case of retirement such saving must be zero. Diamond's (1965) solution is also problematic. Romer (1986) and Benhabib and Farmer (1994) are associated with endogenous growth. They made consumption utility the specific objective of their models. Calculus was used to solve endogenous growth but economists misapplied Pontryagin's principle (Pontryagin, et. al., 1962), arriving at inconsistent results from the golden rule (Choi, 2008). The assumption of increasing return to scale of Young's (1928) model, was confirmed by Adelman (1963). She recognized that the assumption of constant return to scale in many models raised problems. In her model, she separated natural resources from other forms of capital, similar to the way of land separation made by classical economists. She also suggested that the conceptual problems "which arise from the heterogeneity and incommensurability of the production factors may be reduced somewhat if we think of each input as a multi-component vector rather than as a single number".

Jorgenson (1963) is associated with fixed capital gain and maximum growth rate. But, rapid depreciation in fixed capital appears not to be properly factored in. This is somewhat of a setback to understanding growth. In any case fixed capital does not capture entrepreneurship that permits creation through disruption (Schumpeter, 1911, 1928, 1954). The Abramovitz (1986) model presents an explanation of differences in growth rates over the past two centuries, more illustrative than those of the early neo-classical models. Gomulka (1990) points out that technological changes have assumed the primary role because they initiate the original impulses to produce other changes that are qualitative, thereby questioning the usefulness of standard growth theory that is based on the assumption that those qualitative changes are cost free and exogenously given. Freeman (1995) makes a survey of the ideas on economic growth presented by different researchers and concludes that technical change and institutional change are the key

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variables to study in the explanation of economic growth. His paper makes the first tentative effort to develop a theoretical framework to explain the history of economic growth. Galor and Ashraf (2013) suggested that growth is related to genetics. That idea does not explain the difference in economic growth within genetic types such as Western Europe versus Eastern Europe; Japan versus China; Bermuda, Barbados and Trinidad and Tobago versus Haiti, Botswana versus Nigeria, etc. Even if certain limiting human characteristics or natural resources were obstacles in some nations, CDR is salutary to economic development in terms of making the best of what is possible. Choi (2016) reviewed the history of economic growth covering (i) Malthus and Population; (ii) Neoclassical economics; (iii) Endogenous growth; (iv) Real Business Cycles; (v) Savings and GDP. Over many years, various models have contributed to better understanding of economic growth. But, among these he could not find a consistent theory that successfully explains growth. In this paper we believe that it is because except for Schumpeter, these contributors do not appear to have known or understood where capital comes from. It just appears mysteriously in their discussions of growth models. They discuss buildup of capital, and production and distribution, but they do not identify the actual source of capital as human ideas of imagination and creativity (Ellis, 2018, Ridley, 2018b).

The best (smallest mean square) model to date for explaining what is responsible for economic growth is the Ridley (2016, 2017a, 2017b, 2017c, 2018a, 2019, 2020) and Ridley & Khan (2019) CDR model. It is the heterodox model that shows that the way capital is converted to GDP is the same all over the world. That is, it is governed by technology which is governed by the laws of natural science. And, the way to increase growth is to attract more capital. The source of capital is the ineffable human ideas of imagination and creativity. The way to attract capital is to implement guarantees of rule of law. That is, corruption must be reduced (Ridley and de Silva, 2019). Then democracy must be implemented such that capital can be deployed optimally. However, since the only source of wealth is the human mind, growth is ultimately tied to population growth rate. That is, each child brings its own wealth into the world (Simon, 1981). A child is not a liability, it is an asset. The CDR model is reviewed in greater detail in the following section on this contemporary growth model.

4. THE CONTEMPORARY CDR GROWTH MODEL

This paper extends the utility of the CDR model. In addition to a review of the contributions of the CDR model to understanding economic growth theory, it goes further to identify its implications for immigration; and to derive a parametric formula for the theoretical optimal growth rate.

The CDR growth model was created in the search for a model that accounts for the annual contribution to GDP. The objective was to create an index that can be used to calculate GDP for any year. To accomplish that the model was defined as CDR: $g=f(C,D,R)$, where all variables are standardized by linear transformation to ensure lower and upper bounds of 0 and 1. Then, GDP in any year can be estimated for any country by inverse transformation when the highest and lowest GDP are known for the year, hence the appellation “CDR index.” The CDR index is based on published country market capitalization, ranking in democracy, and ranking in corruption (Goel, Mazhar and Nelson, 2016, Czap and Nur-tegin, 2012, see also Couttenier and Toubal, 2017, López, et. al., 2017, Ogun, 2018). The CDR variables are specific to this model and are defined as follows:

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Definitions:

Entrepreneurship *is the process of starting a business, typically a startup company offering an innovative product, process or service.*

Capitalist *is a person who deploys his or her personal capital so as to maximize his or her own benefit and includes all rational people.*

Real gross domestic product adjusted for purchasing power parity (G) *is the net product or value added that equates to standard of living.*

Capitalism (C) *is the mechanism for the collection and assembly of capital, measured by total market capitalization that reflects entrepreneurship capital and capital stock.*

Democracy (D) *is the private work force idea participation and periodic election of public representatives, and catalyst for the process of generating G from C.*

Rule of law (R) *is the reverse of corruption, the protection of shareholder and other property rights, and catalyst for the attraction of C.*

> ***Corruption*** *is the abuse of entrusted power for private gain and can be classified as grand, petty and political, depending on the amounts of money lost and the sector where it occurs.*
>
> ***Property (rights)*** *is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged.*

The value of creativity has been long recognized (Lotto, 2017). There are various tests for content knowledge, skill, aptitude and intelligence quotient. But there is no test for imagination and creativity. Still, we know them when we see them. CDR theory is the first ever to compute the contribution of *C, D, R* and their interaction to GDP. It is also the first to compute the entrepreneurial contributions of imagination and creativity. In the CDR model, *R* attracts *C* and *D* creates new pathways for the optimal deployment of *C* in the *C* to GDP conversion process. Surowiecki (2005) explains how the wisdom of crowds can yield a superior decision compared to that of any one member, even when that member is a superior individual.

Ridley (2016) and Ridley, Davis and Korovyakovskaya (2017) were the first to identify the potential for GDP to be explained by CDR (see also Korovyakovskaya and Ridley (2017) on entrepreneurship). Ridley (2017a) gave a qualitative explanation of how the only source of wealth is the human idea of imagination and creativity. Just as Smith (1776) proposed that division of labor creates surplus capital, Ridley (2017b) explained how division of human capital creates surplus wealth. It is also a didactic account of the bauxite resources curse and how it cost Jamaica its currency (see also Auty, 1993, Frankel, 2012, Humphreys, 2005, Norman 2009, Peach and Starbuck, 2011, Sachs and Warner, 2001, Sala-i-Martin and Subramanian, 2003, Wadho, 2014, van der Ploeg, 2011).

Ridley (2017c) explored how Friedman's (1980, 2002) negative income tax proposal can be implemented to include work and supply side innovation from the bottom up. This is conditional on the understanding that the source of wealth comes from the mind regardless of one's position in the corporate hierarchy. No longer is it necessary to think of vanguards who take care of rearguards via taxation and social welfare payments. All people can contribute in one way or another in return for living or better wages. Ridley and Khan (2019) was a brief mathematical presentation of a model for decoupling exogenous capital from endogenous capital. That was the first time that such quantitative decoupling of capital was performed. It was also the first time that an estimated value was computed for ideas. This value of ideas was equated to entrepreneurship capital versus capital stock. There, entrepreneurship capital was found to

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contribute six times as much to GDP as capital stock. That is, $6/7^{th}$ or approximately 85% of GDP. This is quite surprising until one considers that capital stock is continuously depreciating or on its way to obsolescence. See also V101 Science (2013, 2106) and SPHSGeog (2015) for a visual depiction of the speed of global depreciation in the absence of human beings, maintenance and reinvestment.

Ridley (2020) is an ordinary least squares (OLS) exposition on the genesis of wealth, the negligible importance of natural resources, geography, population characteristics, government spending, and the high importance of the human brain as the true natural resource, and the play on the words of Adam Smith "an inquiry into the nature and causes of the wealth of states" where Laffer, et. al. (2014) compiled American data on the impact of state taxes on the economic growth and movement of people between states. Their data showed that states that tax and spend more exhibit less growth).This suggests that poor countries turn their focus from bemoaning their lack of natural resources and geography that they cannot change to raising their CDR index. The resource differences due to geography recognized by Diamond (1999) can be eliminated by trading. Bear in mind the massive growth and philanthropy from the digital high technology industries (IBM, Google, Facebook, Intel, Amazon, Microsoft, Apple, etc.) that are unrelated to natural resources (Garten, 2016, Gordon, 2016). Technology has created far more wealth than the world of forced labor where human capital is actually destroyed. Ridley (2020) presented a consistent unbiased 2SLS CDR model for year 2014 data and 79 countries representing nearly all the people in the world for which data are available. It showed that the CDR model is global invariant. It established the CDR hypothesis and presented an exposition on the information theory of entrepreneurship. Ridley (2018a) expanded Ridley (2019, 2020) to create the entrepreneurship elasticity of GDP. It also repeated the Ridley (2020) year 2014 CDR model for years 1995 to 2016. It showed that the CDR model is the same for all years in 1995 to 2016 for which data are available. It thereby demonstrated that the CDR model is not only global invariant but is also time invariant. That is, global time invariant.

The avant-garde CDR model is iconoclastic in the sense that it moves the source of wealth from the factory backwards to an earlier point in time when the human ideas of imagination and creativity occur. One of those ideas is indeed said factory itself. A production function can only relate physical units of inputs to physical units of outputs from a single machine. That is, there is no such thing as a macro-economic production function when the inputs are different types of items, or outputs are different types of items, or outputs are made by different constructs. Furthermore, there is the fallacy of composition that we can simply jump from micro-economic conceptions to an understanding of production by society as a whole (Cohen and Harcourt, 2003, Ridley and Ngnepieba, 2018). The CDR model does not challenge the role of the factory as a unit of production. Nor does it challenge the role of the production function. Indeed, the CDR growth model is complementary to the production function and places economic growth theory on a sound scientific footing.

Ridley (2018b), Llaugel and Ridley (2018) and Ngnepieba, et. al. (2018) were the first to suggest a way for introducing economics students to CDR growth economics human ideas of imagination and creativity as the source of wealth. A student from a formerly oppressed community who is only told that wealth is created at a factory where goods are produced and subsequently distributed, exchanged and consumed might be inclined to see that as an activity of the rich and not see themselves in that picture. The student is asked to believe that the factory just exists somehow (Sowell, 2015 objects to this typical introduction). But, a student who understands that the sole source of wealth is human ideas of imagination and creativity, may see him or herself as a potential entrepreneur. At a minimum, he or she will see him or herself as a partner in the entrepreneurial

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community. An entrepreneurial community is required for the success of entrepreneurs, communities and nations.

Discussion

Annual GDP is a one-year contribution to economic growth. The data analyzed in the CDR model are annual. The time from market capital acquisition to investment in the economy is approximately six months. It is encompassed inside one year. Therefore, there is no need to model multiple years to observe the impact from *C*. Still, the CDR model was re-estimated for several years to investigate this, and as it turned out established its time invariance. The *g=f(C,D,R)* exists in four dimensions of which time is not one. In passing, we note that the CDR model can be used as a forecasting model. Global time invariance permits the estimation of *G* for any year in which country *C*, *D* and *R*, and the highest and lowest values of *G* amongst all countries are known for the forecast year. This can be the basis for the partial construction of a forecast for *G*. Forecasts for *C*, *D* and *R* must be made independently of *G* (Ridley, 2018c).

CDR theory is a mathematical demonstration of how the source of wealth is the ineffable human ideas of imagination and creativity and was the first to actually calculate the value of ideas. Low CDR countries are where ideas go to die. It is clear that low CDR countries must raise their CDR if they are to have any chance of economic growth. However, this is easier said than done when corrupt leadership is entrenched. At the time of this writing, South Korea is hosting the 2018 winter Olympics. Fifty years earlier South Korea experienced severe poverty. After the adoption of democracy it is a country that poor countries can model themselves after. Meanwhile, right next door, North Korea continues to languish in poverty while nursing its position on corruption and anti-democracy. The cost of corruption is to corrode the fabric of society, undermine people's trust in political and economic systems, institutions and leaders and can cost people their freedom, health, money – and sometimes their lives. Transparency is a means for shedding light on shady deals, weak enforcement of rules and other illicit practices that undermine good governments, ethical businesses and society at large. Sir John James Cowperthwaite, a disciple of Adam Smith introduced to Hong Kong in experimental fashion, Smiths' principle of peace, easy taxes and tolerable administration of Justice. The rest as we say is history as Hong Kong like South Korea climb the economic growth ladder. The principle is embedded in the CDR model of capitalism, democracy and rule of law.

It is difficult to build reliable institutions of rule of law and democracy. The further behind a low CDR country is in the human capital stock component: science technology engineering and mathematics (STEM), the more it needs to catch up via education. But, CDR theory shows that entrepreneurship human capital ideas of imagination and creativity contribute six times as much as all capital stock contributes to *G*. And, capital stock depreciates in about three generations (Taylor, 2018). So, long term growth is dependent on entrepreneurship capital. That is, a country needs both entrepreneurship capital and capital stock, and entrepreneurship requires democracy and rule of law. And, we now know that the optimal reinvestment of *G* in capital stock is about 21%. That is, STEM education is a necessary but not sufficient requirement for economic growth. On the other hand, CDR is necessary and sufficient.

Gilder (2013) believes that low entropy or low noise systems of predictable government, rule of law, property rights, etc., require great acts of heroism to enact. For example, sacrificial army and police, and inspired leadership are needed to permit the relatively high noise entrepreneurial inventions to pass into society. But, could it be that capitalism, democracy and rule of law are themselves also inventions. Therefore, just as known inventions can be taught

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through formal education, capitalism, democracy and rule of law can be learned through formal education, without the sacrifice of life and limb. Maybe it is a sacrifice only in the sense of being a labor of love?

The component of rule of law that is known as property rights is more difficult. Property rights are a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged. Ninety percent of the countries of the world have no property rights for the common man (de Soto, 2000). Given modern satellite systems it should be that property can be surveyed rapidly. But, once surveyed the occupants and presumed owners of land must agree on the suggested boundaries before meaningful titles can be filed. Property is what Western Europeans and North Americans use as collateral to borrow money. Money in turn is invested in entrepreneurship. Mortgaging a home asset is a popular method used by entrepreneurs. Their mechanism for property rights was not a clean process and involved numerous fights, physical and legal. There was no and there is no manual for the acquisition of property rights that can be shared with undeveloped countries.

The natural effort of every individual to better his own condition...is so powerful, that it is alone, and without any assistance, not only capable of carrying on the society to wealth and prosperity, but of surmounting a hundred impertinent obstructions with which the folly of human laws too often encumbers its operations (Smith, 1776). This principle is embedded in the concept of democracy. For more on the potential of institutional economics for the purpose of raising *D* and *R* see Hamilton, 1919, North, 1991, Acemoglu, Johnson and Robinson, 2005 and Gilder, 2012, 2013, 2016. For future research on institutional design see Koltai and Muspratt, 2017, Acs, et. al, 2016, Feldman, 2014, van Praag and van Stel, 2013, van Hornel, et. al., 2017, Nurunnabi, 2017.

Implications for immigration

CDR is global time invariant. *C* is the sum of entrepreneurship capital (C_e), fixed capital stock (C_k), and trained knowledge stock (C_t). That is, $C=C_e+C_k+C_t$. Compared to other countries, American *C* is relatively very high. The reason is because American *R* is relatively very high. A poorly educated immigrant to America can bring their corporeal labor (*L*) plus their C_e and make contributions of measurable value. As that immigrant acquires C_t they can move up the skills and pay ladder to make larger contributions. Should that immigrant choose to avail themselves of educational opportunities, as they acquire C_t, they can make even greater contributions. A citizen from anywhere in the world will bring their human capital that is the same as that of an American born citizen of comparable education and training. The same immigrant that was unable to contribute in the old country, when allowed to function under American CDR, will add the same amount to GDP as their American born counterpart. Said GDP will not only add to the American economy, it will add to the economy of the world via America. A similar rise in world average GDP would increase if the CDR index of the old country were raised. An increase in CDR anywhere in the world raises the world's average GDP. There is no resulting contemporaneous reduction in GDP anywhere. Kane and Rutledge (2019) studied the effect of the immigration and economic performance from 1980-2015 in the USA. They concluded that although analysis by region and time reveals some differences in results, the overall correlation between immigration and performance variables is positive. Empirical finding by Altonji and Card (1991) indicate a modest degree of competition between immigrants and less skilled natives.

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Parametric derivation of the theoretical expected endogenous growth in g

The first estimate of the CDR model included not only C, D and R but also natural resources (N). The research began with the notion that N was very important. It turned out that *N* contributed only 6% to GDP making it much less important than ordinarily considered to be. Furthermore, a purpose of CDR is to determine national policy regarding what can be done to raise GDP, and *N* cannot occur by policy. Therefore, N can be dropped from the model without loss of generality. Still, the following parametric derivation of the theoretical optimal endogenous growth in g includes *N* for purpose of accuracy in accounting.

From appendix AA and appendix BB, the CDR statistical model for GDP is

$$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} \mathrm{C} \cdot \mathrm{D} \cdot \mathrm{R} + \beta_N N + \varepsilon$$

where all variables are standardized by linear transformation to ensure upper and lower bounds on $0 \leq g,C,D,R,CDR,N \leq 1$. Democracy and corruption are rank ordered, where the highest = 1 and the lowest = the number of countries. Note that N can be dropped for policy making, leaving just CDR.

The estimated OLS model is

$$\hat{\mathrm{g}}_i = \mathbf{1.53} C_i + 0.14 D_i + 0.23 R_i - 1.21 C_i \cdot D_i \cdot R_i + 0.38 N_i. \qquad R^2_{adj} = 83\%.$$

Partial correlations (contributions to R^2_{adj}):

59% 5% 10% 3% 6%

Using latitude measured in L_i units as the instrument for purging endogenous capital from C_i (latitude is correlated with C_i and uncorrelated with ε_i and obviously exogenous since GDP cannot influence latitude),

$$\hat{C}_i = 0.04 - 0.07 L_i - 0.16 D_i + 0.22 R_i + 1.11 C_i \cdot D_i \cdot R_i - 0.02 N_i.$$

The estimated 2nd stage least squares model for estimating g from exogenous new idea human capital entrepreneurship ($\hat{C}_i$) is

$$\hat{\mathrm{g}}_i = \mathbf{1.30} \hat{C}_i + 0.12 D_i + 0.28 R_i - 0.98 \hat{C}_i \cdot D_i \cdot R_i + 0.39 N_i. \qquad R^2_{adj} = 74\%.$$

Therefore, the fraction of total capital that is exogenous entrepreneurship capital = 1.30/1.53=0.85=85%. Alternatively, the contribution from capital stock is the reduction in R^2_{adj} of 0.83-0.74=0.09 per unit or 9%, and the contribution of total capital to R^2_{adj} is 0.59. So, the contribution from exogenous entrepreneurship capital is (0.59-0.09)/0.59 = 0.85 = 85%. And, capital stock from old ideas that occurred earlier amounts to 15%. See Ridley and Khan (2019) for more on decoupling entrepreneurship capital from capital stock.

The CDR model is designed to get at what a country can do to raise its g, not an accurate computation of average world g. *C* does not include non-publicly traded private market capital. Those data are not available and will never be available. Still, let us see what CDR predicts for annual g. All the variables in the CDR model are based on per unit values. Therefore, the regression coefficients are the growth in $\hat{\mathrm{g}}_i$ per unit. So, the purely endogenous growth in g is the expected value of the contribution from the endogenous capital ($C_i - \hat{C}_i$) plus the unbiased 2SLS contributions from $D_i, R_i, \hat{C}_i \cdot D_i \cdot R_i$ converted to endogenous g via the dot product with the unbiased regression coefficients.

That is, expected endogenous growth in g = $(1/2)(\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}}) + \hat{\beta}_D + \hat{\beta}_R + \hat{\beta}_{\hat{C}DR} + \hat{\beta}_N)$, where (1/2) is the mean of the range [0,1]. When calculated from the original regression coefficients prior to rounding, $\hat{\beta}_C = \mathbf{1.534346}$ and $\hat{\mathrm{g}}_i = -0.00051 + \mathbf{1.295617} \hat{C}_i + 0.116963 D_i + 0.275395 R_i - 0.98133 \hat{C}_i \cdot D_i \cdot R_i + 0.388146 N_i$.

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Expected endogenous growth in g = (1/2)(-0.00051 +(**1.534346-1.295617**)+0.116963+0.275395-0.98133+0.388146) per unit
=0.018698 per unit
$\simeq$ 1.8%.

(see also the parametric integral derivation of the theoretical maximum endogenous growth in g in Appendix A).

We mention in passing an interesting observation that this equates to $\frac{1}{4}e^2$, where e is the Napier's constant (Euler's number) and base for the natural logarithm. While some countries might grow faster than 1.8% others will grow slower than 1.8%. As it turns out this theoretical 1.8% is numerically equal to what economists have observed empirically as the steady state rate to which countries converge as they develop. The developed country per capita g dominance of the world might explain the world proximity to 1.8%. The standard deviation of $\hat{g}_i$, $\sigma_{\hat{g}_i}$=0.208513 per unit. The standard deviation of the mean of g, $\sigma_{\bar{g}_i}=0.208513/\sqrt{79}=0.02346\simeq$ 2.3%. We know from the plots of the residuals $\hat{\varepsilon}_i$ versus $\hat{g}_i$ from the regression, their histogram and a chi square goodness of fit test that they are approximately random and normally distributed (Appendix BB, Figure BB2a and Figure BB2b). Therefore, the 95% confidence interval (CI) for the estimate of mean growth in g,

CI = 1.8+/-($z\sigma_{\bar{g}_i}$)% = 1.8+/-(1.96x2.3)% = {-2.7%, 6.3%}.

As best we can tell this derivation of annual endogenous growth rate in g explains the previously observed but unexplained 1.8% and brings that mystery to an end. This statistical account is not a scientific explanation per say. But one might speculate that the growth in g is matched to the growth in human population. That is, each child brings its own wealth into the world. A child is an asset not a liability. Furthermore, the child's discoveries that are exogenous entrepreneurial capital can add to the endogenous growth rate 1.8%.

The foregoing endogenous analysis clears up one of the many mysteries of economics. Price is an item of information that tells consumers how much to purchase and tells suppliers how much to produce (Friedman and Friedman, 1980). It promotes the efficient use of society's resources. Any attempt to interfere with free market prices distorts said information. It is easy to confuse this price with the observed sticker price that appears on products. Rising sticker prices create the illusion that immediate purchases save money. This is bolstered by the impression of rising value reflected in higher prices. Falling sticker prices create the illusion that delayed purchases save money, even though value is being foregone. That is, even though the purchaser must postpone access to the utility of the product. But the true price of a product is the price per unit of value due to the power of its features. Quite often these features are technological. But their source is always human ideas of imagination and creativity. For example, a motor car today that is associated with the common man contains features that previously were only found in the best cars. Although the car sticker price has risen, the price per feature has fallen. Another example is the personal computer that contains features that were once the sole domain of past supercomputers. The example of the computer is special since its sticker price has fallen while the features have risen! This phenomenon began with the industrial revolution and has continued ever since. That is, effective price deflation has been occurring ever since the industrial revolution. Each unit of deflation is the result of a human idea of imagination and creativity. Such entrepreneurship capital has routinely increased the size of the economy beyond the endogenous contribution.

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5. CONCLUSIONS

The history of economic growth models was reviewed beginning with Malthus (1798) and ending with the CDR model. We started with Malthus because his model was so rudimentary and limiting, least promising, with no resemblance to reality. It could easily be eliminated from further consideration as explanatory growth model. Smith's (1776) division of labor was contemporaneous with Malthus (1798). But, while not a model per say, it was expansive and a good explanation of the success of what were to become rich nations. The documented contributions from each model were then considered, including their shortcomings, leading finally to the astonishingly good statistical properties of the parsimonious CDR model. The CDR model gives us the basis for a unified theory for integrating the macro-economic CDR growth model into the micro-economic Cobb-Douglas production function. That is, a homeomorphic mapping from intangible aggregate macro-economic space into tangible micro-economic production spaces.

This paper went further to calculate mean annual growth rate from the coefficients of the CDR model. That calculation estimated a 95% confidence interval that included the observed 1.8% for developed countries that was heretofore unexplained. This serves as one empirical validation of the CDR model. Another was the previous computation of CDR theoretical optimal reinvestment in capital stock (Ridley, 2020) that is validated by observed empirical gross fixed capital formation of approximately 21%. Another was the previous validation and the global time invariant property of the CDR model (Ridley, 2020). These validations of the CDR model place economic growth theory on a sound scientific footing by way of the CDR law.

We have seen from the global time invariant CDR model that the way in which capital is converted to gross domestic product adjusted for purchasing power parity is a universal constant. The only explanation that we offer is that after adjusting for country factors of productivity, said capital is converted in accordance with the physical and chemical laws of the natural sciences. But, the CDR model also includes the catalysts democracy and rule of law. Without these catalysts, the capital attraction and conversion processes are so slow as to be negligible. Low CDR countries are where ideas go to die. With these catalysts the capital attraction and conversion to GDP processes occur at a superior rate. Like capital, the coefficients of democracy, rule of law and interaction variables are global time invariant. The only explanation that we offer is that economic catalysis by democracy and rule of law function the same way across the world. We do not know the basic science that is involved. A suggestion for future research is that which is aimed at discovering this basic science. Suffice it to say that it is likely a natural psychological science that connects people, irrespective of location and culture. While it may be the case that increased economic freedom has resulted in some improvement in the economies of poor countries, they do remain impecunious. The reason is that their efforts to improve democracy and rule of law are perfunctory at best.

The time for recriminations regarding prior mercantilism, colonialism and imperialism has passed. Even if rich countries benefited from such activities, they would have been even better off earlier than now had they pursued higher CDR instead. Future research should be on how poor countries can raise their CDR rather than debate questions about geography and natural resources that cannot be changed. Surely, the effect on distance by modern sea and air transportation if not its annihilation altogether by the internet for purpose of communication, should have mitigated geography. This is as far as science can take us (Ball, 2012). But it hasn't for the poor. How can we raise the estates of the least among us? While this is beyond the scope of this paper, it was determined that the GDP of Singapore is astonishingly high. It is also the

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case that Singapore implemented a bonus pay system for government leaders and workers that is tied to economic performance. Future research can investigate whether or not there is a relationship between their bonus pay system and their CDR index, and ultimately their GDP.

APPENDIX A

Parametric integral derivation of the theoretical maximum endogenous growth in g

The purely endogenous growth in g is the contribution from the endogenous capital $(C_i - \hat{C}_i)$ plus the unbiased 2SLS contributions from $D_i, R_i, \hat{C}_i \cdot D_i \cdot R_i, N_i$ converted to endogenous g via the dot product with the unbiased regression coefficients. $\hat{C}_i$ is fixed exogenous capital unrelated to endogenous capital. Consider C_i, D_i, R_i and $N_i \in [0,1]$, constructed from all countries on the globe (Figure A.1). The integral of the purely endogenous contribution to subset g of a simple closed CDR space $\mathbb{R}^n$ (where n=3), contained in a piecewise smooth boundary of the volume of g:

$$= \oint_{CDR} endogenous\ contribution\ to\ g\ \partial C\ \partial D\ \partial R.$$

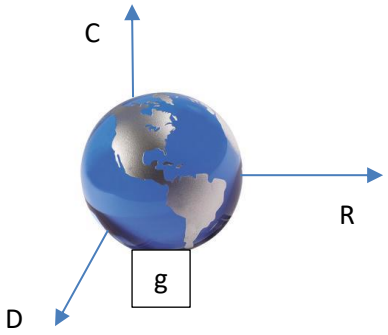

Figure A.1. Subset of volume of g for all countries on the globe.

By extension, and for computational accuracy, we include N_i in the integral of the purely endogenous contribution to subset g of a closed CDRN hyperspace $\mathbb{R}^4$, also contained in a piecewise smooth boundary:

$$\oint_{CDRN} endogenous\ contribution\ to\ g\ \partial C \partial D \partial R \partial N =$$

$$\int_{N=0}^{1}\int_{R=0}^{1}\int_{D=0}^{1}\int_{C=0}^{1}(\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})C_i + \hat{\beta}_D D_i + \hat{\beta}_R R_i + \hat{\beta}_{\hat{C}DR}\hat{C}_i \cdot D_i \cdot R_i + \hat{\beta}_N N_i)\ \partial C \partial D \partial R \partial N$$

$$= \int_{N=0}^{1}\int_{R=0}^{1}\int_{D=0}^{1}[\hat{\beta}_0 C_i + (\hat{\beta}_C - \hat{\beta}_{\hat{C}}){C_i}^2/2 + \hat{\beta}_D D_i C_i + \hat{\beta}_R R_i C_i + \hat{\beta}_{\hat{C}DR}\hat{C}_i \cdot D_i \cdot R_i \cdot C_i + \hat{\beta}_N N_i C_i]_0^1\ \partial D \partial R \partial N$$

$$= \int_{N=0}^{1}\int_{R=0}^{1}\int_{D=0}^{1}(\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})/2 + \hat{\beta}_D D_i + \hat{\beta}_R R_i + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i \cdot D_i \cdot R_i + \hat{\beta}_N N_i)\ \partial D \partial R \partial N$$

$$= \int_{N=0}^{1}\int_{R=0}^{1}[\hat{\beta}_0 D_i + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})D_i/2 + \hat{\beta}_D {D_i}^2/2 + \hat{\beta}_R R_i D_i + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i \cdot {D_i}^2 \cdot R_i/2 + \hat{\beta}_N N_i D_i]_0^1\ \partial R \partial N$$

$$= \int_{N=0}^{1}\int_{R=0}^{1}(\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})/2 + \hat{\beta}_D/2 + \hat{\beta}_R R_i + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i \cdot R_i/2 + \hat{\beta}_N N_i)\ \partial R \partial N$$

$$= \int_{N=0}^{1}[\hat{\beta}_0 R_i + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})R_i/2 + \hat{\beta}_D R_i/2 + \hat{\beta}_R {R_i}^2/2 + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i \cdot {R_i}^2/4 + \hat{\beta}_N N_i R_i]_0^1\ \partial N$$

$$= \int_{N=0}^{1}(\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})/2 + \hat{\beta}_D/2 + \hat{\beta}_R/2 + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i/4 + \hat{\beta}_N N_i)\ \partial N$$

$$= [\hat{\beta}_0 N_i + (\hat{\beta}_C - \hat{\beta}_{\hat{C}})N_i/2 + \hat{\beta}_D N_i/2 + \hat{\beta}_R N_i/2 + \hat{\beta}_{\hat{C}DR} \cdot \hat{C}_i \cdot N_i/4 + \hat{\beta}_N {N_i}^2/2]_0^1$$

$$= \hat{\beta}_0 + \frac{\hat{\beta}_C - \hat{\beta}_{\hat{C}}}{2} + \frac{\hat{\beta}_D}{2} + \frac{\hat{\beta}_R}{2} + \frac{\hat{\beta}_{\hat{C}DR}}{4} + \frac{\hat{\beta}_N}{2}.$$

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Consider the case when $\hat{C}_i$ is set to 1. That is, when entrepreneurship capital is at its maximum. When calculated from the original regression coefficients prior to rounding, the endogenous growth in g:

$$=-0.00051+\frac{1.534346-1.295617}{2}+\frac{0.116963}{2}+\frac{0.275395}{2}-\frac{0.98133(1)}{4}+\frac{0.388146}{2}$$
$$=0.264284$$
$$\simeq 26\%$$

This result is a theoretical maximum conversion of *C, D, R, N* contributions to g in one year. The high value 0.26 per unit =26% is due to the negative CDR friction component being reduced by dividing it by 4, while the *C, D, R, N* components are divided by only 2. It implies that if the democratic decision-making process can be sped up (doubled) while considering all points of view, the deployment of *C* can be such that the annual endogenous growth rate in g is 26%.

Consider the case when $\hat{C}_i$ is set to 0. That is, when entrepreneurship capital is nonexistent. The endogenous growth rate in g:

$$=-0.00051+\frac{1.534346-1.295617}{2}+\frac{0.116963}{2}+\frac{0.275395}{2}-\frac{0.98133(0)}{4}+\frac{0.388146}{2}$$
$$=0.5$$
$$\simeq 50\%$$

Finally, consider the case when $\hat{C}_i$ is set to the value estimated from the above 2SLS. That is, when $\hat{C}_i = 85\% = 0.85$. The endogenous contribution to g:

$$=-0.00051+\frac{1.534346-1.295617}{2}+\frac{0.116963}{2}+\frac{0.275395}{2}-\frac{0.98133(0.85)}{4}+\frac{0.388146}{2}$$
$$=0.3$$
$$\simeq 30\%$$

Economics has no precise definition of overheating. It is recognized that below a certain growth (value unknown) in g, the economy remains stable. The related endogenous economic variables act and interact so as the return the economy to its equilibrium condition. But it is also recognized that sustained high growth in g, due to some exogenous government policy intervention say, can lead to the condition where there is more demand for goods and services than can be supplied by the economy. This can lead to price inflation, reaching a point where a reduction in g does not by itself correct the condition and end inflation. This condition of instability is referred to as overheating. The above single year endogenous percentage growth rate of 30% in g may be plausible for infinitesimally small changes in *C, D, R, N*. However, due to physical limitations, the economy could begin to overheat long before the sustained growth rate in g approaches this value. We do not expect it to be a practical sustainable rate because it is so much higher than the parametrically derived long run theoretical statistical expected endogenous growth rate in g (1.8%) calculated above. We end this chapter by noting that the growth rate in g where economic instability begins has never been formally calculated in the field of economics. This would be a most worthwhile endeavor.

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CHAPTER 13

Game Theoretic Choices between Corrupt Dictatorship Exit Emoluments and Nation-Building CDR benefits: is there a Nash Equilibrium?

Reference: Ridley and de Silva (2019).

Recent developments in economic theory have established that gross domestic product (GDP) is determined almost entirely by the institutions of capitalism, democracy and rule of law (CDR). To raise GDP a corrupt dictator led country must raise its CDR index. Its corrupt ruler aims to maximize his personal wealth in what he perceives to be a zero-sum game. He maximizes personal wealth from a certainty undeserved large share of low GDP versus a deserved small share of high GDP, the former share being larger than the latter in absolute value. We explore the question of how to pay off the corrupt dictator with an emolument, conditional on the dictator reforming or leaving the country, and replaced by a democratically elected government. A game is designed such that when played, it reveals the Nash equilibrium emolument that the reformed or exiting corrupt leader and the entering nation-builders will agree to.

Keywords: Political economy; Entrepreneurship; Capitalist; Capitalism; Democracy; Rule of Law.

JEL: A20, A22

1. INTRODUCTION

About ten percent of the world's people are rich and continue to get richer while ninety percent live in poverty on approximately two to three dollars per day. According to CDR epistemology, all that stands between the impoverished and wealth is corrupt dictatorship. The purpose of this paper is to explore the possibility of ending poverty everywhere that there exists a team of nation-builders who are resolved to raise the CDR index of a country (Olson, 2002). Anything else such as foreign aid, even in the form of cash or machinery, is ephemeral and often does more harm than good (Lomanski and Teson, 2015). Poor countries do not need analgesics for their economy. They need real and lasting change. One would think that corrupt dictators should be punished for their misdeeds and as an example to others, never rewarded. But, corrupt dictators have a way of becoming entrenched, requiring much time and effort to be dislodged. So, as distasteful a paradox as it may at first appear, change can be hastened to the benefit of the impecunious by striking a bargain with a corrupt dictator to exit the country in return for a payoff emolument. Alternatively, the corrupt dictator can be converted to a reformed dictator who extends democracy to the populace in return for an annual emolument. The problems are constructed as economic game theoretic choices.

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We consider the case where there are two parties: a corrupt dictator and a coalition of nation-builders that represent the people in the country ruled by the corrupt dictator. The Nash (1950, 1951) equilibrium applies to a non-cooperative game in which both parties know the outcomes of each other's decisions (see also Von Neumann and Morgenstern, 1947). We assume that the corrupt dictator aims to maximize his personal wealth in what he perceives to be a zero sum game. He believes that his personal wealth is maximized by obtaining a certainty undeserved large share of low GDP versus a deserved small share of expected value of uncertain high GDP, the former share being larger than the latter in absolute value according to his calculations. Hobbes (1651) advocated that the only true and correct form of government is the absolute monarch. This is due to the nature of human beings who at their core are selfish creatures. This implies that absolute monarchy is a form of dictatorship that brings with it efficiency. But, absolute monarchy is not necessarily *corrupt* dictatorship. And, following Magna Carta of 1215 that placed limits on the monarchy; the glorious revolution of 1688 that led to a constitutional monarchy restricted by the Bill of Rights of 1689 and the Act of Settlement of 1701; and the People Acts of 1918 that decreed democracy; the economies of England progressively outperformed their antecedent dictatorships. They also outperformed remaining dictatorships elsewhere in the world. Even more so has the representative republic of the USA. Our objective is to calculate an emolument that is suitable to the corrupt dictator and the nation-builders. Said emolument will lie at a Nash equilibrium. There may be more than one equilibrium and one of them may be the optimal emolument. To date there has been no confidence in speculative outcomes of various political actions because the concomitant estimates of outcomes from various GDP models are accompanied by high variance. Models and theories of economic growth have evolved over time. But, there is none that has inspired confidence in its accuracy, so much so that a corrupt dictator would trade his authoritative perspicacious ideas for it. Nor would the nation-builders place their trust in it for a better economy. How do they know that the ruler is the cause of their poverty? And, that replacing the ruler will raise the national wealth? If nothing else, these concerns would prevent any action that both parties would take on the basis of what they regard as credible information. This paper contains a cursory review of attempts at economic growth models.

The remainder of the paper is organized as follows. Section 2 reviews classical and modern growth models including the most recent CDR growth model. Section 3 discusses the characteristics of the corrupt dictator and nation-builders. Section 4 presents an objective function that is derived from the CDR index. Section 5 presents games, strategies and payoff emoluments, and the search for Nash equilibria. Since the objective function is an actual empirical function, the emolument can be varied from country to country depending on the mores of a particular country. Section 6 presents some conclusions and recommendations for future research. A nomenclature is given in Appendix AA.

2. GROWTH MODELS

2.1. Historical growth models

From the classical to the last century economists, economic growth has been attributed to different causes. Well known models started with Malthus (1798) where growth was limited for lack of resources to meet population needs, followed by its reverse where population has a positive impact on economic growth. See also Becker (1960). Then there was Smith (1776)

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associated with gain from specialization. Ricardo (1817, 1821), associated with gain from trade. Schumpeter (1911, 1928, 1954), associated with the theory of economic growth based on entrepreneurship. Harrod-Domar growth models (Harrod, 1939, 1948; Domar, 1946, 1957), based on Keynesian ideas of incomplete markets (O'Donnel, 1989, 1996a, 1996b). Lewis (1954) used the term economic development instead of growth with a theory that received support from Kuznets (1955). Ramsey (1928), Solow (1956, 1957), Phelps (1961), Koopmans (1965) and Cass (1965), associated with modern growth theory based on optimal savings rate for production. Solow's aggregate adaptation of the Cobb-Douglas production based on fixed installed capital (albeit that there can be no such thing as an aggregate production function (see Cohen and Harcourt, 2003, and Ridley and Ngnepieba, 2018 for a mathematical proof that the aggregate production cannot exist in practice)). Samuelson (1958) and Diamond (1965), associated with the overlapping generations model. Romer (1986) and Benhabib and Farmer (1994), associated with endogenous growth and consumption utility specific models. None of these models promise accurate predictions of GDP by virtue of a measure such as high model R^2. A model that includes economic freedom appears to be working for GDP (Gwartney, Lawson and Hall, 2015, Hall and Lawson, 2014, Faria and Montesinos, 2009). But, the Gwartney, Holcombe and R. Lawson's (2006) model that uses the economic freedom of the world (EFW) index yielded an R^2 =52.5%. This is considerably lower than that obtained from the CDR index reported in the next section of this paper. When the CDR model includes natural resources and latitude, R^2 ~90%. Natural resources and latitude are not policy variables and cannot be changed to improve GDP. The true source of natural resources is the mind (Ridley, Davis and Korovyakovskaya, 2017, Gilder, 2013) and the knowledge of science (Harari, 2015, Hayek, 1945, Jones, 2002, Link and Siegel, 2007). See also Beinhocker, 2006, Ridley (2010), Roncaglia, 2005, Ronstadt, 1986. Nevertheless, the corrupt dictator may be attracted to natural resources and latitude because of what appears to be the low hanging fruit. This can be problematic due to the possibility of the Dutch disease natural resources curse (Auty, 1993, Ebrahim- zadeh, 2003, Humphreys, 2005, Ross, 2001, Sachs and Warner, 2001, Sala-i-Martin and Subramanian, 2003, Simon, 1981, Wadho, 2014). If the global time invariant CDR model is illustrated to be correct in principle and accurate in estimation (see Ridley, 2018a), then both the corrupt dictator and the Nation-builders can recognize that CDR must be raised in order to raise GDP.

2.2.The CDR growth model

Von Neumann and Morgenstern (1947) said "… there exists at present no universal system of economic theory…" They would be happy to know that at least for economic growth the CDR global time invariant universal law has been discovered. Recent contributions to development theory (Korovyakovskaya and Ridley, 2017, Ridley, Davis and Korovyakovskaya, 2017, Ridley, 2016, 2017a, 2017b, 2017c, 2018a, 2018c, Ridley, 2019, 2020) argue that real per capita GDP adjusted for purchasing power parity (G) which measures the golden-rule living standard is maximized by the proper interactions of economic, social and political, and judicial institutions. That is, there exists an optimal blend of institutions that maximizes GDP. We choose to measure the effectiveness of these institutions by levels of capitalism (C) measured by total capitalization, democracy (D) and rule of law (R) and by combining these variables in a mathematical model for computing their sums and products such that GDP=*f*(C,D,R) is a global time invariant model. Total capitalization C is specifically chosen to include exogenous human imagination and creativity plus endogenous capital stock. Prior models that use fixed capital K (instead of C) capture capital stock but do not capture human imagination and creativity. In

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passing, we mention that fixed capital data are not available for many countries. The choices of C, D and R are discussed further below in the section on *Democracy Rule-of-Law and growth*. The CDR model is global invariant because it computes GDP for all countries in the world, subject only to small mean square error. It is time invariant because its computational results are independent of year. It is the first theoretical construct to place economic growth modeling on a sound scientific footing. The high coefficient of multiple determination and the randomness and normality of distribution of the residuals from this model (Ridley, 2018c) supports global invariance. These also suggests that there are no missing variables from the model that might cause missing variables bias. Global invariance implies that the way that C is converted to G is constant everywhere in the world, determined solely by the laws of natural science. After adjusting for factors of production, what determines a country's GDP is how much capital it has available through the mechanism of capitalism and the instrument of the limited liability corporation.

The parsimony of this model obtains because while there are many economic, sociopolitical and judicial institutional factors affecting GDP, they are all subsumed in C, D and R, respectively. See North and Weingart (1989) for an account of English institutional evolution preceding, near and up to the cusp of the industrial revolution. There might have been some historic economic growth starts and stops. But, the industrial revolution was the single event that was inextricably linked to massive and sustainable economic growth that persists to this day. Also, there are no policy variables other than C, D and R that any country can change that will impact GDP significantly. So, the lacuna between C, D, R and all their elementary institutions and strategic interactions among their economic agents, is inconsequential for the statistical computation of GDP. Variables such as natural resources and latitude turn out to be negligible. In any case, they are not policy variables that a country can change. The parsimony of this model also permits the participants in the game to easily see (as the dust settles) what variables determine GDP and what must be done to change GDP. Therefore, the GDP=*f*(C,D,R) model is an apt objective function for determining the Nash equilibrium emolument to pay off the corrupt dictator, conditional on the dictator leaving the country, and replaced by a new democratically elected leader, a government comprising an executive, a judiciary, a legislature, separation of powers with checks and balances. All this spelled out in a written constitution, a bill of rights, term limits, an impeachment clause and anti-trust legislation to prevent recurrence of corrupt dictatorship.

The GDP=*f*(C,D,R) model excludes geography and culture where C, D and R are the measurement of the effects of three institutions. Therefore, one might wonder if geography or culture or disease environment or all affect C, D and R, such that geography, disease environment and/or culture are the true causal factors, not institutions. To answer this conundrum, Acemoglu, Johnson and Robinson (2005) considered North and South Korea as a natural experiment to demonstrate how different institutions both at the same geographic location, resulted in vastly different economic outcomes and GDP. In addition to geography the Koreans were of one culture prior to their separation in 1948 into two countries north and south of the 38th parallel, and then governed by different institutions. The obvious conclusion in that case is that institutions are what made the difference. And, geography, disease environment and culture may be excluded from a regression analysis of GDP vs institutions without causing any omitted variables bias.

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2.3. Democracy Rule-of-Law and growth

Przeworski and Limongi (1993) reviewed 18 studies on various data samples ranging from 1949 to 1992 on the question of democracy and economic growth (see Adelman and Morris, 1967, Dick, 1974, Huntington and Dominguez, 1975, Weede, 1983, Kormendi and Meguire, 1985, Kohli, 1986, Landau, 1986, Sloan and Tedin, 1987, Marsh, 1988, Pourgerami, 1988, Scully, 1988, 1992, Barro, 1989, Grier and Tullock, 1989, Remmer, 1990, Pourgerami, 1991, Helliwell, 1992). The findings were split equally between yes and no, and no findings at all (see Barro (1996), Przeworski and Limongi (1997) for more on democracy). Therefore, the conclusion of the review was that the answer was as yet unknown. None of the models applied included an interactive CDR term. The CDR model research uncovers and clears up the reason for the confusion by presenting a statistical cross country regression model (see Appendix BB) that includes both a positive democracy term and a negative interaction term that contains democracy. The signs are easily explained as a positive democracy effect and negative friction between capitalism, democracy, and rule of law, where all three make significant contributions to explaining G. The negative component is due to friction from democracy that reduces G from what it might otherwise be if there was perfect agreement amongst decision makers. Acemoglu et. al. (2012, 2014) characterize corrupt dictatorship as an extractive institution designed to exploit the populous for the sole benefit of the dictatorship. They characterize democracy as an inclusive institution designed for the benefit of long-run growth that ultimately benefits all parties. These characterizations are consistent with the CDR growth model. Despite the inconclusive Przeworski and Limongi (1993) review on democracy, Doucouliagos and Ulubasoglu (2008) applied meta-analysis and meta-regression analysis to a total pool of 84 studies with 483 published estimates of the democracy-growth relationship and found no accumulated evidence of democracy being detrimental to economic growth. However, they find that democracy has significant indirect effects on growth through various channels; in particular, it has favorable impact on human capital formation, and on the level of economic freedom, inflation, and political stability. The study also suggests "clear regional effects," with democracy having larger impact on economic growth in Latin American and lower in Asia, due to region-specificity. For more discussion on why institutions cause growth see Faria, et. al. (2016), Glaeser et. al. (2004), Keefer and Knack (1997), and Ogun (2018). For further discussion on the relationship between economic freedom and the potential for reduction in corruption see Qerimi and Sergi, 2012, and Sergi and Qerimi, 2007.

One might also wonder about the independence of the D and R surrogates for sociopolitical and judicial institutions respectively. There is no reason to think that there exists a uniform code of ethics and measurement scale for all countries. So, instead of pursuing absolute values, D and R are rankings of country democracy and rule of law (reported by Transparency International). The GDP=*f*(C,D,R) model represents the conversion of C to GDP in the presence of D and R catalysts (Berzelius, 1779–1848) that speed up the conversion process. To see that D and R are catalysts, consider one year's contribution from the conversion of C to GDP. C includes exogenous elements of human ideas of imagination and creativity, and endogenous capital stock of human knowledge, machines, computers, computer programs, recordings, etc. At the end of the year the endogenous elements will be depreciated. D and R on the other hand remain unchanged. Therefore, D and R are heterogeneous exogenous catalysts. So, while D and R might be endogenous to the sociopolitical and judicial elements that are responsible for them, D and R are exogenous in the GDP=*f*(C,D,R) model. Furthermore, Gwartney, Holcombe and Lawson (2004, 2006) applied Ganger causality to show that the direction of causation must be from D and R to GDP. Rule of law ranking is a proxy for the discouragement of corruption, the

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protection of shareholder and property rights, enforcement of contracts, and the stability that attracts C. Regardless of how many or how few assets are owned by an individual, property is the legal right to exclude others from what that individual lawfully possesses. Therefore, property rights, where they exist, are equal for the impecunious and the rich alike (see also Leblang, 1996). Democracy is a proxy for new pathway creations that connect human ideas of imagination and creativity for the optimal deployment of C. We recognize that D and R are complicated variables that contain the effects of many other variables. For the purpose of statistical modeling, these effects are subsumed in D and R and are therefore highly correlated with D and R. Therefore, said other variables are not necessary for the CDR growth model (see also Appendix BB).

2.4. Capitalism and growth

In the CDR model, a capitalist is a person who deploys his own personal capital so as to maximize his own benefit. Capitalism is the mechanism for the collection and assembly of capital. It is the degree to which a country can make capital available for investment via the limited liability corporation. It is measured by total market capitalization as an expression of confidence in capital. Market capitalization is the discounted value of all future earnings from products that are expected to be created from capital. Therefore, market capitalization takes into account current and all future years. The only data available for market capitalization are those for publicly traded corporations. Non-publicly-traded business capitalization data are not available and will never be available, and cannot be included in the CDR model. These omissions must be part of the error in the theoretical CDR model and part of the error in estimating the CDR model from data. Therefore, while the error term in the any regression model is by definition unobservable, there is a part of the CDR model error that while observable is unavailable and is therefore considered unobservable in theory.

The endogenous elements in C will lead to bias in the estimates of the parameters of the regression model. However, the model will still be an efficient estimator of GDP. And, for that reason, will serve as an objective function that provides the information for the corrupt dictator and the nation-builders to make their decisions. Unbiased two stage least squares estimators may be pursued. This was done by Ridley (2018c) and Ridley (2018a). But, they are only helpful in studying the parameters themselves. Furthermore, two stage least squares yields less efficient estimates of GDP. In any case, this detail is of no interest to the decision makers who are only interested in the GDP estimate.

2.5. Lifting CDR and growth

The purpose of reviewing the root institutions and how they affect D and R is to determine how to raise a country's CDR index and automatically increase GDP (see also the below section: The objective function). In the process of comparing world GDP values, it was observed that Singapore experienced extremely high CDR index values and extremely high GDP (see Appendix BB). It also turns out that Singapore employs the institution of democracy in a unique way. It rewards government leaders and workers in accordance with the country's economic performance. This reward system is what one might normally associate with the private sector. Perhaps the reason that it is not practiced (except in Singapore) is because of the assumption that government employees are natural patriots who care about their country and should not need to be rewarded for caring. Otherwise, they would work in the private sector. It appears now from the Singapore experiment that despite what might be the patriotic nature of government

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employees, the force of democracy is even greater. And, when extended to the government employee in the presence of economic incentives, the employees create the correct pathways to national economic success along with their own. That is, they are capable of figuring it out and they do. At a very minimum it shows that government employees possess many talents normally associated with the private sector employees. In any case, in designing the aforementioned game, it would make sense to extend the specification to: "determining the Nash equilibrium emolument to pay off the corrupt dictator, conditional on the dictator leaving the country, and replaced by a new democratically elected leader, a government comprising an executive, a judiciary, a legislature, separation of powers with checks and balances, *and a bonus system of rewards for government leaders and workers based on the country's GDP*." Llaugel and Ridley (2018), Ngnepieba, et. al. (2018), and Ridley (2018b) suggest pedagogies for raising CDR by an entrepreneurial approach to teaching university students.

3. THE TWO PARTIES

North and Weingart (1989) and North (1991) argue that "the fundamental institutions of representative government - an explicit set of multiple veto points along the primacy of the common law courts over economic affairs - are intimately related to the struggle for control over government power. p829." If the seventeenth century English crown's quest for power defined the monarchy as corrupt dictators, then they are comparable to the corrupt dictators of the twenty first century. There is copious evidence for this analogy. The study of the process by which the English economy overcame them might lead us to the process by which modern day twenty first century economic failures can overcome their corrupt dictators. Hence there is the corrupt dictator and the nation-builders, much like the English crown and the English parliament, and these competitors exist in all time and space. And, the corrupt dictator and the nation-builders are the two parties that we must consider.

In English history some monarchs were beheaded and some were banished and exiled. So, today's corrupt dictators who ipso facto have soured their economies for centuries even in the presence of examples of great economic successes elsewhere should ex post facto expect to meet a similar fate. In the cases of crimes against humanity they should expect to be incarcerated. Otherwise, they should expect to be banished and exiled where there is a host country. Revolution is more likely now than for past dictators. See Kiss, Rodríguez-Lara and Rosa-García (2017) on the role of the omnipresent social media in raising the likelihood of revolution. In either case they should expect to be removed from any form of rule or government.

If an acceptable alternative to a tyrannical monarch were for the corrupt dictator to be restricted like the English parliament restricted the powers and activities of the crown, then the nation-builders could entreat the corrupt dictator to arrive at a bargain wherein the corrupt dictator is paid to create no more economic harm. Per the Coase theorem (Coase, 1960, Acemoglu, 2003), if actions by the corrupt dictator benefit the corrupt dictator while creating a disproportionate cost for the nation, the corrupt dictator and the nation can negotiate to change the existing institutions. By doing so they will increase the size of the total surplus that they can divide between themselves, and they can then bargain over the distribution of this additional surplus.

It is possible that countries that are the victims of corrupt dictators can have a reversal of fortune wherein the corrupt dictator self-reforms. Countries where there was voluntary change to democracy have also seen their GDP rise sharply. These include Botswana, Equatorial Guinea, Poland and Chile. But, these are few and far between. A better plan for early improvement in

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standard of living may be to determine what it will take for the corrupt dictator to exit the country and accept exile elsewhere. An example of that approach is Haiti. Because of the involvement of nuclear weapons of mass destruction, North Korea may be a tougher case (Carabaugh, and Gaush, 2018).

3.1.The corrupt dictator

3.1.1 Psychological profile

Limited psychological research has been conducted investigating dictators, although there is a considerable amount of research exploring authoritarian beliefs and corrupt behaviors. Dictators ascend to and maintain their power through authoritarian leadership. They also seem to share many traits with psychopaths, as they have a disregard for laws and rights of others, lack empathy and remorse, seem to have a high degree of narcissism, and have a strong drive for unlimited power. Although psychopathy has been grouped under Antisocial Personality Disorders in both Diagnostic and Statistical Manual: DSM-IV and DSM-5, the characteristics of psychopaths overwhelmingly seem to be descriptive of dictators. Itzkowitz (2018) argues that the core motivator of many psychopaths is a malignant narcissism, in which psychopaths are unable to or are disinterested in distinguishing between moral and immoral acts. He argues that many brutal dictators, such as Stalin and Hitler, were also psychopaths. Some researchers have also argued that psychopathy is also highly related to Machiavellianism, which describes behaviors that seem to be used by many dictators, involving manipulation, exploitation and lack of ethical concern for others (Hodson, Hogg, & MacInnis, 2009). In their paper, Hodson, Hogg, and MacInnis (2009) also found that Machiavellianism, psychopathy and narcissism were highly related to social dominance orientation, which may be a personality trait shared by dictators. Those who have a social dominance orientation tend to be low in empathy for others, have self-interested goals, are extremely competitive, and have a strong desire for power (Duckitt and Sibley, 2010).

While there is limited literature on the psychological underpinnings of dictators, some research has investigated power as a motivator for corrupt behaviors and acts of moral turpitude. Through a series of experiments, Bendahan, Zehnder, Pralong, and Antonakis (2015) convincingly showed that individuals who were given more leadership power in decision making were more likely to behave corruptly in ways that solely benefitted themselves. Once given greater power, participants were also more likely to violate social norms to which they had previously subscribed, compared to participants who were in leadership roles where they had less autonomy to make decisions. The researchers argued that power protected individuals from the psychological ramifications of breaking social norms, as the participants felt free to behave corruptly and benefitted themselves from the wealth of the group they oversaw. Furthermore, the findings also suggested that participants who reported having higher levels of honesty, which was also related to their having lower levels of antisocial behavior, were not significantly different in their levels of corruption from those who initially reported as being less honest. Having greater levels of power seemingly corrupted even participants who were previously rated as being honest. In further exploring the characteristics of those who behaved the most corruptly in their experiment, the researchers also found high levels of corruption in the participants who were given high levels of power and who had high levels of testosterone, which has been linked to higher levels of antisocial behavior and egocentrism (Wright, et al., 2012), as well as social dominance orientation (Rowe, Maughan, Worthman, Costello and Angold, 2004).

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3.1.2 Economic profile

At the time when the English monarchy extended democracy through parliament, their objective was to stave off riot and revolution (Acemoglu, Johnson and Robinson, 2005). There is no prior evidence that they would have foreseen an outcome that would lead to the articulation of the political doctrine of the sovereign individual. There is no evidence that they knew the massive economic growth impact that democracy would unleash to the benefit of the English commoners and England as a whole, and the prestige that would be bestowed upon the monarchy. A tour de force. They would have perceived the economy as a zero-sum game as it relates to democracy.

One problem with defining the corrupt dictator lies in the notion that he is afoul of the law. This accusation is easily established if the law preceded the corrupt dictator. But, if the corrupt dictator made the law originally or changed the law, and is following such law, then clearly the corrupt dictator is not afoul of the law. But, can he still be corrupt? Can he vitiate the intent of sovereignty, primacy and the interstitial common law constitution? What defines corruption? Corruption is the abuse of entrusted power for private gain. We know from Lord Acton (1834-1902) that 'Power tends to corrupt, and absolute power corrupts absolutely.' Corruption is a violation of ethics. Ethics are moral principles that govern a person's behavior or the conduct of an activity. Still, what is ethical in one community can be unethical in another. Much depends on the essential or characteristic customs and conventions of a community. To avoid this ambiguity, we must only consider rule of law according to the mores of the particular nation of interest as determined by the nation-builders who represent them.

3.2.The nation-builders

3.2.1 Psychological profile

In the same way that research seems to be limited in describing the psychological profiles of dictators, research seems also to be very limited in describing the profiles of nation-builders. Based on the limited research, however, nation-builders seem to be heterogeneous groups of actors who promote ideals to influence the direction in which the nation is heading. Kolstø (2006) argues that nation-builders in both established and unestablished states are universally motivated to promote national unity within the state through various national symbols such as flags, national anthems and coats of arms. Although nation-builders generally promote patriotic visions for their respective countries, particularly after war and political instability to seemingly benefit and unite the nation's populace, nation-builders may also act selfishly to promote visions that uphold institutions that benefit their place in society. In Guatemala, during the dictatorial rules (1898-1920) of Manuel Estrada Cabrera and (1931-1944) of Jorge Ubico Castañeda, the nation-builders were those who focused on creating laws and promoted the direction of the country in part by supporting and promoting patriarchal institutions that also reflected the authoritarian rule of the state during the two regimes (Carey, 2013). Carey (2013) argues that the nation-builders during the two regimes had set visions for the country involving family preservation and order, and thus promoted numerous laws and upheld various institutions to ensure patriarchal structures in society were maintained, by promoting and enforcing laws regulating men and women's gendered roles within the home. The nation-builders supported the regimes in constructing a national identity of order by promoting gendered family values, to enshrine the privileged roles of men in both the home and in the larger society. They were

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motivated by their vision of order within the family. From the example in Guatemala, it can be argued that nation-builders can work together with dictators to promote shared visions, when those visions converge in promoting the same ideals. The case of post Magna Carta England is a solid demonstration that this can work. A proud and peaceful monarchy has existed for centuries. Today, the Queen receives an annual emolument in the amount of many millions of pounds which through marketing, has been parleyed into a most grand and profitable tourist economic institution bar none. It more than pays for itself.

3.2.2 Economic profile

Nation-builders are a coalition of ombudsmen representing the nation's people. They are patriotic agents, governing actors on behalf of the population. Unlike the corrupt dictator who perceives the economy as a zero sum game, the economic benefit of democracy to the nation-builders is the growth impact and increased standard of living that derives from democracy. Therefore, the nation–builders perceive the economy as a plus sum game as it relates to CDR.

One problem with defining the nation-builders lies in the notion that they are ethical and possess the moral authority to make law. There might not as yet be an established executive, judiciary, and legislature, with separation of powers and checks and balances. There is no guarantee that the nation-builders will themselves act in good faith and follow through in their commitment to the nation (Olson, 2002). This is the nation's dilemma. We know from Lord Acton (1834-1902) that 'The danger is not that a particular class is unfit to govern. Every class is unfit to govern.' And, as stated above, what is ethical in one community can be unethical in another. The nation-builders will certainly be acting on discontent with the corrupt dictator. But, the nation can only hope and implicitly trust the nation-builders to promulgate law in a manner that is consistent with the mores of their nation. One of the incentives that nation-builders have to engender broad support from the populous for representative democracy is that the vote of the impecunious will count exactly the same as that of the wealthiest citizen.

4.0. THE OBJECTIVE FUNCTION

The Nash equilibrium requires that both parties have knowledge of the outcomes of each other's actions. For that we will need a transparent objective function. Our choice of objective function is the GDP=*f*(C,D,R) economic growth model.

The estimated CDR index for year 2014 (see Appendix BB) is

$\hat{g}$= 1.53C + 0.14D + 0.23R - 1.21C·D·R + 0.38N

where ^ denotes estimated or fitted value and G can be estimated from

$\widehat{G}$= $\hat{g}$ (highest G-lowest G) + lowest G.

Highest G=83,066. Lowest G=1,112.

For other years, Highest G and Lowest G must be the values for the particular year of interest.

Appendix BB illustrates the aptness of the CDR model with respect to linearity, normality of the residuals and homoscedasticity of the residuals. Also illustrated are the results of repeated model estimations for all years other than 2014 for which data are available.

The contribution to *G* depends on a wide variety of combinations of C, D and R. For purposes of simplicity, assuming that C, D and R rise together, then estimated contributions for different levels of C, D and R are plotted in Figure 1. The marginal return on the expected per capita market capitalization $\partial E(\hat{g})/\partial C = \hat{\beta}_C + \hat{\beta}_{CDR} D \cdot R$ =1.53-1.21·*D*·*R*. Estimated marginal returns for different levels of D and R are plotted in Figure 2. For the particular scenario depicted

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in Figures 1 and 2, for the most part, the contribution to G increases as C, D and R increase. The contribution increases at a declining rate. Above about 0.75, the contribution to G declines. The reason for the decline may be due to excessive democracy and costly delays in decision making, or compromising for the sake of reaching a timely decision. The decline may also be due to over regulation in the pursuit of justice through rule of law and the resulting reduction in solution spaces.

Figures 1 and 2 describe global characteristics, not any one country. Here, C, D, and R are set equal and increased from 0 to 1. It would be pure chance if any country were to match these C=D=R or D=R configuration exactly. However, it just so happens that Denmark has the global characteristic of being highest on both D and R, so their D=R=1. For them, marginal return on C is approximately 0.3. And, their C=0.3, so their C·D·R=0.3x1.0x1.0=0.3. The D·R multiplier in this product just happens to be 1.0 and has no effect. For Denmark, the contribution to *G* is 0.53.

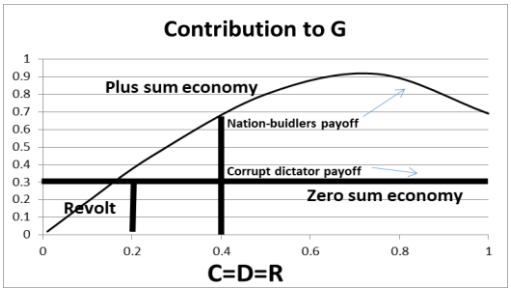

Figure 1.

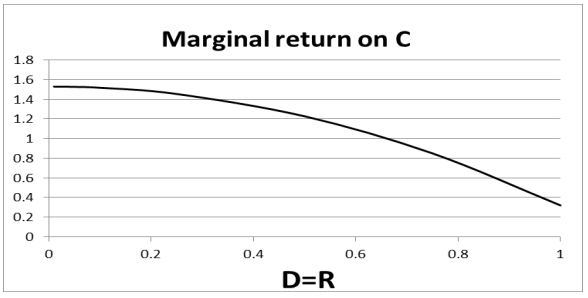

Figure 2.

5.0. NASH EQUILIBRIUM

Let (*S, f*) be a game with n players, where S_i is the strategy set for player *i*, $S = S_1 \times S_2 \times \cdots \times S_n$ is the set of strategy profiles and *f(x)* = ($f_1(x)$,…, $f_n(x)$) is its payoff function evaluated at $x \in S$. Let x_i be a strategy profile of player i and x_{-i} be a strategy profile of all players except for player *i*. When each player $i \in \{ 1 , \dots , n \}$ chooses strategy x_i resulting in strategy profile $x = (x_1, \dots, x_n)$ then player *i* obtains payoff $f_i(x)$. Note that the payoff depends on the strategy profile chosen, i.e., on the strategy chosen by player *i* as well as the strategies chosen by all the other players. A strategy profile $x^* \in S$ is a Nash equilibrium if no unilateral deviation in strategy by any single player is profitable for that player, that is $\forall i , x_i \in S_i : f_i(x_i^*, x_{-i}^*) \geq f_i(x_i, x_{-i}^*)$.

When this inequality holds strictly (with > instead of ≥) for all players and all feasible alternative strategies, then the equilibrium is classified as a strict Nash equilibrium. If instead, for some player, there is exact equality between x_i^* and some other strategy in the set *S*, then the equilibrium is classified as a weak Nash equilibrium.

A game can have a pure-strategy or a mixed-strategy Nash equilibrium. In the mixed strategy, a pure strategy is chosen stochastically with a fixed probability. A pure strategy may be thought of as a degenerate case of a mixed strategy, in which that particular pure strategy is selected with probability 1 and every other strategy with probability 0.

Consider now the corrupt dictator vs. nation-builders game where *n*=2. Stated simply, the corrupt dictator and the nation-builders are in Nash equilibrium if the corrupt dictator is making the best decision he can, taking into account the nation-builders' decision while the nation-builders' decision remains unchanged, and the nation-builders are making the best decision they

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can, taking into account the corrupt dictator's decision while the corrupt dictator's decision remains unchanged. Considering the possibility of violent revolt if democracy is unduly withheld, this watershed is the corrupt dictator's dilemma.

One of the problems associated with arriving at agreements is the question of commitment (Acemoglu, Johnson and Robinson, 2005). How does one party to an agreement know that the other party will follow through on its part of the agreement? This is particularly problematic when one party is defined as a corrupt dictator. The corrupt dictator is by definition disrespectful of the wishes of nation-builders, has a tendency to ignore rules, and violates agreements. This problem can be solved for the corrupt dictator by paying the corrupt dictator up front at the time when the agreement is reached. The nation-builders lose nothing because if the corrupt dictator reneges, he can take whatever monetary equivalent he would have taken in his capacity as corrupt dictator. And, as before, the nation-builders can order up a revolution, a risk that the corrupt dictator always faced. Indeed, the purpose of the game is to avoid a revolution that is costly on both parties and to pursue economic success instead. The abstract territory of conceptual dispute is the substitute for war and death. Regardless of the details of the agreement, a third-party enforcer that also benefits from a peaceful settlement outcome and economic success, and possesses superior influence and force compared to either of the two parties, is required sine qua non.

Another problem is associated with value assignment and measurement. Even when we can assign value and take measurements, the values obtained may not be accessible through mathematics. For example, in the physical world, heat and temperature are inextricably linked. But, heat is additive in the sense that it is cumulative, whereas temperature is not. That is, if two identical cubes, say, are placed adjacently so as to be touching one another, then their total heat is the sum of the heat possessed by each while their temperatures remain the same. And, there is no combination of heat and temperature that makes any sense in a calculation. In the psychophysical world, even more abstract is the concept of one's utility for say, money. The corrupt dictator may be motivated by money or by power. Or, his utility for money may be power. So, we assume that power is a linear function of money such that there is no loss of generality in using money to calculate payoff. The corrupt dictator by definition has no dedication to a sense of fair play in the distribution of wealth. So, although rational in his thinking process, principles such as homogeneity and superposition are not what he chooses to feature in his rules. To play the game we must know the utility function for both parties. Everybody is different and has a different utility function, so there is no way to play the game in specific numerical monetary terms. In the real world, the parties must play the game to arrive at the equilibrium. The objective in this paper is to determine the design of the hypothetical pure strategy game assuming a straight-line monetary value utility for both parties. And, in the case of a mixed strategy game, assume a straight line expected monetary value utility. That is, their utilities for money are linear functions of monetary value. The parameters of the CDR model are global time invariant and therefore are always fixed in spacetime for all countries. In a suboptimal strategy, even though both players are awarded less than the optimal payoff, neither player has an incentive to change strategy due to a reduction in the immediate payoff.

5.1 Example : hypothetical persistent corrupt dictatorship

Table 1 is a payoff table of fraction of g computed from the above objective function expressed in per unit terms and depicted in Figure 1. Actual standard of living, G, is obtained from g by inverse linear transformation G = g (highest G - lowest G) + lowest G. But, it is easier

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to work in terms of the per unit values of g. Table 1 shows relative payoff for corrupt dictator (row) / nation-builders (column) with each of thirty six combinations of six chosen strategies 1, 2, 3, 4, 5, 6 by each player.

Each cell contains two payoffs separated by a comma. The payoff on the left of the comma is the perceived payoff that the corrupt dictator believes will be realized from a zero-sum game. The payoff on the right of the comma is the payoff that nation-builders believe will be realized from a CDR plus sum game. Let us assume that the allocation that the corrupt dictator appropriates to himself from the zero-sum game is 10% of g. Let us assume that the allocation that the nation-builders will offer to the corrupt dictator is 5% of g. That is, a smaller percentage of a larger g versus a larger percentage of a smaller g. Particularly noteworthy is the extreme case where the bedeviling corrupt dictator insists on CDR<= 0.2 to reign in almost all freedoms. If the nation-builders accept that policy, the country g will be zero and the payoff will be zero for both parties. The alternative is a revolt that is certain to exile the corrupt dictator with his payoff equal to zero. With the exile of the corrupt dictator and replacement by the nation-builders, they can pursue CDR>0.2 and the corresponding payoff that they believe will occur. The computations are as follows and the results are shown in Table 1.

If corrupt dictator chooses 0.0 and nation-builder chooses 0.0 the expected payoff is 0.0	0.0
If corrupt dictator chooses 0.0 and nation-builder chooses 0.2 the expected payoff is 0.0	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.0 and nation-builder chooses 0.4 the expected payoff is 0.0	0.65(1-0.05 =0.6175
If corrupt dictator chooses 0.0 and nation-builder chooses 0.6 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.0 and nation-builder chooses 0.8 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.0 and nation-builder chooses 1.0 the expected payoff is 0.0	0.7(1-0.05) =0.665
If corrupt dictator chooses 0.2 and nation-builder chooses 0.0 the expected payoff is 0.0	0.0
If corrupt dictator chooses 0.2 and nation-builder chooses 0.2 the expected payoff is 0.0	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.2 and nation-builder chooses 0.4 the expected payoff is 0.0	0.65(1-0.05 =0.6175
If corrupt dictator chooses 0.2 and nation-builder chooses 0.6 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.2 and nation-builder chooses 0.8 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.2 and nation-builder chooses 1.0 the expected payoff is 0.0	0.7(1-0.05) =0.665
If corrupt dictator chooses 0.4 and nation-builder chooses 0.0 the expected payoff is 0.3(0.1)=0.03	0.0
If corrupt dictator chooses 0.4 and nation-builder chooses 0.2 the expected payoff is 0.3(0.1)=0.03	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.4 and nation-builder chooses 0.4 the expected payoff is 0.3(0.1)=0.03	0.65(1-0.05)=0.6175
If corrupt dictator chooses 0.4 and nation-builder chooses 0.6 the expected payoff is 0.3(0.1)=0.03	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.4 and nation-builder chooses 0.8 the expected payoff is 0.3(0.1)=0.03	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.4 and nation-builder chooses 1.0 the expected payoff is 0.3(0.1)=0.03	0.7(1-0.05) =0.665

and so on.

TABLE 1

Relative payoff for persistent corrupt dictator (row)/nation-builders (column) with each combination

	Nation-builders	**1**	**2**	**3**	**4**	**5**	**6**
Corrupt dictator	CDR	0.0	0.2	0.4	0.6	0.8	1.0
1	0.0	0.0,0.0	0.0,0.38	0.0,0.6175	0.0,0.855	0.0,0.855	0.0,0.665
2	0.2	0.0,0.0	0.0,0.38	0.0,0.6175	0.0,0.855	0.0,0.855	0.0,0.665
3	0.4	0.03,0.0	0.03,0.38	0.03,0.6175	0.03,0.855	0.03,0.855	0.03,0.665
4	0.6	0.03,0.0	0.03,0.38	0.03,0.6175	**0.03,0.855**	0.03,0.855	0.03,0.665
5	0.8	0.03,0.0	0.03,0.38	0.03,0.6175	0.03,0.855	**0.03,0.855**	0.03,0.665
6	1.0	0.03,0.0	0.03,0.38	0.03,0.6175	0.03,0.855	0.03,0.855	0.03,0.665

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There appear to be two Nash equilibria. They occur when both parties agree to a CDR of 0.6 or 0.8 and the payoffs are 0.03 for the corrupt dictator and 0.855 for the nation-builders on behalf of the nation. There are six other neighboring combinations of CDR that yield the same payoffs but those off diagonal payoffs do not represent an agreement on CDR strategy. That is, the off diagonal CDRs are dissonant. In any case, neither party can benefit from changing their strategy to CDRs below 0.6 or greater than 0.8.

5.2. Example : hypothetical reformed corrupt dictatorship

Next, consider Table 2 where the payoff on the left of the comma is the perceived payoff that a reformed corrupt dictator is willing to believe is realized from the plus sum game implied by the g curve in Figure 1. The purpose here is to entreat the corrupt dictator to accept an emolument that he might agree to if they believe the calculations obtained from the objective function. The corrupt dictator must also have audacious faith that the nation's populace will from time to time experience divine inspiration leading to wealth generating innovation that derives from the proffered democracy and the practice of rule of law. Otherwise, why bother to navigate this complex nation-builders' decision space. He must also have faith that the nation-builders will honor their commitment to pay the emolument. The payoff on the right of the comma is the payoff that nation-builders believe will be realized from the CDR plus sum game. Let us assume that the allocation that the nation-builders will appropriate to the reformed corrupt dictator is 5% of g. This is less than the 10% that corrupt dictator would enforce. That is, a smaller percentage of a larger g versus a larger percentage of a smaller g. The computations are as follows and the results are shown in Table 2.

If corrupt dictator chooses 0.0 and nation-builder chooses 0.0 the expected payoff is 0.0	0.0
If corrupt dictator chooses 0.0 and nation-builder chooses 0.2 the expected payoff is 0.0	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.0 and nation-builder chooses 0.4 the expected payoff is 0.0	0.65(1-0.05 =0.6175
If corrupt dictator chooses 0.0 and nation-builder chooses 0.6 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.0 and nation-builder chooses 0.8 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.0 and nation-builder chooses 1.0 the expected payoff is 0.0	0.7(1-0.05) =0.665
If corrupt dictator chooses 0.2 and nation-builder chooses 0.0 the expected payoff is 0.0	0.0
If corrupt dictator chooses 0.2 and nation-builder chooses 0.2 the expected payoff is 0.0	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.2 and nation-builder chooses 0.4 the expected payoff is 0.0	0.65(1-0.05 =0.6175
If corrupt dictator chooses 0.2 and nation-builder chooses 0.6 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.2 and nation-builder chooses 0.8 the expected payoff is 0.0	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.2 and nation-builder chooses 1.0 the expected payoff is 0.0	0.7(1-0.05) =0.665
If corrupt dictator chooses 0.4 and nation-builder chooses 0.0 the expected payoff is 0.0	0.0
If corrupt dictator chooses 0.4 and nation-builder chooses 0.2 the expected payoff is 0.4(0.05)=0.020	0.4(1-0.05) =0.38
If corrupt dictator chooses 0.4 and nation-builder chooses 0.4 the expected payoff is 0.65(0.05)=0.0325	0.65(1-0.05)=0.6175
If corrupt dictator chooses 0.4 and nation-builder chooses 0.6 the expected payoff is 0.9(0.05)=0.045	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.4 and nation-builder chooses 0.8 the expected payoff is 0.9(0.05)=0.045	0.9(1-0.05) =0.855
If corrupt dictator chooses 0.4 and nation-builder chooses 1.0 the expected payoff is 0.7(0.05)=0.035	0.7(1-0.05) =0.665

and so on.

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TABLE 2
Relative payoff for reformed corrupt dictator (row)/nation-builders (column) with each combination

	Nation-builders	**1**	**2**	**3**	**4**	**5**	**6**
Corrupt dictator	CDR	0.0	0.2	0.4	0.6	0.8	1.0
1	0.0	0.0,0.0	0.0,0.38	0.0,0.6175	0.0,0.855	0.0,0.855	0.0,0.665
2	0.2	0.0,0.0	0.0,0.38	0.0,0.6175	0.0,0.855	0.0,0.855	0.0,0.665
3	0.4	0.0,0.0	0.02,0.38	0.0325,0.6175	0.045,0.855	0.045,0.855	0.035,0.665
4	0.6	0.0,0.0	0.02,0.38	0.0325,0.6175	**0.045,0.855**	0.045,0.855	0.035,0.665
5	0.8	0.0,0.0	0.02,0.38	0.0325,0.6175	0.045,0.855	**0.045,0.855**	0.035,0.665
6	1.0	0.0,0.0	0.02,0.38	0.0325,0.6175	0.045,0.855	0.045,0.855	0.035,0.665

Here again, there appear to be two Nash equilibria. They occur when both parties agree to a CDR of 0.6 or 0.8 and the payoffs are 0.045 for the corrupt dictator and 0.855 for the nation-builders on behalf of the nation. There are six other neighboring combinations of CDR that yield the same payoffs but those off diagonal payoffs do not represent an agreement on CDR strategy. That is, the off diagonal CDRs are dissonant. In any case, neither party has any incentive to change their strategy to CDRs below 0.6 or greater than 0.8. Note however that the Nash equilibria in both of the above examples are optimal. But, the payoff of 0.045 to the reformed dictation is greater than the payoff of 0.03 to the persistent corrupt dictator. Therefore, the reformed dictator is the better option for both parties. The above hypothetical examples are based on an actual empirical objective function. Therefore, the allocation percentages can be varied from country to country depending on the mores of a particular country. The payoff results and Nash equilibria may vary accordingly.

6.0. CONCLUDING REMARKS

The recommendation from this research is that low GDP corrupt dictator ruled countries must, via a coalition of nation-builders, entreat their corrupt dictator to increase the country CDR index. Failing that, the corrupt dictator must be exiled because only then can a nation raise its CDR index, GDP, and the estates of the least amongst them. That is, ameliorate the human condition. The only source of wealth is human ideas of imagination and creativity. The greatest intellect often comes from the humblest origins. The dictator must be replaced by a newly elected leader and government comprised of an executive, a judiciary, a legislature, separation of powers with checks and balances, all this spelled out in a written constitution, a bill of rights, term limits, an impeachment clause and anti-trust legislation to prevent recurrence of corrupt dictatorship. In this research, the utility function of the corrupt dictator was assumed to be linear. For a particular hypothetical 5 percent of GDP emolument paid to the corrupt dictator, two Nash equilibria were found. Other percentages can easily be investigated. Also, since the CDR model is immutable, various hypothetical non-linear utilities can be investigated to see if they make any difference. Future research can investigate whether or not there is a relationship between the Singapore bonus system for government employees, their raised CDR index, and ultimately their impressively high GDP. That might well be the secret to their rapid success that underdeveloped countries can adopt.

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CHAPTER 14

An Entrepreneurship Strategy for a Russian Curriculum

This chapter is an English translation from the Russian reference:Korovyakovskaya and Ridley (2017).

This paper identifies a strategy for improving entrepreneurship education at Voronezh State University (VSU). The concept discussed may for the most part be generalized to other Russian universities. However, entrepreneurship is not a purely academic subject. While entrepreneurship education builds on the academic curriculum, in its essence, it is applied and professional. Therefore, the strategy is considered in the context of a specific university example and the principal region and student body that it serves. Primary consideration is given to experiential learning, designed to raise the rate and sustainability of business success in Russia.

Keywords: Entrepreneurship, Live case study, Computer simulation.

INTRODUCTION

Russian business history is rooted in many decades of central economic planning. Private business enterprise is relatively new. In order to provide for itself and to compete globally, great effort must be made to transform the way business is done in Russia. This involves changing business education to include entrepreneurship. Entrepreneurship should not be left to chance or to the burden of individual discovery. The university program should be designed to deliver entrepreneurship education.

The world of business has seen a recent acceleration in global outsourcing (Friedman, 2005). Modern rapid transportation systems and the internet have flattened the world of trade and commerce. Trade based on comparative advantage can be realized more than ever before. If Russia is to benefit from globalization it must become part of a global supply chain network, providing those products and services for which it has some natural advantage.

The average failure rate of businesses during the first five years is 80% (Gerber, 1986, 1995, 2007). The failure rate of the survivors is 80% in the subsequent five-year period. One way to reduce this very high failure rate might be to improve the skills of new business owners through entrepreneurship education. This education can be provided through an undergraduate minor and through graduate certificate programs for already practicing business owners and professionals.

INSTITUTIONAL FOCUS

Ridley and Davis, 2009 proposed an entrepreneurship curriculum for Florida Agricultural and Mechanical University (FAMU), an American University. FAMU is a doctoral research University. Their strategy focuses on technology based entrepreneurship. That is, research, development and the commercialization of new products, or new technical solutions to existing problems. One example of a new business plan that won the year 2003 business plan competition at that university is now the worlds most advanced wireless real time heart monitor (see

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www.MyPulseMonitor.com). Other inventions have been a direct outcome of their business plan competition. Prior to 2003, FAMU had no tradition in entrepreneurship.

Voronezh State University is a Russian university and is also a doctoral research institution. Correspondingly, a suitable focus for the university could be technology based entrepreneurship. VSU also has no tradition in entrepreneurship. Before we consider the possibilities for entrepreneurship education at VSU, we review the history and current status of entrepreneurship education in Russia.

RUSSIAN BUSINESS EDUCATION

Background

For the last two decades, education in Russia has undergone numerous changes. Significant modification of the structure and quality of education started in the early 1990s (Grigorenko, 1999; Zalogina, 1995) after the dissolution of the Soviet Union in 1991 and continues to the present (Baskan and Erduran, 2009; Lapidus, Tarkhanov and Razumovskaya, 2014; Uvarov and Perevodchikov, 2012). Uvarov and Perevodchikov (2012) reported "Over the last decade, Russia has built an innovative infrastructure and created an entrepreneurial culture".

During the Soviet time period, universities followed the European education model that allowed students to earn a Diploma after 5-6 years of studies. Education reforms of the late 1980s resulted in adoption of the American model of higher education. In this model, the student first decides on the stream of education, gets the basic knowledge and skills and then narrows down the specialization within this stream of education. In this system, the state does not participate in the process of providing higher education to the students and the competition between the universities to attract the students leads to continuous improvement of the education program.

Standards

To ensure compatibility in the standards and quality of higher education due to the existence of European and American systems of education, a common education space was created as a result of intergovernmental cooperation and agreements between European countries. This process came to be known as ‘Bologna’ as the European Higher Education Area (EHEA) was adopted in Bologna on June 19, 1999. At present, the Bologna Process unites 47 countries in Europe and Asia, including Russia and are committed to the goals of the European Higher Education Area.

The Bologna Process involves a two-tier education system. The system was divided into the Bachelor’s Degree (BS/BA) and the Master’s Degree (MS/MA). This two-tier system allows the students to work while pursuing higher education and at the same time remaining competitive in the market. At the same time, Russia has not abandoned the old model of education. Thus, there are currently three stages of Higher Professional Education:

- Bachelor’s (4years for BS/BA)
- Specialist diploma (BS/BA +1 year)
- Master's Degree (BS/BA +2 years)

Under the new system (Bachelor + Master) of education, students mainly from humanities, sciences, medical, and technical universities maintain continuous education for 5-6 years.

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Delivery

Business education is one of the fastest growing and most promising in Russia. However, rather than creating entrepreneurship faculties and entrepreneurship majors within existing departments, universities open stand-alone business schools where the main focus is on additional professional training and education of managers employed in Russian companies.

At present, there are over 100 business schools in Russia, including more than 50% in Moscow and about 10% in St. Petersburg. On average, 63% of corporate employees undergo at least one training event per year (Lapidus et al., 2014). Currently, the Russian population is 142,423,773 individuals of which 10.15% are 15-24 years old (7,393,188 males, 7,064,060 females) and 16.68% are 0-14 years old (12,204,992 males, 11,556,764 females) (CIA World Factbook, July 2015 estimate). Combined, about one third of the Russian population is undergoing some training and will continue attending educational settings in a few years. They are the current and potential recipients of business and other education and training.

Experts estimate that 70 % of the Russian business education market is in Moscow (Lapidus et al., 2014). This is due to distinctive characteristics of Moscow's education market that include well developed relationships with public authorities and companies, and established international partnerships and agreements that allow for fast growth of business education services in the City of Moscow and Moscow region.

Cost

Advanced education in Moscow comes at a high price. The cost of one day of training in the year 2008 ranged from 140 000 to 175 000 rubles for top managers, from 50 000 to 80 000 rubles for line managers, and from 30 000 to 65 000 for professionals. For programs of study, from $ 6 000 to $ 25 000 for Master of Business Administration (MBA) programs (about $ 100 000 in the Skolkovo School of Management), and from $ 30 000 to $ 35 000 for Doctor of Business Administration (DBA) programs (Lapidus et al., 2014). Currently, the exchange rate is 65 rubles to $1.

Other regions of the country strive to follow the progressive education trends set by universities in the City of Moscow and its region. VSU is one of the oldest and more innovative universities in the central region of Russia. It is a research-led institution that houses 10 research and development centers with a strong record of collaborating with the region’s leading commercial and public sector organizations; 6 research institutes and 16 research laboratories administered by the Russian Academy of Sciences; and state-of-the-art facilities equipped with advanced technologies. VSU has become one of 27 Russian universities included in the international Round University Ranking (RUR) and 90th among BRICS (Brazil, Russia, India, China and South Africa). The university was recently included in the A+ category of Academic Ranking of World Universities - European Standard ARES-2015 published by the European Scientific-Industrial Chamber (VSU Press Service, September 3, 2015).

VSU has been educating students who pursue business education under the Faculty of Economics which is comprised of 11 departments. Among the majors are Economic Analysis and Audit, Economics and Organization Management, Accounting, Credit and Finance, Regional Economics and Territorial Administration, Economics and Management of Human Resources, Information Technology and Mathematical Methods for Economics, Human Resource

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Management, Marketing, General Economic Theory, and Economic Theory and International Economics.

In addition, the University offers business education under the Business School formed as a structural subdivision of the university. The School awards the Bachelor of Business Administration (BBA) and MBA degrees in Economics, Management, Human Resource Management, and State and Municipal Management. It also awards the MBA in Finance and Credit. The Business School was created in year 1995 in response to the urgent need for continuous professional development of corporate employees at the time of reforms and structural changes in the corporate world. Since then, the Business School has been well positioned in the education market by providing high quality education and professional development services to managers at all levels, corporate employees, and individuals who would like to pursue careers in international companies. While the quality of education and educational standards are very high, the costs are significantly lower than those in the City of Moscow and the Moscow region. For instance, the cost of one year for a student in the 2015-2016 academic year is 90 000 rubles for MBA and 78 000 rubles for a BBA (VSU Business School, http://econ.vsu.ru/bs/money.html).

Opportunity

Although the Economics Faculty and Business School offer a wide range of majors, as of today, there is no entrepreneurship major or minor. There is an Entrepreneurship Club, but it was only recently formed in Spring, 2015. The club was formed by students in the Economics Department who had an interest in entrepreneurship. It does not extend to other students who are much more likely to be technological innovators. One faculty member volunteered to mentor the students.

Thus, there exists a great avenue for creativity and entrepreneurship programs and courses to be offered to students and professionals with an entrepreneurial attitude. There is also a great potential for establishing interdisciplinary majors, interdisciplinary research, business incubators, entrepreneurial organizations and clubs, and other related activities such as outreach to local high schools (see APPENDIX). Going forward, the following are elements of entrepreneurship for consideration by VSU.

ENTREPRNEURSHIP & CAPITALISM

Wealth is not a fixed quantity. Wealth acquisition by one individual does not occur at the expense of another individual. Wealth is derived from the pursuit of self-interest, division of labor and freedom of trade (Smith, 1776, 2007). This theory is now validated by data. Today, we see that the world's wealthiest nations, are associated with capitalism, democracy and the rule of law. Entrepreneurship is justified by Adam Smith's invisible hand characterization of the positive unintended consequences of the individual pursuit of one's own wants and needs. The Butcher, the Baker, and the Brewer provide goods and services to each other out of self-interest and the unplanned result of this division of labor is a better standard of living for all three.

BUSINESS PROCESS

It is important to distinguish between the commodities that a business produces and sells and the business process of the business itself. Whereas a new business owner might understand the commodities, he or she might not understand the business process. It is not unusual for a

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business owner to describe the business in terms of its commodities. For example: Our business is "pencil sharpeners." Unless the business is the world's only providers of pencil sharpeners, customers can get the commodity elsewhere. Invariably, the enterprise is better off by being in the business of conducting good business practices and satisfying the needs of customers who happen to need pencil sharpeners. Business failure can occur due to not understanding the business process, the practical realities affecting a new business and customer needs (Gerber, 1986, 1995, 2007). There is a tendency for this to occur even amongst new business owners who are graduates of business schools. This may be surprising since the business student spends several years taking courses that together, cover the study of the business process.

Misunderstanding the business process is not surprising for new business owners who are non-business majors. Their primary contribution to the business is the commodities of the business. For example, a new technology, or a professional engineering, legal, medical or other service.

Science and engineering involve processes that are fully acknowledged as necessary. So it is with the business process. A business process can be such that it requires extraordinary people to make ordinary accomplishments. The preferred business process is one that is as much as possible standardized, thereby permitting ordinary people to achieve extraordinary accomplishments.

In order for a business to grow, it must employ people who are both competent and appropriately qualified to serve its needs at each stage of its development (Welsh, 2005). Welsh instituted a system of careful annual employee evaluation. Based on those evaluations the least effective employees are replaced. The terminated employees can become highly successful at other businesses where their particular skills are a better match for the needs of the other business. A new business needs an entrepreneurial owner who is an innovator to give life to the business. However, there comes a time when if it is to grow, it needs a manager. The skill and psychology of the entrepreneur is to innovate (Gerber, 1986, 1995, 2007). The owner cannot successfully continue in the role of innovator when in fact the business needs a manager. The typical post entrepreneurial business needs are as follows. 1) A technician that must convert the innovation into a commodity. 2) A marketing and advertising technician. 3) A telephone answering technician 4) An order fulfillment technician. 5) A bookkeeper technician. 6) A business process manager. Initially, while the operating budget is small, depending on the type of business, it may be possible to outsource needs 1-5. One way or another, these needs must be satisfied. Otherwise, the business will fall into the 80% pool of failures. The first person to be terminated must be the owner-entrepreneur, who must be replaced with the owner-business process manager.

So, we see that it is an entrepreneurial myth that business is synonymous with entrepreneurship. The reality is that entrepreneurship is only one business component. While it is the very important component that gives birth to the business in the very first place, it is the first component that must be replaced.

The rapid growth and development of trade and wealth came with the emergence of the limited liability company (Micklethwait and Wooldridge, 2003). The company is among the greatest ever inventions. The company exercises capitalism through the mechanism for capital formation for the new business venture entrepreneur, subject to democracy and the rule of law as it applies to the shareholders of the company. Before the emergence of the company, business had no legal rights. Its longevity was determined entirely by a feudal monarch. That was the case whether or not it was financed by the monarch. The best environment for the company is where there is a well governed society. The society must be committed to capitalism and democracy.

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The company, its shareholders, its suppliers and its customers must be protected by the rule of law.

EXPERIENTIAL LEARNING

Across all professions, approximately 10,000 hours are required to acquire competence (Gladwell, 2002). This equates to 40 hours per week for a period of 5 years. University graduates will not have experience at their time of graduation. It may be possible to substitute for some post-graduation experience with experiential learning. Such experiential learning must be built into the curriculum. This is very demanding on the student, and may not be for everyone. The opportunity can be provided for the potential entrepreneur to choose. Experiential learning can include internships, interaction with corporate leaders, live case study computer color graphics animation of existing business (Harrel, Ghosh and Bowden, 2004), and business incubators.

Students can choose an entrepreneurship course elective. In that course, students who propose to start a new business can be allowed to use that business to develop a business plan. Traditional data analysis is based entirely on formulas that assume deterministic constants, averages and relationships. The need for numerous deterministic assumptions can make the business plan unrealistic. The real world of business is not the occurrence of averages. It is a set of random occurrences that are governed by the laws of probability. Computer simulation will incorporate random considerations.

A university entrepreneurship club is essential to promote partnerships between business students and other students enrolled in arts and sciences and professional schools and colleges (Ridley, McKinley-Floyd and Davis, 2008). Russian organizations that promote small business development could be a source of knowledge and training on skills necessary for entrepreneurs to start and operate their businesses. Another excellent source of experience is a retired business partner and advisor who will invest money in the new business. Figure 1 depicts an existing academic curriculum with the following additions: An introduction to entrepreneurship in the first year, a final year course that incorporates live case study and computer simulation, and a business incubator.

CONCLUDING REMARKS

Russia, along with many countries of the former Soviet Union is steeped in a history of central economy. To compete in a global economy, they need to transition to entrepreneurship. Therefore, Russian universities need to incorporate entrepreneurship into their university curricula. This will require standalone departments and programs, apart from the traditional department of economics. Entrepreneurship courses must be accessible by all students. Research institutions like VSU will best contribute via high technology innovation. Other (liberal arts) universities will best contribute to life style business entrepreneurship and social entrepreneurship, involving new business startups to meet increasing demand for existing products and services, and the expansion of existing business into new product and service offerings.

Although the flagship universities in the City of Moscow and the Moscow region have been actively educating students and issuing degrees in entrepreneurship, other regions in the country still have a long way to go.

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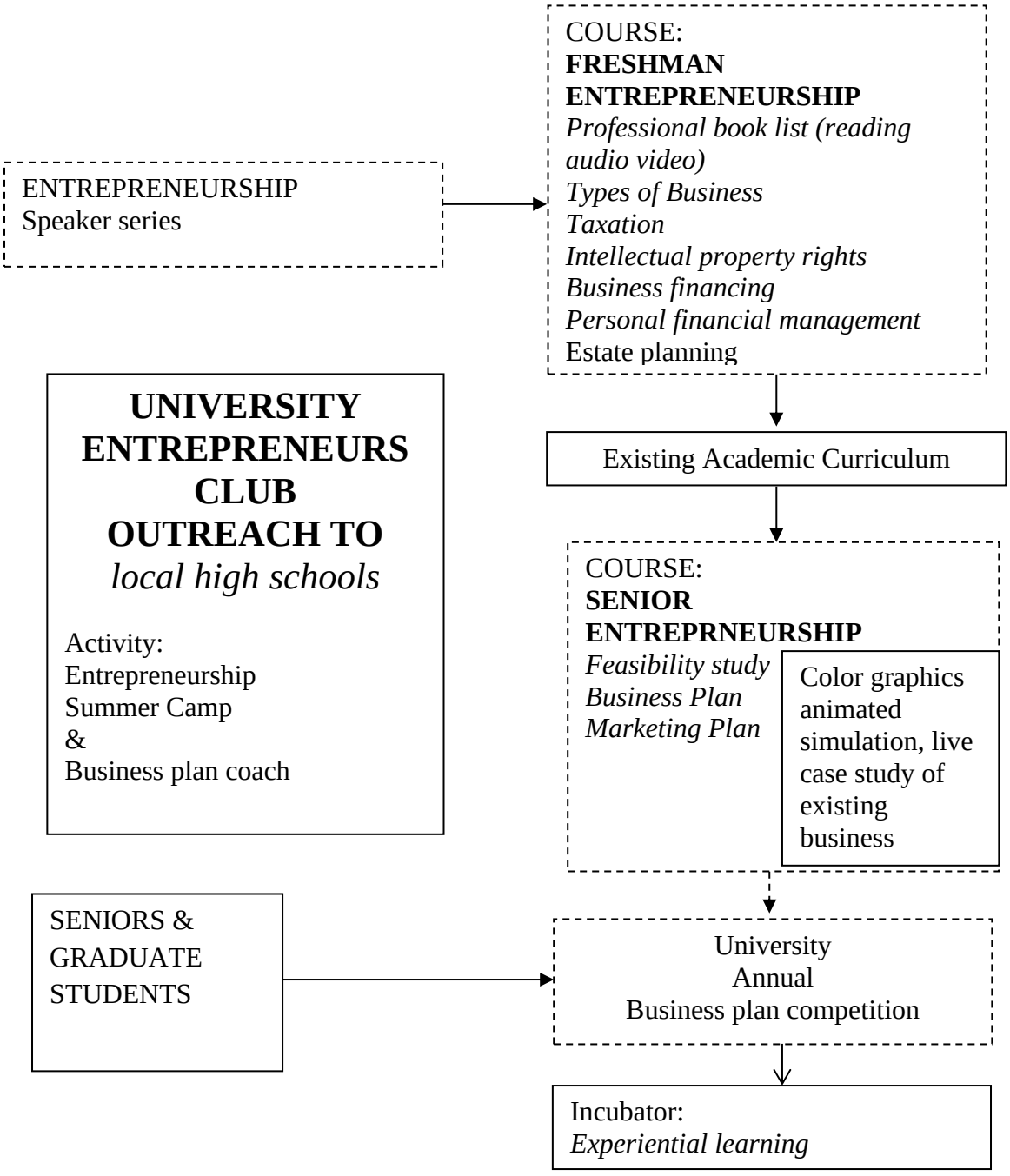
APPENDIX: Outreach

VSU and its economics department have established relationships with regional high schools. For the last 20 years, VSU has been involved in activities of the Student Scientific Organization, including numerous academic competitions (Olympiads), lecture series', academic and scientific conferences, research and publication assistance (VSU Press Service, 2015).

The Spring VSU Open House is one of the major events that prospective students look forward to every year. They meet with Department Deans and other administrators to seek answers to their burning questions.

Figure 1. Experiential-learning-based entrepreneurship.



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CHAPTER 15a

Entrepreneurial Economics: revising the econ 101 course

Reference: Ridley (2018)

The typical course in economics begins with the assumption that there exists a demand for goods and services. It is also assumed that a capital stock of facilities that produce final goods and services just exist somehow, do not have to be created, and that economics are concerned with wealth distribution from these facilities to the exiting demand. In reality, all such capital must have been previously created. Its only source must be human capital ideas of imagination and creativity, otherwise known as entrepreneurship. Entrepreneurship, where it succeeds, creates its own demand in the minds of people who do not know what they want until it is shown to them. A new CDR *growth model that accounts for entrepreneurial capital and capital stock, and combines them with democracy and rule of law, is discussed for inclusion in the beginning university course in economics.*

Keywords: Political economy; Entrepreneurship; Capitalist; Capitalism; Democracy; Rule of Law.

JEL: A20, A22

INTRODUCTION

As best as one can tell, the frameworks for capitalism, democracy and rule of law: Magna Carta of 1215, the English King Charles II 1662 royal charter for the study of science, and the New York 1811 limited liability law created the perfect storm for the start of the industrial revolution around 1776-1840. Before the advent of science, the human DNA had to change if man was to survive, advance from the middle to the top of the food chain and achieve through physical ability. Science reintroduced human capital, the genesis of wealth, by way of a cognitive revolution. Commensurate with the cognitive scientific industrial revolution, countries that represent ten percent of the world's population comprised mainly of Western Europe and its American descendants have experienced unprecedented economic growth. They became rich and continue to get richer. At the same time ninety percent of the world's population remains impecunious. This includes the approximately two hundred and forty years since Smith (1776) became the father of economics. Traditional economics has not come anywhere close to eliminating poverty. It is truly enigmatic that economics can do so much for ten percent of the world and yet so little for ninety percent. Jones C.I. and Vollrath D. (2013) suggest that a critical difference between astronomy and economics is that the economic universe can be potentially re-created by economic policy. That economic policy can shape the course of growth and development. If that is true it is high time that economic policies help the poor. So, it is time to re-examine economic growth theory, its descriptive properties and its prescriptive properties.

The purpose of this paper is to present a modern pedagogy for introducing university economics. Very little attention has been given to entrepreneurship in first year economics textbooks (Kent, 1988 and Kent & Rushing, 1998). The explosion of entrepreneurship education (Ronstadt, 1986, Sexton and Upton, 1987) has been undertaken by management departments in schools of business. Their courses provide guidance to students interested in starting their own

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business (U.S. Small Business Administration, 1986). They do not provide an education in the economic theory of entrepreneurship. In this paper a traditional introductory course is reviewed for its entrepreneurship content and suggestions are made for modifying said course to introduce entrepreneurship. The most recent capitalism (*C*), democracy (*D*) and rule of law (*R*) Ridley (2017a, b, c) CDR growth model is chosen. The model is an estimator of real per capita gross domestic product adjusted for purchasing power parity G=*f*(C,D,R).In this paper a capitalist is defined as a person who deploys his personal capital so as to maximize his benefit. Capitalism is defined as a method of organizing capital. It is measured by total market capitalization *C* and includes entrepreneurial human capital plus capital stock. Market capitalization is the value of outstanding shares of stock sold on the capital markets. Democracy is defined as a measure of participatory governance and management. Rule of law, the reverse of corruption, is defined as a measure of the enforcement of property rights where property is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged. The CDR model is the first to show that standard of living is dependent on C, D and R (see North, 1991 on institutions), and is independent of natural resources, government spending, country size, location, culture, and physical characteristics of the population. It forms an economic theory of entrepreneurship and indicates that all countries can enjoy a high standard of living. Multivariate model development and estimation is beyond the scope of this paper and the ambit of any principles course to which it may apply. But, it must be demonstrated that the source of wealth is entrepreneurial human capital. So, the CDR model is demonstrated on fact based worldwide empirical data and the results are given in appendix BB. The particular course and the particular entrepreneurship model are not important. Each professor can start with their own syllabus, and there are other entrepreneurship models (see for example Gunter (2012) for an arrangement of Schumpeterian and Kirznerian entrepreneurs). But, the model must recognize the source of wealth as the human idea of imagination and creativity if it is to best engage the student. Furthermore, it must recognize the importance of an entrepreneurial environment containing D and R institutions.

The current consensus in economic thought is that R is necessary for economic growth (Gwartney and Lawson, 2003, Leblang, 1996, Keefer and Knack, 1997). However, the case for D is not so clear until now. Przeworski and Limongi (1993) reviewed 18 studies on various data samples ranging from 1949 to 1992 on the question of democracy and economic growth (see Adelman and Morris, 1967, Dick, 1974, Huntington and Dominguez, 1975, Weede, 1983, Kormendi and Meguire, 1985, Kohli, 1986, Landau, 1986, Sloan and Tedin, 1987, Marsh, 1988, Pourgerami, 1988, Scully, 1988,1992, Barro, 1989, Grier and Tullock, 1989, Remmer, 1990, Pourgerami, 1991, Helliwell, 1992). The findings were split equally between yes and no, and no findings at all (see Barro (1996), Przeworski and Limongi (1997) for more on democracy). Therefore, the conclusion of the review was that the answer is as yet unknown. This paper uncovers and clears up the reason for the confusion by presenting a statistical cross country regression model that includes both a positive D term and a negative interaction term (C·D·R) that contains D. The signs are easily explained as a positive D effect and negative friction between C, D, and R, where all three make significant contributions to explaining G. These will be discussed more, later in this paper.

Traditional introductory economics assumes that supply and demand for goods and services exist. There is an upward sloping supply curve and a downward sloping demand curve. Attached to the supply curve are hypothetical producers of goods that the producer believes to be in demand, the prices of which determine the quantity supplied. Attached to the demand curve are consumers who always know what goods they want, the prices of which determine the

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quantity demanded. The source of wealth is the facility where the goods are produced. The mission of this element of economics then is to understand how the goods are produced, distributed, exchanged and consumed (Cowen and Tabarrok, 2015). Throughout, the traditional economic thought process is designed on the Malthusian (1798) assumption of scarce resources. But, the CDR growth model suggests that the source of wealth is the unlimited human ideas of imagination and creativity. All the evidence observed for the past two thousand years suggest that massive human population growth is unlimited by what was thought to be scarce resources and that each person brings their own wealth into the world (Simon, 1981).Isolated communities fare poorly (Sowell, 2016). As the internet enables coordination of individual knowledge throughout the economy, democratic countries only grow richer. But, the internet cannot create democracy where it does not already exist. The internet is a financial highway for incoming capital and for the flight of money at the first sign of instability.

The remainder of the paper is organized as follows. The essence of traditional economics pedagogy that begins with land, labor and capital is briefly reviewed. A modern economics pedagogy that begins with human capital and a growth model based on capitalism, democracy and rule of law is proposed. Some of the terms used in the extant literature require modification in order to arrive at the CDR model. Some of the terms are not defined anywhere in the literature. Concepts such as capitalist, capitalism, entrepreneurship and other consequential terminologies, are defined explicitly in nomenclature in appendix AA.

TRADITIONAL ECONOMICS PEDAGOGY

Traditional economics pedagogy does not tell us definitively where wealth comes from. That in itself renders it growth descriptive, unable to be growth prescriptive. To be growth prescriptive, economics must account for the genesis of wealth (Docherty, 2014). It must tell us where wealth comes from. The extant theory that wealth comes from land, labor and capital is grossly deficient in that it has not stood up as new technologies have developed over time. The theory that wealth derives from an aggregate production function such as $Q=f(K,L)=AK^{\alpha}L^{1-\alpha}$, where A is the total factor productivity and α and 1- α are output elasticities of capital and labor respectively, K is the fixed part of physical capital stock and L is human capital (Solow, 1956)or $Y_t = f(A_t, K_t, H_{Yt}) = A_t^{\sigma} K_t^{\alpha} H_{Yt}^{1-\alpha}$, where $A_t$is total stock of ideas, $K_t$is physical capital, and H_{Yt} is human capital(Jones, 2002), $0<\alpha<1$,must also be reconsidered. There cannot be any such thing as an aggregate production function when the function maps physical units of inputs to physical units of outputs from a single machine and the inputs are different types of items. Also, it is a fallacy of composition to think that we can simply jump from microeconomic conceptions to an understanding of production by society as a whole (Cohen and Harcourt, 2003, Ridley and Ngnepieba, 2018).While A_t might contain the entrepreneurship elements in C, neither one of these models accounts for the D and R institutions for an entrepreneurial environment.

Another problem is that the aggregate production function does not explain the source and evolution of K. K is fixed capital stock. But machines of various types, computers and recording devices, and training of people such as technicians and technologists, are not the source of capital. The source of all capital is human capital ideas of imagination and creativity. Therefore, K is a reinvestment of income that in a prior time period was income from the conversion of human capital ideas into income, less depreciation and obsolescence. That is, K is endogenous capital stock. The production function does not account for the original exogenous

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human capital. The original human capital is exogenous entrepreneurial capital. This disambiguation is discussed further below in the subsection on entrepreneurship.

Yet another problem with the aggregate production function is its requirement for varying degrees of skills in labor. That is, human capital is confounded with physicality. But, skills are related only to human intelligence not brawn. Human capital knowledge that is learned from entrepreneurship activities becomes skill and takes the form of capital stock. The human being has the ability to convert skill in a seamless fluidic adaptation to a machine or tool such that the capability or capital stock of the machine or tool is automatically expanded. In extant economic theory labor would have to be such that economics would violate its own original tenet of comparative advantage in which labor is homogenous (Ricardo, 1817). The production output from homogenous labor is by definition proportional to units of labor. Therefore, labor must be corporeal, all the same, and there is no skilled and unskilled labor. The representation of ideas as a separate variable (A_t)by Jones (2002) is an attempt to get at entrepreneurship, except it does not resolve this issue because it leaves human capital and labor mixed inside of H_{Yt}, implying skilled and unskilled labor.

Yet another problem is that the assumption that the inputs to the production function are founded in scarce natural resources (Malthus, 1798). We now know myriads of ways in which new discoveries of natural resources, energy and methodologies have forced the land, labor and capital premise to yield to various technologies and technological ages. Introductory economics discusses natural resources, geographical latitude and government fiscal policy. But, the importance of these tends to be overstated. They are discussed further herein the subsection on the source of wealth.

A MODERN ECONOMICS PEDAGOGY

In the foregoing traditional economics account of wealth, it is assumed that factories exist and they are operated with raw materials and natural resources. But, the question remains, where do factories come from? As explained by Steve Jobs (1955-2011) “A lot of times, people don’t know what they want until you show it to them,” and the alleged statement by Henry Ford (1863-1947) “If I had asked people what they wanted, they would have said faster horses,” demand side Keynesian financial economics can only act on existing products (see O’Donnell, 1989, 1996 on Keynesian economics). It cannot stimulate the creation of new products and wealth. The source of wealth is actually the ideas of imagination and creativity of the human mind. That is, wealth is all in the mind (Ridley, 2017a). And, the true source of natural resources is the mind (Ridley, Davis and Korovyakovskaya, 2017) and the knowledge of science (Harari, 2015). See also Beinhocker (2006) and Ridley (2010).The last fifty years has seen massive economic growth due the digital influences from companies like IBM, Microsoft, Amazon, Google, Apple, Intel, etc., unrelated to natural resources.

The process of converting human capital to tangible wealth includes the development of machinery and the teaching of entrepreneurial technological knowhow to other people (Faria, et. al., 2016). It can also include the programming of computers and storage in recording devices. Not unlike division of labor that creates surplus capital (Smith, 1976), this division of human capital creates surplus wealth (Ridley, 2017b). Furthermore, since imagination is unlimited, wealth must also be unlimited. This is the basis of a compelling argument that economic growth should be credited to entrepreneurship, where entrepreneurship is the process of starting a business, typically a start-up company offering an innovative product, process or service. See alsoCDRindex.blogspot.com and Ridley, 2017c.Recognizing this, Ridley (2016), Ridley, Davis

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and Korovyakovskaya (2017), and Korovyakovskaya and Ridley (2017a), developed a modern pedagogy for entrepreneurship. Ridley and Khan (2019) is the first to compute the values of ideas.

The Source of Wealth: intangible versus tangible

The *G=f*(*C,D,R*) model for year 2014 data and 79 countries that represent practically all the people in the world is reproduced in Appendix BB. The CDR epistemology comprises a regression model and corresponding vexillographical chart. The fitted CDR function is CDR index = 1.53*C* + 0.14*D* + 0.23*R* - 1.21*C·D·R*, where *G*= CDR index (highest *G*-lowest *G*) + lowest *G*, highest *G*=$83,066 and lowest *G*=$1,112.That is, a function that serves as an index that can be used to compute *G* in any year for any country where *C*, *D* and *R* are known, and the highest and lowest *G* in the world are known. The CDR model explains 83% of the variation in *G* with a straight line. The residuals (not shown) are random, implying that there is no omitted variables bias.

C comprises both exogenous entrepreneurship capital and endogenous capital stock. The endogenous capital stock component can bias the estimated model thereby requiring special econometric methods that are beyond the syllabi of introductory economics. Suffice it to say that the model was re-estimated for years 1995 through 2016 for which data were available and the results were approximately the same. This establishes that after adjusting for country factors of production, the conversion of *C* to *G* is global time invariant. The conversion is always the same in all countries and is governed by the natural laws of science. It places the former dismal science as it relates to economic growth theory on a sound scientific footing. The time invariance of the CDR model implies that dynamic modeling is unnecessary. What is often described as high country productivity is actually its ability to attract capital. In this model R creates stability that attracts *C* and *D* is a virtue that creates additional pathways for the efficient deployment of *C*. Tangible wealth includes natural resources. But, CDR theory shows that after controlling for *C*, *D*, and *R*, natural resources explains only a negligible 6% of the variation in g. Furthermore, there is the problem of the Dutch disease paradox that natural resources can be responsible for (Ebrahim-zadeh, 2003). See also Auty, 1993, Sachs and Warner, 2001, Ross, 2001, Sala-i-Martin and Subramanian, 2003, Humphreys, 2005, Wadho, 2014. Ridley (2017b) gives a didactic account of how bauxite negatively impacted the Jamaican dollar. So, the natural resources variable was dropped from the CDR model. Geographical latitude explains only 4% of the variation in *G*. Furthermore, latitude can play no role in policy making since a country cannot change its latitude. Government spending had no impact on the model R^2_{adj}. So, latitude and government spending were also dropped from the CDR model.

To convert intangible *G* to tangible wealth, *G* must be distributed to all the units of production in terms of *C* that is as a fraction of *G*. In general, consider *m* countries, *i=1,2,3,..m*, where country i contains $n_i$microeconomic production units of monetary value $v_{ij}=f(f_{ij}G_{ij},w_{ij})= A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}$, where f_{ij} is the fractional allocation of total capital and $w_{ij}$is the monetary payment for corporeal labor. Here, fixed capital stock *K* is replaced by total capital *C* (entrepreneurship human capital and capital stock) and *G=f*(*C,D,R*).The aggregate production for country i is given by$\sum_{j=1}^{n_i} A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}$.The global aggregate for all *m* countries is $\sum_{i=1}^{m}\sum_{j=1}^{n_i} A_{ij}(f_{ij}G_i)^{\alpha_{ij}}w_{ij}^{1-\alpha_{ij}}$.

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Entrepreneurship: information theory of economics

So, what is a modern economics pedagogy that begins with an economic theory of entrepreneurship? Entrepreneurship is the process of starting a business, typically a start-up company offering an innovative product, process or service. It distinguishes itself from the expansion of routine business for which the outcomes are well known. Contrary to the standard economics curriculum, it cannot be reduced to a simple career choice between a job and self-employment in pursuit of profit incentive versus wages. To do so would be to ignore the human spirit that is involved. When successful, the rich entrepreneur continues to innovate. This is despite their inability to eat more than three meals daily, drive more than one car at a time, live in more than one house at a time, etc. This is evidence that entrepreneurship is an act of giving rather than one of taking.

We know from the CDR index model that intangibles are what create wealth and tangibles like natural resources are negligible. Furthermore, negligent financial management can mark the onset of the natural resources curse. Combined with capital stock, including knowledge, both of which continuously depreciate, equilibrium leads eventually to poverty. Knowledge is about the past and entrepreneurship is about the future. New entrepreneurial human capital ideas are the source of wealth. But, to be wealth effect positive, ideas must create disequilibrium. That is the nature of innovation. With no more innovation, there is a return to equilibrium (see also Schumpeter (1911), pp. 43 & 81, Knight(1921), pp. 264-266, Schumpeter (1928), p. 241, Weber (1930), p.67, Hayek (1945), p.523, Lina and Siegel (2007), p.21, and Spulber (2009), p.194, Schumpeter (1954), Roncaglia (2005)).

Capital is typically converted via a production process into products and services. *R* is necessary to attract *C* and *D* is necessary to create additional pathways that deploy *C* effectively. New ideas appear to us as quanta of information that must be detected and acted on (Gilder, 2013, Romer, 1990). But, a low *D*, low *R* high noise environment blocks exogenous innovative *C*. A high *D*, high *R* low noise environment is required for the detection of human entrepreneurial ideas. Sometimes it is the people who no one imagines anything of, that do the things that no one can imagine. Heterogeneous exogenous catalysts *D* and *R* are government variables that provide positive social equilibrium effects. Heterogeneous variables do not change their form. Exogenous variables are external to the process, do not get used up, and at the end of process are ready for reuse as before. Catalysts do not take part in the process (Berzelius, 1835). The process by which exogenous innovative *C* is converted to products is depicted in Figure 1. The variable g is the standardized version of *G* used to estimate the CDR model (see Appendix BB).

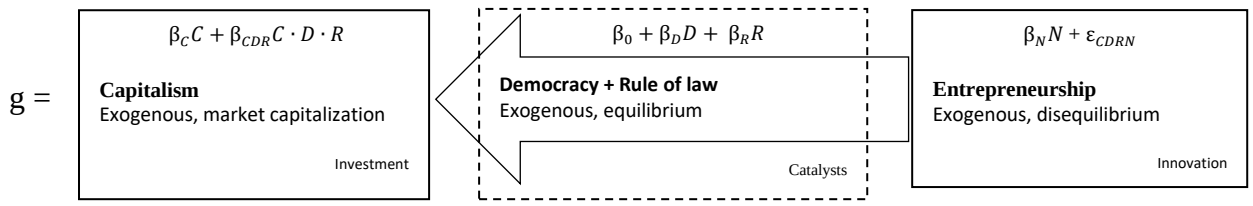

Figure 1. Conversion of exogenous innovation *C* to g through a DR channel.

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Revising the econ 101 course

In order to incorporate the new CDR growth model, it is necessary to revise the extant economic curricula in a small number of ways. Although only few, the implication of the revisions is profound. And, there is no need to push any topics out to make room for entrepreneurship. The presentation and explanation just need to be modified. In order to fit the limited number of pages in this paper, only a single syllabus for an introductory course will be considered. Other courses can be revised similarly. The first item to include is the CDR model itself as the genesis of wealth. It is not a competitor of the production model. It is a prerequisite to the production function. It provides the initial human capital to the production function. Without CDR, the creation of wealth will be negligible. Furthermore, there will be no growth. A few other topics are revised where appropriate to account for the CDR effects. The selected course is that of Professor Randall Holcombe of Florida State University (Holcombe, 2013), and co-author of Gwartney, Holcombe, Lawson (1999, 2004, 2006). He and others identified the importance of economic freedom. And, the D and R components of the CDR model are economic freedom-like variables in the way they impact economic growth (see also Mailer and Miller, 2017).The course is titled "Introduction to Economic Thinking (ECO2000)"and is listed in the State of Florida, USA as a principles course for non-majors. Principles courses are also listed for economics majors. So, ECO2000 is the most rudimentary. Professor Holcombe's syllabus and course outline are particularly well articulated, making it easy to identify subtopics related to entrepreneurship. For example, the first subtopic "Spontaneous social order" is perfect for introducing entrepreneurship albeit in this paper the preferred title is "The genesis of wealth." The textbook is "Economics and Contemporary Issues, 7th ed., by Moomaw and Olson."The original topics 1-12 in the syllabus are listed in the left column in Table 1. The centre and right columns list descriptions and reasons for the revisions, respectively.

Table 1

Introductory Economics Course (*changes in italics*)

Traditional Topics	***Proposals in italics***	**Rationale for change/addition/removal**
1.Spontaneous social order A. Do we take our wealth for granted? Why are we rich? B. Language, money, markets. C. The results of human action but not of human design. D. The problems of coordinating the individual knowledge of everyone in the economy.	**1.** ***The genesis of wealth*** A. *Wealth is all in the mind Ridley (2017a).* B. *Market capitalization (C).* C. *Democracy (D).* D. *Rule of law(R).* E. *Entrepreneurship.* F. *Real per capita gross domestic product adjusted for purchasing power parity G=f (C, D, R).*	The source of wealth is human capital entrepreneurial ideas of imagination and creativity. Capitalism is a method of organizing capital. It is measured by total capitalization and includes human capital plus capital stock. Rule of law (*R*) establishes stability that attracts capital. Democracy (*D*) creates additional pathways for the effective deployment of capital (*C*). The internet enables coordination of individual knowledge throughout the economy. *D* and *R* are catalysts. CDR generates intangible wealth that is subsequently converted to tangible wealth. Natural resources account for 6% of *G*. Latitude account for 4%.
2. Economics and prosperity. A. Economics is the study of how we use what we have to get what we want. B. Adam Smith and the division of labor. "The division of labor is limited by the extent of the Market." C. David Ricardo and Thomas	**2. Economics and prosperity.** A. Economics is the study of *wealth creation and* how we use what we have to get what we want. B. Adam Smith*:* Division of labor. "The division of labor is limited by the extent of the market." *Denis Ridley (2017b): Division of*	The source of wealth must be acknowledged to permit each newborn person to bring their own wealth into the world. Said wealth must be released through human capital entrepreneurial ideas of imagination and creativity, and conversion from intangible wealth to tangible wealth of goods and services via a production process. Capital is comprised of entrepreneurship and capital stock of machines, knowledge learned from entrepreneurs, computers and

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Robert Malthus: Economics as the dismal science. D. How long has the world economy been growing? E. Capital and labor productivity.	*capital. Wealth is unlimited.* C. David Ricardo and Thomas Robert Malthus: Economics as the dismal science. *Dennis Ridley(2017a-b): CDR predicts 83% of variation in growth.* D. *Massive growth began with the industrial revolution.* E. Capital and *corporeal labor* productivity.	recording devices. Just as division of labor creates surplus capital, the division of human capital creates surplus wealth. If human imagination is unlimited, then wealth is unlimited. Magna carta, scientific and cognitive revolution, democracy, rule of law, and the limited liability company created the perfect storm for the start of the industrial revolution and unprecedented economic growth. The human being has the ability to convert skill in a seamless fluidic adaptation to a machine such that the capability or capital stock of the machine is automatically expanded. All labor is corporeal.
3. Some key concepts for economic thinking. A. People respond to incentives. B. The Production Possibilities Curve and Opportunity cost. C. Gains from trade: 1. Exchange is a positive sum game. 2. People earn income from providing benefits to others. 3. Comparative advantage. D. Compound interest and the "rule of 72." E. How you can get rich. Pay attention to this lecture!	**No change**	
4. Supply and demand. A. How markets determine prices and quantities. B. Market efficiency and the "Invisible Hand." C. Interference with markets. D. Stock market prices and the efficient markets hypothesis. E. Wage determination and the marginal product of labor. F. Karl Marx and the labor theory of value.	**No change**	
5. Profits guide resources toward activities that increase wealth. A. Profits are a reward for enhancing the wealth of the economy. B. Losses are a penalty for squandering the wealth of the economy. C. Entrepreneurship is the key to economic progress. 1. The process of entrepreneurial discovery. 2. The environment conducive to entrepreneurship. 3. Ludwig von Mises and the socialist calculation debate.	**5. Profits guide resources toward activities that increase wealth.** A. Profits are a reward for enhancing the wealth of the economy. B. Losses are a penalty for squandering the wealth of the economy. C. Entrepreneurship is the key to economic progress. 1. The process of entrepreneurial discovery. 2. The environment *required for* entrepreneurship ~ *CDR.* 3. Ludwig von Mises and the socialist calculation debate.	The environmental that is not only conducive but required for entrepreneurship comprises capitalism (*C*), democracy (*D*) and Rule of Law (*R*). The source of wealth is human capital entrepreneurial ideas of imagination and creativity. Capitalism is a method of organizing capital. It is measured by total capitalization and includes human capital plus capital stock. R establishes stability that attracts capital. *D* is a virtue that creates additional pathways for the effective deployment of *C*. *D* and *R* are catalysts. CDR generates intangible wealth that is converted to tangible wealth. Entrepreneurship is an act of giving and entrepreneurs are a gift to mankind. They give up their leisure time to perfect products and their manufacture to make them affordable to the common man so as to promote increased leisure time for all. A high *D*, high *R* low noise environment is required for the detection of human entrepreneurial ideas. Heterogeneous exogenous catalysts *D* and *R* are government variables that provide positive social equilibrium effects. Heterogeneous variables do not change their form. Exogenous variables are external to the process, do not get used up, and at the end of process are ready for reuse as before. Catalysts do not take part in the process.
6. Economic efficiency. A. Monopoly. 1. Barriers to entry and monopoly profits. 2. Transitional profits and the		

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return to entrepreneurship. 3. Government-produced barriers to entry. B. Other market failures. 1. External benefits 2. Public goods 3. External costs 4. Imperfect insurance markets	**No change**	
7. The role of government. A. Protect individual rights. B. Protect freedom of exchange. C. Protect private property. D. Enforce a rule of law. E. Address problems with markets. 1. Externalities and public goods. 2. Money and monetary policy. 3. Infrastructure and investment. F. The role of government in: 1. Health care. 2. Crime and drugs 3. Education 4. Poverty.	**No change**	
8. Private ownership provides incentives for wealth creation. A. Incentives with private ownership. B. Private versus public property. C. Applications: Endangered species and natural resource conservation.	**No change**	
9. Economic indicators A. Income indicators like Gross Domestic Product. B. Nominal versus real GDP. C. Price level indicators like the Consumer Price Index D. Government's share of GDP. E. Aggregate supply and aggregate demand. F. Unemployment: the natural rate and deviations from it.	**No change**	
10. Monetary Policy. A. Money and the equation of exchange. B. Real versus nominal prices and interest rates. C. The concept of full employment. D. Short-run and long-run impacts of money. 1. Interest rates. 2. Price level. 3. Real income. 4. Employment.	**No change**	
11. Money and banking. A. The Free Banking Era. B. The role of government in the monetary system. 1. The origins of the Federal Reserve System. 2. The role of the Federal Reserve System. 3. Monetary policy and the Great Depression. Milton Friedman's monetarism.	**No change**	
12. Economic policy. A. Stability versus fine-tuning. John Maynard Keynes and	**12. Economic policy.** A. Stability versus fine-tuning. *Demand side:* John Maynard	As explained by Steve Jobs (1955-2011) "A lot of times, people don't know what they want until you show it to them," and the alleged statement by Henry Ford (1863-1947) "If I had asked

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economic policy. B. International trade and trade barriers. C. Human and physical capital, and per capita income. D. Competition and monopoly. E. Public policies toward wealth and poverty.	Keynes and economic policy. *Supply side: Dennis Ridley (2017a-b) and economic policy.* B. International trade and trade barriers. C. Human and physical capital, and per capita income. D. Competition and monopoly. E. Public policies toward wealth and poverty. *Growth requires CDR. Ridley (2017c).*	people what they wanted, they would have said faster horses,"demand side financial economics can only act on existing products. Since people do not naturally know what they want. Demand side policy cannot stimulate the creation of new products and wealth. The creation of an entrepreneurial environment will tap into the only source of wealth and growth, the mind. A negative income tax in which the government pays a living wage supplement to all employed people is a source of micro intrapreneurship wealth. Welfare supported unemployed people are dead capital that cannot produce wealth. Economic growth is independent of natural resources, government spending, country size, location, culture, and physical characteristics of the population. Rule of law improves as corruption is reduced, contracts are enforced and property rights are clarified.

CONCLUDING REMARKS

This paper brings to the attention of economics professors the need to explain the true genesis of wealth. The Ridley (2017a, b, c) CDR growth model was selected, not to compete with the production function but as a complementary prerequisite to the production function. Students that lack an entrepreneurial family background and who think that the only source of wealth is always already established in existing factories and distribution networks might easily see no relationship to their life and be discouraged from entrepreneurship (see also Celuch, Bourdeau, Winkel (2017),Tognazzo, Gubitta and Martina (2016)). The real tragedy of the poor is the poverty of their aspirations (Adam Smith).The CDR model identifies the source of wealth as being the human ideas of imagination and creativity. Therefore, even the poorest person is a carrier of the source of wealth and might more easily see themselves as a potential entrepreneur when so exposed through the modified course (see also Ridley, 2017c).

The introductory course should begin with the genesis of wealth based on the aggregate CDR growth model $G=f(C,D,R)$. Then, progress to micro production functions that convert intangible wealth of human capital ideas into tangible wealth of goods and services. The micro production function should be a single unit in which capital is a fraction of G, labor is replaced by corporeal labor, and the value of the production is summed up and reconciled with gross domestic product. An economic theory of entrepreneurship based on the CDR growth model should be included. Other topics should be modified to reflect the implication of the CDR model, namely global time invariance of the conversion of capital to standard of living, dependent on capitalism, democracy and rule of law, and independent of natural resources, government spending, country size, location, culture, and physical characteristics of the population.

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CHAPTER 15b

Entrepreneurial Engineering: revising the engineering 101 course

Reference: Llaugel and Ridley (2018).

The typical course in engineering begins with the assumption that manufacturing operations already exit. It also assumes that capital represented by facilities that produce final goods and services already exists, do not have to be created, and that engineering is only concerned with technical design execution, production and operations. In reality, all capital must have been previously created. The only source of capital must be human capital ideas of imagination and creativity, otherwise known as entrepreneurship. Entrepreneurship, where it succeeds, creates its own demand in the minds of people who do not know what they want until it is shown to them. Therefore, engineering must be concerned with entrepreneurship education. A new CDR model is discussed for inclusion in the beginning university course in engineering.

Keywords: Engineering; Entrepreneurship; Capitalist; Capitalism; Democracy; Rule of Law.

1. INTRODUCTION

Entrepreneurship has an important role in job creation and that has increased worldwide interest in the topic. In developing countries, entrepreneurial activities energize weak economies. Recent changes in the world present challenges and opportunities to engineering education. Market conditions, population demographics and employment dynamics, create different circumstances today than those existing a decade ago. Entrepreneurship is known as the creative destruction that leads to innovation. Entrepreneurial behavior has a clear effect in increasing the economic wealth of a nation (Mueller, 2011). Entrepreneurship is also known as the process where the entrepreneur searches for new opportunities in the environment leading to a new venture. Others consider the entrepreneurial activity as an innovation process to exploit a business opportunity by applying entrepreneurial learning. In this process something new or different is created adding value to the society (Tung, 2011, Kao, 1993).

Traditionally, courses on entrepreneurship originated in business or management schools. This began to change during the last decade when many educational institutions began to introduce entrepreneurial education in the engineering curriculum (Luryi et al., 2007). In developing countries the process has been slower, due in part to what is referred to as resource limitations, but especially due to the wrong mind set and culture of university administrators. Often, resource limitations are actually resource suppression of talent and innovation capacity (see section 3.1 below). This situation has been recognized by governments. And, several politically motivated plans are in place to overcome limitations and lack of funding. In Dominican Republic the Ministry of Higher Education prepared a strategic plan to implement entrepreneurship knowledge in engineering curricula. Business courses are complemented with startup business development assistance and encouragement for filing patents.

The purpose of this paper is to acknowledge a new CDR index that is remarkable for explaining real gross domestic product adjusted for purchasing power parity (G) and use it to introduce entrepreneurship theory to engineering students. It epitomizes the role of science and engineering in the true creation of wealth. The CDR index = $f(C,D,R)$ is a function constructed

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from capitalism (*C*), democracy (*D*) and rule of law (*R*). Capitalism is measured by market capitalization, the value of outstanding stocks on the financial markets. Democracy is a method for creating new pathways that connect human capital ideas of imagination and creativity. Rule of law is the opposite of corruption, and promotes property rights and justice. The traditional introduction to economics assumes that wealth is produced by manufacturing goods at a factory and distributing them to customers. But, it does not answer the question: where do factories come from? The CDR model says that wealth is created solely from human ideas of creativity and imagination. These are the types of ideas that emerge from engineers. That is, capital is embedded in the human being. And said capital is embedded in the value of outstanding stocks sold on the capital markets. In the capital to wealth production mechanism, rule of law attracts capital and democracy deploys capital optimally.

The remainder of this paper is organized as follows. In section 2 we review the traditional engineering pedagogy. In section 3 we present a modern engineering pedagogy that includes entrepreneurship. Section 4 contains conclusion and recommendations for future research. Next, a nomenclature is given to help beginning students understand various terminology used in economics, particularly the elements of the CDR index. A derivation of the new CDR index on which our theory of entrepreneurship (Ridley (2016), Korovyakovskaya and Ridley (2017), Ridley, Davis and Korovyakovskaya (2017), Ridley, (2017a, b, c), Ridley and Khan (2019), Ridley and Ngnepieba (2018)) is based is given in Appendix BB.

2. TRADITIONAL INDUSTRIAL ENGINEERING PEDAGOGY

In developing countries, a major concern is the poor quality of education and the lack of financing available to universities. This often results in insufficient capacity to join industry in innovation-related projects. Building effective university-industry linkages in this context takes time and sustained effort by college authorities. This is due in part to universities in developing countries generally having little experience in industry collaboration and limited managerial capacity in research (Guimon 2013). That is why universities concentrate on teaching, with low or no space for research, industry collaboration and joint venture. The research activity of these universities is less likely to lead to spin-offs or patents that can be commercially exploited. In many developing countries university-industry collaboration is constrained by historically based cultural and institutional barriers that take time to overcome.

Three university missions have given rise to the distinct concepts of *teaching university*, *research university* and *entrepreneurial university*. Universities in developing countries have fostered the teaching activity over the other two. One possible way to incentivize the entrepreneurial spirit in college graduates is to promote university-industry collaboration. This collaboration may take place under all of these university missions, although it will have a distinct focus on training in the teaching university, on research and development in the research university, and on technology commercialization and spin-offs in the entrepreneurial university. In any case, complementarities exist among the different university-industry links (Guimon 2013).

3. A MODERN ENTREPRENEURIAL ENGINEERING PEDAGOGY

Entrepreneurship education is explained as the methods and approaches used to teach people to start new businesses successfully and operate such businesses profitably.

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Entrepreneurship education is defined as the "process of transmitting entrepreneurial knowledge and skills to students to help them exploit a business opportunity" (Tung, 2011).

Entrepreneurship education has an impact on increasing start-up rates (Tung, 2011). Entrepreneurship education leads to the improvement of the level of knowledge about how to launch and manage a new business venture (Schaper, 2007), enables students to gain experience in a real business context, foster favorable attitudes towards entrepreneurial activities (Gorman, et al., 1997) , develops perception of self-efficacy of students, raises the level of students' entrepreneurial intentions, and stimulates students to choose an entrepreneurial career (Charney, et al., 2003). Entrepreneurial education in engineering students contributes to develop the attitude and aptitude necessary to foster the venture mindset in future professionals. Universities in developing countries must foster innovation to contribute to economic growth. No longer is the teaching activity enough to create value and to attract funding from industry and financing agencies.

Initiatives from the government have increased entrepreneurship in engineering colleges in the Dominican Republic. According to WonJoon, Byungheon, and Jungtae (2011), it is an initiative directed to the programmatic adjustment of the Dominican Republic's higher education system regarding productive technological innovation. It acknowledges the challenges to adapt the university's engineering academic programs and recognizes the importance and necessity of competitive improvement of the productive sectors. All this within the framework of the Free Trade Agreement with United States and Central America, and other similar processes of commercial integration. The background of this project can be found in two great initiatives: (I) National Plan of Systemic Competitiveness (National Council of Competitiveness, March 2007), and (II) the Strategic Plan of Science, Technology and Innovation 2008-2018 (Ministry of Higher Education, Science and Technology, October 2008).

The group of government initiatives has three main components as part of the National System of Innovation and Technological Development: a) Institutes of Innovation and Technological Development; b) Network of business incubation systems; c) Creation and Strengthening of Technology parks. The second component will support the creation of an entrepreneurship culture, incorporating entrepreneurship activities in engineering curricula.

The Strategic Plan of Science, Technology and Innovation, constitutes the planning tool and political and institutional articulation of the national system of science, technology and innovation. Thus, it has become the main tool to lay the foundations for innovation and a knowledge based economy that supports the competitive improvement of the productive sector, elevating the quality of life of the Dominican people and strengthening the commitment with the paradigm of sustainable development. Concretely, this program of the Strategic Plan is oriented to scientific research, innovation and technological development. It provides for the creation of a program for strengthening the incubation and entrepreneurship systems of technology base companies that are incubated in universities (WonJoon et al., 2011).

To enrich the engineering curricula the study program should include these topics:

a). Hands on business experience based on innovating engineering projects,
b). The program must be based on multidisciplinary teamwork projects that improve the entrepreneurial experience while adding versatility and functionality. Students learn from each other and strong partnerships may occur.

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c). It has to have a competitive component to encourage in students the entrepreneurial education needed in the real world. This goal may be achieved with competition funding to be awarded to the best proposal that also leads a start-up development.
d). Enterprise participation is made convenient so as to increase the probability of developing new products or improving existing products. This participation is vital for fine tuning the competencies that are included in study programs.
e). Access to funding from the Ministry of Higher Education Science and Technology. This is a specialized fund to incentivize research in basic science and technology.
f). Technology fairs, where students can exhibit their project ideas and get exposure to potential partners and venture capital.

To become an entrepreneur who is able to tackle dynamic, economic, social and potential challenges; one must possess entrepreneurial attributes such as risk-taking, innovation, self-confidence, creativity, problem solving skills, management skills, professional business skills, and readiness for change (Tung, 2011). The reformulation of the engineering curricula is focused on developing in students the characteristics of an entrepreneurial mindset.

3.1 From intangible wealth to tangible wealth

The source of all wealth is intangible human capital ideas of imagination and creativity. Capital comprises both exogenous entrepreneurship capital and endogenous capital stock. The endogenous components of capital are knowledge from training, machines, computers, recording devices, etc., all related to prior entrepreneurship ideas. Endogenous capital is subject to depreciation and obsolescence. Therefore, the only source of growth is the entrepreneurship components of human capital. There are various manufacturing and other processes that convert intangible wealth (human capital) to tangible wealth of goods and services. In such processes *C* is converted to *G*. The CDR growth model for year 2014 is derived in Appendix BB as CDRindex = 1.53*C* + 0.14*D* + 0.23*R* - 1.21*C*·*D*·*R*, where *G* = CDRindex(highest *G*-lowest *G*) + lowest *G*, highest *G*=$83,066 and lowest *G*=$1,112. That is, a function that serves as an index that can be used to compute *G* in any year for any country where *C*, *D* and *R* are known, and the highest and lowest *G* in the world are known. The CDR model explains 83% of the variation in *G* with a straight line (Figure 2). The residuals (not shown) are random, implying that there is no omitted variables bias. There are other growth models (Solow, 1956, Gwartney, et, al., 1999, 2003, 2004, 2006) but they yield much lower values of R^2_{adj} and do not explain growth in terms of policy variables that can be modified to create growth.

The model was re-estimated for years 1995 through 2016 for which data were available and the results were approximately the same. This establishes that after adjusting for country factors of production, the conversion of *C* to *G* is global time invariant. The conversion is governed by the laws of natural science. It is therefore the same in all countries. What is often thought of as high country productivity is actually its ability to attract capital. In the CDR model, R creates stability that attracts *C* and *D* is a virtue that creates additional pathways for the efficient allocation of *C*. Notice that natural resources explains only a negligible 6% of the variation in g. Also, unless well managed, natural resources can create many economic and social problems known as the Dutch disease paradox (Ebrahim-zadeh, 2003, Auty, 1993, Sachs and Warner, 2001, Ross, 2001, Sala-i-Martin and Subramanian, 2003, Humphreys, 2005, Wadho, 2014, Ridley, 2017b). Geographical latitude explains 4% of the variation in G. But, latitude can

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play no role in policy making. Government spending had no impact on the model R^2_{adj}. So, latitude and government spending were also dropped from the CDR model.

3.2 Entrepreneurship information theory of engineering

Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. Entrepreneurship is different from the routine business activity that has well known outcomes. Consider the conversion of capital to products via a production process (Figure 1). Quanta of new information must be detected if they are to be acted on (Gilder, 2013, Romer, 1990). An environment in which *D* is and *R* is low constitutes a high noise environment. A high noise environment blocks exogenous innovative *C*. On the other hand, a high *D*, high *R* low noise environment will permit detection of human entrepreneurial ideas. Sometimes it is the people who no one imagines anything of, that do the things that no one can imagine. Heterogeneous exogenous catalysts *D* and *R* are government variables that provide positive social equilibrium effects. *D* and *R* are catalysts do not take part in the process (Berzelius, 1835).

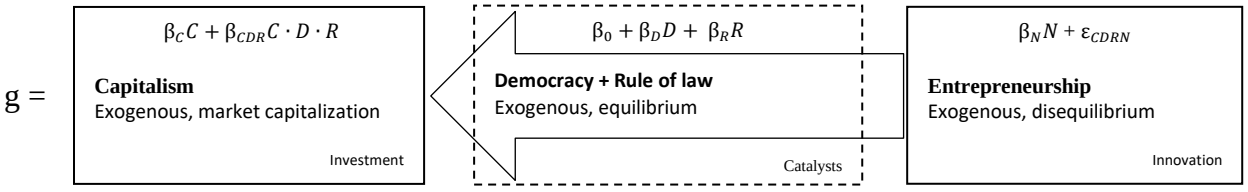

Figure 1. Conversion of exogenous innovation *C* to g through a DR channel. Process by which exogenous innovative *C* is converted to products. The variable g is the standardized version of *G* used to estimate the CDR model (see Appendix BB).

3.3 Revising the engineering 101 course

In order to incorporate the new discovery of the CDR model (see Appendix BB), it is necessary to revise the extant engineering curricula in a small number of ways. Although only few, the implication of the revisions is profound. In order to fit the limited number of pages in this paper, only a single syllabus for an introductory course will be considered. Other courses can be revised similarly. The first item to include is the CDR model itself as the genesis of wealth. It is a prerequisite to business and growth. It provides the initial human capital that can be converted to tangible wealth. Without CDR, the creation of wealth will be negligible. Furthermore, there will be no growth. A few other topics are revised where appropriate to account for the CDR effects. The selected course is that of Felipe Llaugel of the College of Engineering, Universidad Dominicana O&M, Dominican Republic. The original topics in the syllabus are listed in the left column in Table 1. The center and right columns list descriptions and reasons for the revisions, respectively. (Insert Table 1 here)

4. CONCLUDING REMARKS

This paper reminds engineering professors that the true genesis of wealth is human ideas of imagination and creativity. Ideas are the most prized possession of the very students that they teach. Students who lack an entrepreneurial family background are likely to think that wealth comes from existing factories that make products and distribution networks that deliver them to

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consumers. They may lack a vision of themselves as entrepreneurs (see also Celuch, Bourdeau, Winkel (2017), Tognazzo, Gubitta and Martina (2016)). The CDR global time invariant growth model and introductory course modifications suggested in this paper are designed to bring this awareness to the attention of the students. The real tragedy of the poor is the poverty of their aspirations (Smith, 1776). So, even when engineers do not themselves experience an idea, they must be on the constant look out for the ideas of the poorest amongst us that they can bring to fruition through their professional education (see also Ridley, 2017c). For, economic growth is derived from the conversion of human capital to standard of living, dependent on capitalism, democracy and rule of law, and independent of natural resources, government spending, country size, location, culture, and physical characteristics of the population.

Table 1. Introduction to Industrial Engineering Course

Traditional Topics	***Proposed Topics***	**Rationale for change/addition/removal**
1. Introduction to engineering -History -Evolution of Engineering -Modern Trends	**1a. Introduction to engineering** -History -Evolution of Engineering -Modern Trends ***1b. Engineering innovation*** *-Entrepreneurship* *-Property* *-Intellectual property rights* *-Property rights* *-Patents filing* *-Administration and operation*	Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service (see also CDRindex.blogspot.com). Innovators possess capital (*C*) that is required for the production of tangible wealth. They require an environment of democracy (*D*) and rule of law (*R*). *R* attracts *C* and *D* creates additional pathways for the optimal deployment of *C*.
2. Decision making - Decision making process - Alternative generation - Classification - Evaluation	**No Change**	
3. Market Analysis - Demand forecasting - Market segmentation - Statistical methods - Economic environment	**No Change**	
4. The Enterprise - The Organization - Enterprise classification - Operations - Legal aspects	**4a. The Enterprise** - The Organization - Enterprise classification - Operations - Legal aspects ***4b. Entrepreneurship project*** *-Product design* *-Prototype development* *-Business plan construction* *-Market analysis* *-Plant design* *-Financial analysis* *-Economic analysis*	To start a business some previous background is necessary. The demand analysis will quantify the market size. Funding and financial analysis will reveal the feasibility of the idea. Students learn to identify market opportunities.
5. Supervision - Supervision techniques - Training - Coaching - Discipline		
6. Quality - History - Evolution - Quality Control - Quality Assurance		

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CHAPTER 15c

Entrepreneurial Mathematics: revising the math 101 course

Reference: Ngnepieba, Ridley, Stephens, Johnson and Edington (2018).

The typical course in mathematics begins with the assumption that applications of mathematics in the manufacture and distribution of products are already known. It also assumes that mathematics is only concerned with symbolic manipulation and technical design. In reality, the best mathematics relies on creativity. Mathematics is a means for the expression and investigation of creative ideas. The only source of creativity must be human capital ideas of imagination and creativity, otherwise known as entrepreneurship. Entrepreneurship, where it succeeds, creates its own demand for products and services in the minds of people who do not know what they want until they are shown to them. Therefore, mathematics must be concerned with entrepreneurship education. A new CDR *model is discussed for inclusion in the beginning university course in mathematics for students majoring in business administration.*

Keywords: Mathematics; Entrepreneurship; Capitalist; Capitalism; Democracy; Rule of Law.

INTRODUCTION

The traditionally courses on entrepreneurship originated in business or management schools. Then, during the last decade many educational institutions began to introduce entrepreneurship education in engineering (Luryi et al., 2007) and other curricula. In developing countries the process has been slower, due in part to what is referred to as resource limitations, but especially due to the wrong mindset and culture of university administrators. Business courses are complemented with startup business development assistance and encouragement for filing patents. However, in many colleges and universities mathematics courses or lectures in general are conducted in the traditional setting where students passively receive information from the instructor. In the traditional approach to college teaching, most class time is spent with the professor lecturing and the students watching and listening. The students work individually on assignments, and cooperation is limited. Such instructor-centered instructional methods have repeatedly been found inferior to instruction that involves active learning, in which students solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during class (Hacisalihoglu et al, 2018). Active learning refers to activities that are introduced into the classroom. The core elements of active learning are student activity and engagement in the learning process.

The purpose of this paper is to acknowledge a new CDR index that is remarkable for explaining real gross domestic product adjusted for purchasing power parity (G) and use it to introduce the active learning in a beginning finite mathematics course and entrepreneurship theory to business administration students. It is best to introduce entrepreneurial mathematics at the earliest point in the curriculum so we refer to that point as the proverbial math 101. The actual name will vary from university to university. The CDR index = $f(C,D,R)$ is a function constructed from capitalism (C), democracy (D) and rule of law (R). It epitomizes the role of science, technology, engineering and mathematics (STEM) in the true creation of wealth. Capitalism is measured by market capitalization, the value of outstanding stocks on the financial

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markets. Democracy is a method for creating new pathways that connect human capital ideas of imagination and creativity. Rule of law is the opposite of corruption, and promotes property rights and justice. The traditional introduction to economics assumes that wealth is produced by manufacturing goods at a factory and distributing them to customers. But, it does not answer the question: where do factories come from? The CDR model says that wealth is created solely from human ideas of creativity and imagination. These are the types of ideas that emerge from STEM personnel. That is, capital is embedded in the human being. And, said capital is embedded in the value of outstanding stocks sold on the capital markets. In the capital to wealth production mechanism, rule of law attracts capital and democracy deploys capital optimally.

The remainder of this paper is organized as follows. In section 2 we review the traditional pedagogy used in teaching Finite Mathematics. In section 3 we present a modern pedagogy that includes active learning techniques and entrepreneurship. Section 4 contains conclusion and recommendations for future research. Next, a nomenclature (appendix AA) is given to help beginning students understand various terminologies used in economics, particularly the elements of the CDR index.

TRADITIONAL MATHEMATICS PEDAGOGY

The traditional college or university mathematics classroom is depicted in Figure 1. There is a front and centre lecture console where the instructor stands. Students sit in rows and face the instructor, whiteboard (or blackboard) and white screen. The instructor transmits information very efficiently via didactic lecture, with the aid of the whiteboard and writing implements and by projecting images onto the white screen. The students watch and listen passively and/or do whatever else they choose to do. The students work independently on assignments if any. The instructor intentionally limits student interaction, concerned that it might distract from the lecture.

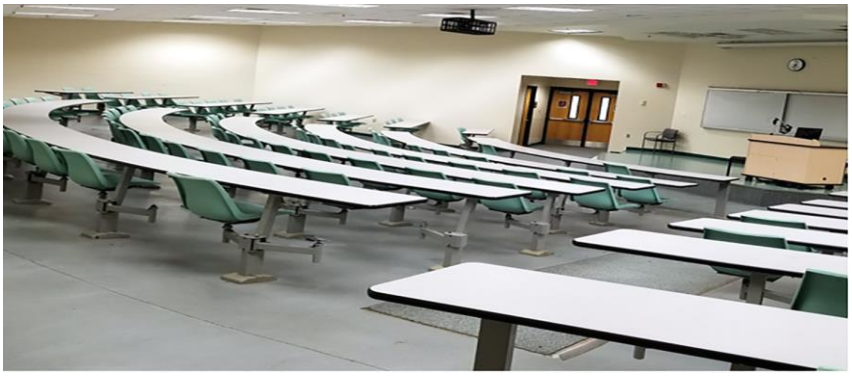

Figure 1: Traditional classroom setting

A MODERN MATHEMATICS PEDAGOGY FOR FINITE MATHEMATICS

Bonwell and Eison (1991) defined strategies that promote active learning as “instructional activities involving students in doing things and thinking about what they are doing.” Approaches that promote active learning focus more on developing students’ skills than on just transmitting information. Active learning requires that students do something—read, discuss, write, etc. Student activity requires higher order thinking beyond just listening. They also tend to place some emphasis on students’ explorations of their own attitudes and values. Active learning techniques described by Brame (2016) are given as follows:

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The Pause Procedure— Pause for two minutes every 12 to 18 minutes, encouraging students to discuss and rework notes in pairs. This approach encourages students to consider their understanding of the lecture material, including its organization. It also provides an opportunity for questioning and clarification and has been shown to significantly increase learning when compared to lectures without the pauses (Bonwell and Eison, 1991).

Retrieval practice—Pause for two or three minutes every 15 minutes, having students write everything they can remember from the immediately preceding class segment. Encourage questions. This approach prompts students to retrieve information from memory, which improves long-term memory, ability to learn subsequent material, and ability to translate information to new domains.

Demonstrations—Ask students to predict the result of a demonstration, briefly discussing the demonstration with their neighbor. After the demonstration, ask them to discuss the observed result and how it may have differed from their prediction. Then, follow up with instructor explanation. This approach asks students to test their understanding of a system by reconciling their prediction with an actual outcome. If their prediction is incorrect, it helps them see the misconception and thus prompts them to restructure their mental model.

Think-pair-share—Ask students a question that requires higher order thinking (e.g., application, analysis, or evaluation levels within Bloom's taxonomy). Ask students to think or write about an answer for one minute, then turn to a peer to discuss their responses for two minutes. Ask groups to share responses and follow up with the instructor's explanation. By asking students to explain their answer to a neighbor and to critically consider their neighbor's responses, this approach helps students articulate newly formed mental connections.

Peer instruction with Concept Tests—This modification of the think-pair-share involves personal response devices (e.g., clickers). Pose a conceptually based multiple-choice question. Ask students to think about their answer and vote on a response before turning to a neighbor to discuss. Encourage students to change their answers after discussion, if appropriate, and share class results by revealing a graph of student responses. Use the graph as a stimulus for class discussion. This approach is particularly well-adapted for large classes and can be facilitated with a variety of tools (e.g., Poll Everywhere, TopHat, Turning Point).

Minute papers—Ask students a question that requires them to reflect on their learning or to engage in critical thinking. Have them write for one minute. Ask students to share responses to stimulate discussion or collect all responses to inform future class sessions. Like the think- pair-share

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approach, this approach encourages students to articulate and examine newly formed connections.

A particular advantage of the active learning comes from its unique classroom design (see Figure 2) that helps students to foster collaborations and increases interaction among students and instructor. Unlike the traditional classroom, this design directly facilitates overall student engagement.

Figure 2: Student-Centered Active Leaning environment classroom setting

The Source of Wealth: intangible versus tangible

The source of all wealth is intangible human capital ideas of imagination and creativity. Capital comprises both exogenous entrepreneurship capital and endogenous capital stock. The endogenous components of capital are knowledge from training, machines, computers, recording devices, etc., all related to prior entrepreneurship ideas. Endogenous capital is subject to depreciation and obsolescence. Therefore, the only source of growth is the entrepreneurship components of human capital. There are various manufacturing and other processes that convert intangible wealth (human capital) to tangible wealth of goods and services. In such processes *C* is converted to *G*. The CDR growth model for year 2014 is derived in Appendix BB as CDR index = 1.53*C* + 0.14*D* + 0.23*R* - 1.21*C*·*D*·*R*, where *G* = CDR index(highest *G*-lowest *G*) + lowest *G*, highest *G*=$83,066 and lowest *G*=$1,112. That is, a function that serves as an index that can be used to compute *G* in any year for any country where *C*, *D* and *R* are known, and the highest and lowest *G* in the world are known. The CDR model explains 83% of the variation in *G* with a straight line (Figure 4). The residuals (not shown) are random, implying that there is no omitted variables bias. There are other growth models (Solow, 1956, Gwartney, et, al., 1999, 2004, 2006). Solow's aggregate adaptation of the Cobb-Douglas micro production function is a fallacy of composition (Ridley and Ngnepieba, 2018). Gwartney's model of growth as a function of economic freedom yields much lower values of R^2_{adj}. Neither of these explains growth in terms of policy variables that can be modified to create growth. The CDR model was re-estimated for years 1995 through 2016 for which data were available and the results were approximately the same. This establishes that after adjusting for country factors of production, the conversion of *C* to *G* is global time invariant. The conversion is governed by the laws of natural science. It is therefore the same in all countries. What is often thought of as high country productivity is actually its ability to attract capital. In the CDR model, *R* creates stability that attracts *C* and *D* is a virtue that creates additional pathways for the efficient allocation of C. Notice that natural resource explains only a negligible 6% of the variation in g. Also, unless well managed, natural resources (*N*) can create many economic and social problems known as the Dutch disease paradox (Ebrahim-zadeh, 2003, Auty, 1993, Sachs and Warner, 2001, Ross, 2001,

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Sala-i-Martin and Subramanian, 2003, Humphreys, 2005, Wadho, 2014, Ridley, 2017b). Geographical latitude explains only 4% of the variation in *G*. And, latitude can play no role in policy making. Government spending had no impact on the model. So, latitude and government spending were also dropped from the CDR model and the appellation CDR was adopted.

Entrepreneurship information theory of mathematics

Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. Such innovation is different from the normal business activities for which the outcomes are well known. Figure 3 depicts the conversion of capital to products via a production process. Gilder, 2013 and Romer, 1990 explain why quanta of new information must be detected before they can be acted on. A high noise environment is implied by low *D* and low *R*. A high noise environment blocks exogenous innovative *C*. On the other hand, a low noise environment is implied by high *D* and high *R*. A low noise environment will permit detection of human entrepreneurial ideas. Sometimes it is the people who no one imagines anything of, that do the things that no one can imagine. *D* and *R* are heterogeneous exogenous government catalysts that provide positive social equilibrium effects. *D* and *R* are catalysts and do not take part in the process (Berzelius, 1835). They are the same before and after the process. While one may discover N or invent methodology ε_{CDRN}, the ultimate resource is not N but scientific knowledge to detect N and the idea of what can be done with it.

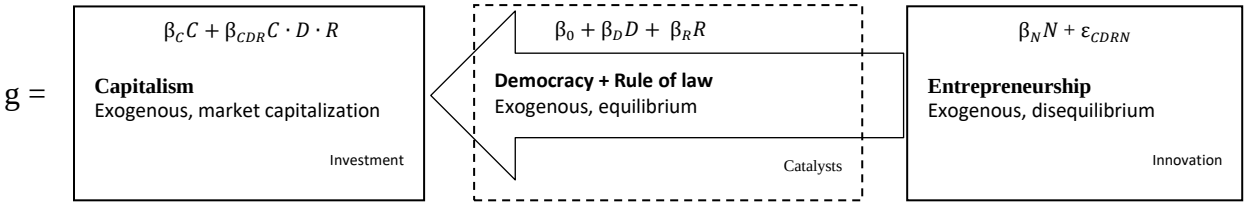

Figure 3. Conversion of exogenous innovation *C* to g through a DR channel. Process by which exogenous innovative *C* is converted to products. The variable g is the standardized version of *G* used to estimate the CDR model (see Appendix BB).

Revising the finite mathematics MAD 2120course

In order to incorporate the new discovery of the CDR model, it is necessary to revise the extant mathematics curricula in a small number of ways. Although only few, the implication of the revisions is profound. In order to fit the limited number of pages in this paper, only a single syllabus for an introductory course will be considered. Other courses can be revised similarly. The first item to include is the CDR model itself as the genesis of wealth. It is a prerequisite to business and growth. It provides the initial human capital that can be converted to tangible wealth. Without CDR, the creation of wealth will be negligible. Furthermore, there will be no growth. A few other topics are revised where appropriate to account for the CDR effects. The selected course is the Florida A&M University Department of Mathematics (MAD 2120) under the supervision of Professor Pierre Ngnepieba. The original topics in the syllabus are listed in the left column in Table 1. The center and right columns list descriptions and reasons for the revisions, respectively.

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Table 1

Introductory Finite Mathematics Course: MAD 2120 (*changes in italics*)

Traditional Topics	***Proposed Topics/Pedagogy***	**Rationale for change/addition/removal**
1. Set operation, Probability and counting techniques -Set and set operations -Basic concepts of probability -Conditional Probability, independent events -Fundamental Counting Principle -Permutation and Combinations -Applications of Counting Principles	**1. Set operation, Probability and counting techniques** No change in topics. *Change in pedagogy:* *-Before class activities* *-In-class activities* *-After class activities*	
2. Logic and Matrix Arithmetic -Logical Statements, Basic Operators, Truth Tables -Truth Tables, Logical Equivalence -Conditional and Biconditional, More on Truth Tables -Arguments with Truth Tables -Arguments with Quantifiers	**2. Logic and Matrix Arithmetic** No change in topics. *Change in pedagogy:* *-Before class activities* *-In-class activities* *-After class activities*	
3. System of Linear equations and Linear programming - Systems of Linear Equations, Echelon Elimination Method - Systems of Linear Equations, Gauss-Jordan Method - Addition and Subtraction of Matrices - Multiplication of Matrices -Linear Programming, Graphical Solutions -Applications of Linear Programming - Linear Programming, Simplex Method -Linear Programming, Maximization Problems	**3. System of Linear equations and Linear programming** No change in topics. *Change in pedagogy:* *-Before class activities* *-In-class activities* *-After class activities*	
4. Statistics -Frequency Distributions, Measures of Central Tendency - Measures of Variation - Normal Distributions - Binomial Probability -Normal Approximation to a Binomial Distribution	**4. Statistics** - Frequency Distributions, Measures of Central Tendency - Measures of Variation - Normal Distributions *Mixed deterministic & stochastic systems.* *Per unit analysis* - Binomial Probability - Normal Approximation to a Binomial Distribution *Change in pedagogy:* *-Before class activities* *-In-class activities* *-After class activities*	Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service (see also CDRindex.blogspot.com). Innovators possess capital (*C*) that is required for the production of tangible wealth. They require an environment of democracy (*D*) and rule of law (*R*). *R* attracts *C* and *D* creates additional pathway for the optimal deployment of *C*. *Mixed deterministic & stochastic systems* (see Figure 3) The deterministic components are $\beta_C C + \beta_{CDR} C \cdot D \cdot R$ and $\beta_0 + \beta_D D + \beta_R R$. The stochastic component is $\beta_N N + \varepsilon_{CDRN}$. The student must be taught how to apply the normal distribution to the understanding of the stochastic component. This will allow them to understand the genesis of entrepreneurship and how to place a confidence interval around estimates of g. *Per unit analysis* The standardized g model in Appendix BB comprises variables that have all been transformed such that their values range from 0 to 1. This permits easy interpretation and parametric computation of world average endogenous $\bar{g}$ and standard deviation $\bar{g}$+/-z$\sigma_{\bar{g}}$. GDP can be obtained from inverse transformation of g: $\hat{G}$=$\hat{g}$(highest *G*-lowest *G*)+lowest *G*. $\bar{g}=\hat{\beta}_0 + (\hat{\beta}_C - \hat{\beta}_{\hat{C}}) + \hat{\beta}_D + \hat{\beta}_R + \hat{\beta}_{\hat{C}DR} + \hat{\beta}_N$ (see Ridley and Khan, 2019 for calculation of $\hat{\beta}_{\hat{C}}$).

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The pre-class, in-class and after class activities as they apply to inferential statistics and the normal distribution are designed so as to foster student understanding of entrepreneurship principles of CDR.

Pre-class activities – The pre-class activities consist of textbook reading assignments and video assignments.

In-class activities – The in-class activities consist of group activities, mini lectures, one minutes paper, peer learning, clicker quizzes.

After class activities – The after class activities consist of additional video assignment, online homework and quizzes, Blackboard worksheets

CONCLUDING REMARKS

Adam Smith (1776) said that the real tragedy of the poor is the poverty of their aspirations. The CDR global time invariant growth model shows that economic growth is derived from the conversion of human capital to standard of living, dependent on capitalism, democracy and rule of law, and independent of government spending, country size, location, culture, and physical characteristics of the population. The impact of natural resources and latitude are negligible. See also Korovaykovskaya and Ridley, 2017, Ridley, 2016, Ridley, Davis and Korovykovskaya, 2017, Ridley, 2017c. Ridley and Khan (2019) is the first to compute the values of ideas.This paper reminds college and university mathematics professors that the true genesis of wealth is human ideas of imagination and creativity. Mathematics is an excellent tool for the derivation and storage of scientific facts that can be passed on to others. Stored knowledge constitutes endogenous human capital from which wealth can be produced. But, such wealth is associated with current technology and methodology. And, equipment and technology can and does depreciate. As technology depreciates, the relevant mathematics can become obsolete. Therefore, mathematics education must not be designed to stagnate in the individual. It must be designed to stimulate the mathematical thinking process for lifelong learning and the release of human capital ideas of imagination and creativity. It must also encourage the student to be democratic in their interaction with other people so as to create new pathways for the deployment of their human capital. This may also help the many students who lack family exposure to entrepreneurship (see also Celuch, Bourdeau, Winkel (2017), Tognazzo, Gubitta and Martina (2016)).

Acknowledgments

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APPENDIX AA

Nomenclature

Capitalist	A person who deploys his personal capital so as to maximize his benefit.
Capitalism	Mechanism for the collection and assembly of capital.
Capital stock	Fixed installed capital less depreciation and obsolescence plus skills and knowledge acquired from entrepreneurs and taught to others.
Catalysis	The creation of alternative pathways to enable a process.
CDR index	The vector inner product (dot product) of the global constant [1.53 0.14 0.23 -1.21] and the country [*C D R C·D·R*].
Company	The instrument of capitalism for the profitable investment of capital.
Democracy	Private work force idea participation and periodic election of public representatives (catalyst for the process of generating G from capital).
Endogenous	Generated from within a system.
Entrepreneurship	The process of starting a business, typically a startup company offering an innovative product, process or service.
Exogenous	Generated from outside a system.
Gross domestic product	The monetary value of all the finished goods and services produced within a country's borders in a specific time period (economic growth = GDP per capita).
Growth in Wealth	Gross domestic product less consumption, depreciation and obsolescence.
Human capital	Capital human ideas of imagination and creativity and skill (not including physical corporeal labor).
Human labor	Physical corporeal labor (not including capital human ideas of imagination and creativity or skill).
Limited liability	Limitation of loss to capital invested.
Natural resources rents	Surplus value of natural resources after all costs and normal returns are accounted for.
Property rights	Property is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged.
Rule of Law	Reverse of corruption (protection of shareholder and other property rights) (catalyst for the attraction of capital).
Shareholder	An owner of shares in a company.
Virtue	Self-governing human property that promotes fairness and justice without the need for central government.

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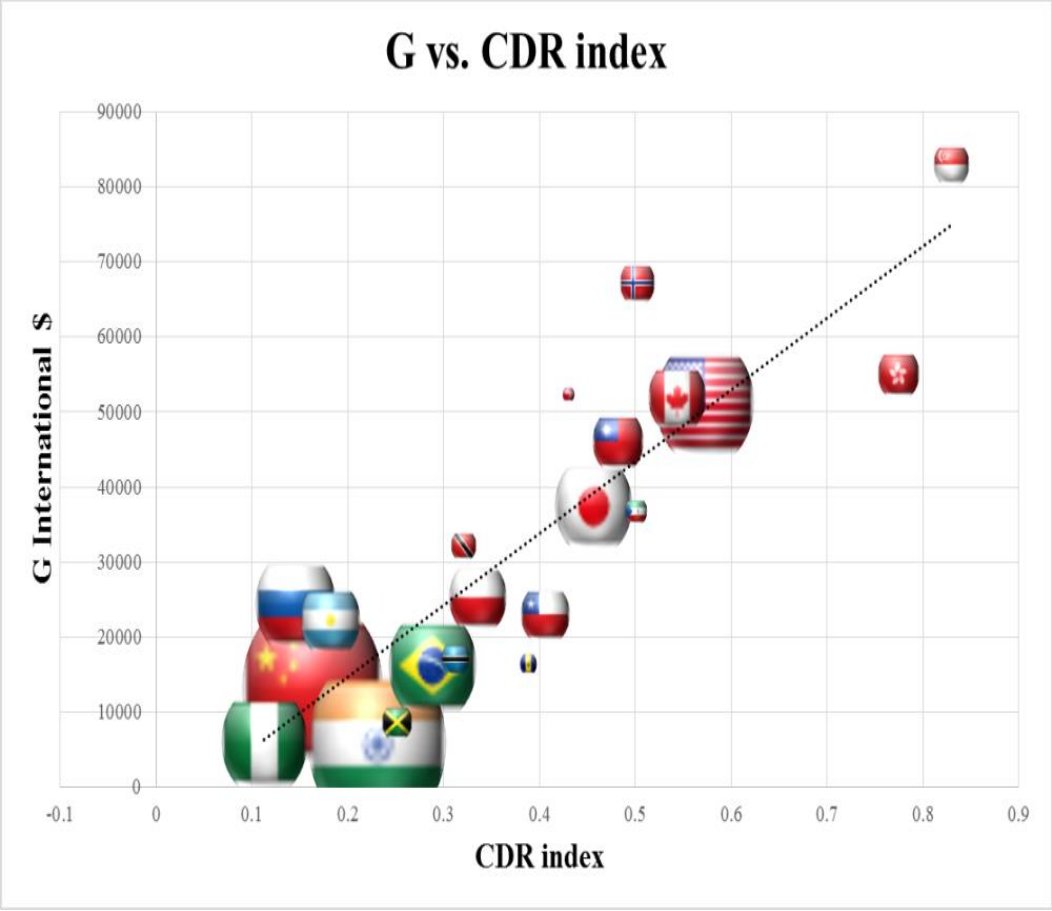
APPENDIX BB

The Source and Mechanism of Wealth



Argentina	
Barbados	
Bermuda	
Botswana	
Brazil	
Canada	
Chile	
China	
Equatorial Guinea	
Hong Kong	
India	
Jamaica	
Japan	
Nigeria	
Norway	
Poland	
Russia	
Singapore	
Taiwan	
Trinidad & Tobago	
United States	

Figure BB1. Year 2014 *G* vs CDR Index for 79 countries (line). Bubble size (21 countries) is the square root of population. This model was re-estimated for years 1995 to 2016 with similar results. For additional comments on the countries listed see Ridley (2017a, 2017b).

Standardized g model

The ordinary least squares *g* model is specified as follows:

$g = \beta_0 + \beta_C C + \beta_D D + \beta_R R + \beta_{CDR} C \cdot D \cdot R + \beta_N N + \varepsilon$

where, the intercept β_0 and the coefficients β_C,β_D, β_R, β_{CDR},β_N are all dimensionless,
ε is arandom, normally distributed error with a mean of zero and constant standard deviation,
and where all model variables are standardized as follows:

$g = \frac{G - \text{lowest } G}{\text{highest } G - \text{lowest } G}$

G = per capita real gross domestic product per capita (PPP)
(change in per capita wealth = G less consumption, depreciation and obsolescence)

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C (Capitalism) $= \frac{\text{per capita capitalization} - \text{lowest per capita capitalization}}{\text{highest per capita capitalization} - \text{lowest per capita capitalization}}$

D (Democracy) $=$ lowest democracyrank $-$ democracyranklowest democracyrank $-$ highest democracyrank

R (Rule of law) $=$ lowest corruptionrank $-$ corruptionranklowest corruptionrank $-$ highest corruptionrank

N (Natural resources) $= \frac{\text{per capita total natural resource rents} - \text{lowest per capita total natural resource rents}}{\text{highest per capita total natural resource rents} - \text{lowest per capita total natural resource rents}}$

These transformations standardize the variables and ensures upper and lower bounds on $0 \leq g,C,D,R,C{\cdot}D{\cdot}R,N \leq 1$.
Democracy and corruption are rank ordered, where the highest=1 and the lowest = the number of countries. G is measured in $/capita/year.

$\hat{g} = 1.53C + 0.14D + 0.23R - 1.21C{\cdot}D{\cdot}R + 0.38N$
t= (6.60) (1.69) (2.60) (4.40) (5.59) F ratio = 81.
Partial correlations (contributions to R^2_{adj}*):*
59% 5% 10% 3% 6% R^2_{adj} *= 83%.*

Where ^ denotes estimated or fitted value and G can be estimated from
$\hat{G} = \hat{g}$ (highest G-lowest G) + lowest G.
Highest G=83,066. Lowest G=1,112.

The CDR index = $1.53C + 0.14D + 0.23R - 1.21C{\cdot}D{\cdot}R$ comprises positive C, D and R effects and a negative component due to friction from democracy that reduces G from what it might otherwise be if there were perfect agreement amongst decision contributors. The contribution from N is negligible and can be dropped from the model and can be dropped from the model since it is not a decision variable that is under the control of government.

Data sources

G (PPP, constant international$ for 2014, reported by the IMF)	http://www.imf.org/external/data.htm
Population	http://data.worldbank.org/indicator/SP.POP.TOTL
Capitalization (US$ mundi)	http://www.indexmundi.com/facts/indicators/CM.MKT.LCAP.CD/rankings
Democracy rank	http://democracyranking.org/wordpress/rank/democracy-ranking-2014/
Corruption rank	https://www.transparency.org/research/cpi/
Total natural resources (% of G)	http://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS

Democracy rank & corruption rank for Bermuda set to that for United Kingdom as the governing country
Democracy rank & corruption rank for Hong Kong set to that for United Kingdom as the recent & last governing country
Barbados (high CDR) and Equatorial Guinea (high G) are too small for attention by the reporting agencies.
Note: A caveat associated with capitalization is that it only includes publicly traded stocks. Therefore, this measure understates the degree of capitalism in a country.
Barbados (high CDR) and Equatorial Guinea (high G) are too small for attention by the reporting agencies.
Purchasing power parity (PPP) is used to correct for the effect of currency exchange rate.
Nigeria is the least capitalized country in the list giving it a standardized C value of zero.
Bermuda, Hong Kong, Japan, Singapore and Taiwan have no reported natural resources and an N value of zero.
CDR index=1.53C+0.14D+0.23R-1.21C·D·R where the coefficients are ordinary least squares estimates**.**

Click here to download supplementary source data.

https://www.dropbox.com/s/0lm9se63o3hlljf/CDR%20data%20-%20for%2079%20countries.xlsx?dl=0

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Aptness of the CDR model

Ramsey RESET (1969, 1974) test for linearity misspecification error.
Consider the following hypotheses
H_0: The CDR model is linear
H_1: The CDR model is nonlinear
When the CDR model is modified to include the squares of the fitted values ($\hat{g}^2$) the result is:
$\hat{g}$= 1.11C + 0.14D + 0.20R - 0.91C·D·R + 0.32N + 0.26$\hat{g}^2$
|t|= (1.78) (1.63) (2.11) (1.83) (2.98) (0.72) R^2 *= 0.84844.*
The number of parameters estimated p=6.
$t_{\alpha,n-p-1} = t_{0.05,79-6-1} = t_{0.05,73} = 2.0$
The coefficient of $\hat{g}^2$ is 0.26 with *t*=0.72
t=0.72<$t_{0.05,73} = 2.0$ implies that at a 5% level of significance, we fail to reject Ho and accept that the linear specification is appropriate for the CDR model.

Jarque and Bera (1980, 1987) test for normality of the residuals.
Consider the following hypotheses.
H_0: The residuals from the CDR model are normally distributed
H_1: The residuals from the CDR model are not normally distributed
The number of parameters estimated p=2.
The number of observations n=79.
Skewness S = 0.1287438
Kurtosis K = 2.9588357
JB = $\frac{n}{6}(S^2 + \frac{1}{4}(K-3)^2) = \frac{79}{6}(0.1287438^2 + \frac{1}{4}(2.9588357-3)^2) = 0.2238$
$\chi^2_{\alpha,p} = \chi^2_{0.01,2} = 9.21$
JB = 0.2238< $\chi^2_{0.01,2} = 9.21$ implies that at 1% level of significance, we fail to reject Ho and accept that the residuals of the CDR model are normally distributed.
See also the below histogram of residuals.

Breuch and Pagan (1979) test for homoscedasticity of the residuals.
Consider the following hypotheses
H_0: The residuals from the CDR model are homoscedastic
H_1: The residuals from the CDR model are heteroscedastic
Regressing the variance of residuals on the independent variables,
$\hat{\varepsilon}^2$= 0.0 + 0.01C + 0.02D - 0.01R - 0.02C·D·R + 0.01N
|t|= (0.78) (0.39) (2.08) (1.15) (0.52) (1.27) R^2 = 0.087269 .
The number of parameters estimated p=5.
The number of observations n=79.
F test:
F= $\frac{R^2/p}{(1-R^2)/(n-p-1)} = \frac{0.087269/5}{(1-0.087269)/(79-5-1)}$ = 1.39
$F_{\alpha,p,n-p-1} = F_{0.01,5,79-5-1} = F_{0.01,5,73}$ = 3.29
F = 1.39< $F_{0.01,5,72}$ = 3.29 implies that at 1% level of significance, we fail to reject Ho and accept that the residuals of the CDR model are homoscedastic.

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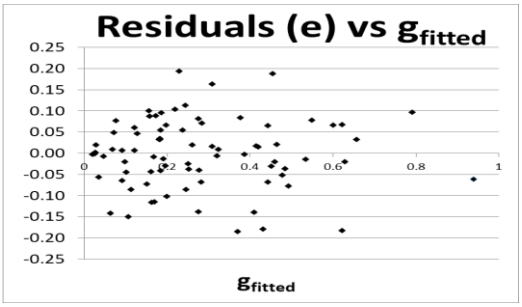
Chi Square test:
LM = nR^2 = 79• 0.087269 = 6.89
$\chi^2_{\alpha,p} = \chi^2_{0.01,5} = 15.09$
LM = $6.89 < \chi^2_{0.01,5} = 15.09$ implies that at 1 % level of significance, we fail to reject Ho and accept that the residuals of the CDR model are homoscedastic.

White (1980) test for homoscedasticity of the residuals.
Consider the following hypotheses
H_0: The residuals from the CDR model are homoscedastic
H_1: The residuals from the CDR model are heteroscedastic
Regressing the variance of residuals on the independent variables,
$\hat{\varepsilon}^2$= 0.0 + 0.03$\hat{g}$ - 0.03 $\hat{g}^2$
|t|= (0.73) (1.66) (1.35) *R^2= 0.04021613.*
The number of parameters estimated p=2.
The number of observations n=79.
F test:
F=$\frac{R^2/p}{(1-R^2)/(n-p-1)} = \frac{0.04021613/2}{(1-0.04021613)/(79-2-1)}$ = 1.59
$F_{\alpha,p,n-p-1} = F_{0.01,1,79-2-1} = F_{0.01,1,76}$ = 7.00
F = 1.59< $F_{0.01,1,76}$ = 7.00 implies that at 1% level of significance, we fail to reject Ho and accept that the residuals of the CDR model are homoscedastic.
Chi Square test:
LM = nR^2 = 79• 0.04021613 = 3.17
$\chi^2_{\alpha,p} = \chi^2_{0.01,2} = 9.21$
LM = $3.17 < \chi^2_{0.01,2} = 9.21$ implies that at 0.01% level of significance, we fail to reject Ho and accept that the residuals of the CDR model are homoscedastic.
See also the below plot of residuals vs. fitted values of g.



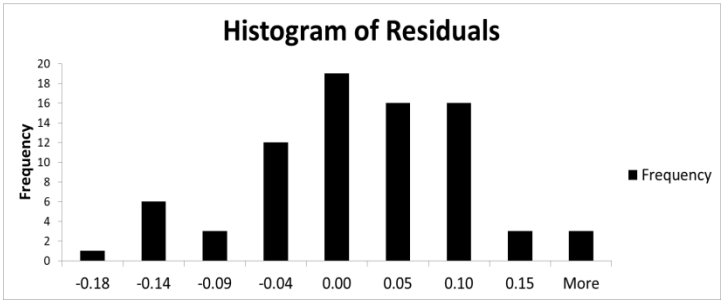


Figure BB2a. Plot of residuals vs. fitted values of *g*. Figure BB2b. Histogram of residuals

CDR model global time invariance

The CDR model is re-estimated for different year g's from 1995 to 2016 for which data are available (see Table BB3 and Figure BB3). The B′s replace $\widehat{\beta}'s$ since they are the closest to the available characters in the legend of the chart. The *Bo*′s are all zero (not shown). The parameter estimates are nearly identical for the most recent nine years from 2008 to 2016, and similar for earlier years 1995 to 2007. The parameter estimates are practically time invariant.

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Table BB3. CDR model OLS parameters for 22years.

YEAR	*Bc*	*Bd*	*Br*	*Bcdr*	*Bn*	R^2_{adj}
2016	1.53	0.14	0.24	-1.25	0.33	0.81
2015	1.53	0.14	0.24	-1.23	0.35	0.82
2014	1.53	0.14	0.23	-1.21	0.38	0.83
2013	1.51	0.14	0.23	-1.15	0.39	0.84
2012	1.52	0.16	0.22	-1.16	0.42	0.83
2011	1.53	0.17	0.22	-1.16	0.42	0.83
2010	1.56	0.18	0.21	-1.19	0.42	0.83
2009	1.57	0.22	0.21	-1.13	0.48	0.82
2008	1.52	0.23	0.22	-1.09	0.50	0.82
2007	1.62	0.22	0.20	-1.23	0.44	0.82
2006	1.66	0.24	0.20	-1.27	0.49	0.82
2005	1.72	0.25	0.19	-1.33	0.52	0.82
2004	1.73	0.26	0.19	-1.32	0.53	0.82
2003	1.77	0.29	0.18	-1.33	0.55	0.81
2002	1.77	0.32	0.19	-1.26	0.56	0.81
2001	1.77	0.33	0.17	-1.23	0.64	0.81
2000	1.78	0.30	0.17	-1.24	0.63	0.81
1999	1.81	0.31	0.16	-1.27	0.65	0.81
1998	1.81	0.32	0.15	-1.25	0.74	0.81
1997	1.83	0.27	0.15	-1.32	0.68	0.82
1996	1.85	0.27	0.14	-1.31	0.73	0.81
1995	1.84	0.27	0.14	-1.29	0.75	0.81

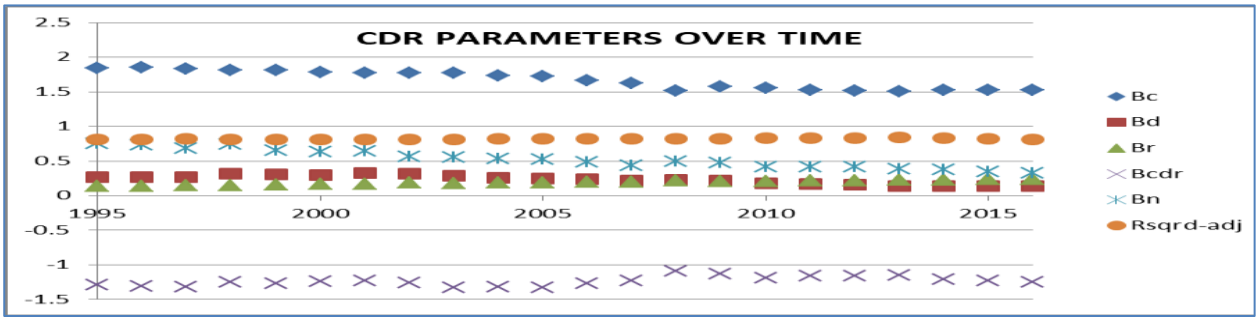

Figure BB3. CDR model OLS parameters for 22 years

Other measures of rule of law

Rule of law reflects government effectiveness indicators such as the prevention of theft, the protection of property rights and contracts, the control of corruption, regulatory quality, political stability and absence of violence, access to justice and efficient court proceedings, the status and role of legal professionals, administration of justice and management of courts (see also, the Venice Commission's Rule of Law Checklist[*]). With the exception of corruption, these variables are complicated constructs, the details of which are not understood by the average investor.

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Despite their presence, rules can be broken and corruption can persist. And, everybody has a strong perception of corruption, when and where it exists. It is this perception that informs their willingness to invest time, money and effort. Precise breakdowns and measurement are impossible. But, it is generally agreed which countries are more or less corrupt. Therefore, despite what might have been small differences in component scores, the country ranking can be the same. In this paper, the transparency international corruption perception index is chosen to represent the opposite of rule of law.

The year 2014 CDR model estimate in this appendix is based on R estimated from the reverse of the Transparency International corruption index. One might be interested to see the outcome based on R estimated from the world justice project (wjp) rule of law index and the wjp rule of law rank. The index is an arithmetic average of the wjp component scores: constraints on government powers, absence of corruption, open government, fundamental rights, order and security, regulatory enforcement, civil justice, criminal justice and informal justice. The estimated models are:

$\hat{g}$ =1.53C + 0.14D + 0.23R -1.21·C·D·R + 0.38N Based on Transparency International reverse corruption
$\hat{g}$ =1.35C + 0.09D + 0.34R -1.12·C·D·R + 0.44N Based on wjp rule of law index
$\hat{g}$ =1.39C + 0.10D + 0.31R -1.12·C·D·R + 0.43N Based on wjp rule of law rank

It turns out that the estimated CDR model is practically the same when the rule of law variable is Based on the reverse of the Transparency International corruption index, or the wjp rule of law index or rank. They all yield the same coefficient of multiple determination.

The world justice project data was obtained from
https://worldjusticeproject.org/sites/default/files/files/wjp_rule_of_law_index_2014_report.pdf.

*https://www.venice.coe.int/webforms/documents/?pdf=CDL-AD(2011)003rev-e

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APPENDIX CC

10.2478/9788395771361-020

Question and Answer Review

	Extant theory	**CDR Theory**
What is economics?	Economics is the study of the production and distribution of goods and services.	The typical course in economics begins with the assumption that there exists a demand for goods and services. It is also assumed that a capital stock of facilities that produce final goods and services just exist somehow, do not have to be created, and that economics are concerned with wealth distribution from these facilities to the exiting demand. In reality, all such capital must have been previously created. Its only source must be human capital ideas of imagination and creativity, otherwise known as entrepreneurship. Steve Jobs said entrepreneurship, where it succeeds, creates its own demand in the minds of people who do not know what they want until it is shown to them. Henry Ford is alleged to have said that if I had asked people what they wanted; they would have said faster horses. A new CDR growth model that accounts for entrepreneurial capital and capital stock, and combines them with democracy and rule of law, should be the first point in a beginning university course in economics.
Question number 1	**Extant theory**	**CDR Theory**
What is CDR?	CDR is a statistical model proposed to estimate GDP. It ignores the Solow growth model and Cobb Douglas production function. Therefore, it lacks economic validity.	The CDR model is an estimator of real per capita gross domestic product adjusted for purchasing power parity $G=f(C,D,R)$. Here, Capitalist is a person who deploys his personal capital so as to maximize his own benefit. That is, all rational people. Capitalism is a method of organizing capital. It is measured by total market capitalization C and includes entrepreneurial human capital plus capital stock less depreciation and obsolescence. Market capitalization is the value of outstanding shares of stock sold on the capital markets. Democracy is a measure of participatory governance and management. Rule of law, the reverse of corruption, is a measure of the enforcement of property rights where property is a legal expression of an economically meaningful consensus by people about assets, how they should be held, used and exchanged. The CDR model is the first to show that standard of living is dependent on C, D and R, and is independent of natural resources, government spending, country size, location, culture, and physical characteristics of the population. It forms an economic theory of entrepreneurship and indicates that all countries can enjoy a high standard of living.

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		Solow and Cobb-Douglas are limited to fixed capital stock and cannot capture entrepreneurship. The CDR model is not a competitor of the production model. It is a prerequisite to the production function. It provides the initial human capital to the production function. Without CDR, the creation of wealth will be negligible. Near perfect equilibrium will prevail. There will be no growth. Instead, there will be depreciation, poverty and early death.
Question number 2	**Extant theory**	**CDR Theory**
What is the source of wealth and why are some people rich and some people poor?	Historical forced labor is the cause of poverty today. As best we can tell, the CDR model ignores the historical impact of forced labor. Therefore, CDR cannot possibly explain wealth and poverty.	As best as one can tell, the frameworks for capitalism, democracy and rule of law: Magna Carta of 1215, the English King Charles II 1662 royal charter for the study of science, and the New York 1811 limited liability law created the perfect storm for the start of the industrial revolution around 1776-1840. Before the advent of science, the human DNA had to change if man was to survive, advance from the middle to the top of the food chain and achieve through physical ability. Science reintroduced human capital, the genesis of wealth, by way of a cognitive revolution. Commensurate with the cognitive scientific industrial revolution, countries that represent ten percent of the world's population comprised mainly of Western Europe and its American descendants have experienced unprecedented economic growth. They became rich and continue to get richer. At the same time ninety percent of the world's population remains impecunious. This includes the approximately two hundred and forty years since Adam Smith (1776) became the father of economics.
Question number 3	**Extant theory**	**CDR Theory**
What is the impact of government spending on GDP?	Government is an enabler that contributes to wealth creation fostering a good business environment and producing the appropriate wealth distribution through spending. .	Government spending effect on GDP is negligible. It does cause a small level of inflation that amounts to a tax on income. Because it falsely appears to be money for the masses, it is the only tax that is welcomed with joy.
Question number 4	**Extant theory**	**CDR Theory**
What is the role of economics in reducing poverty?	Economics as a science explains how wealth is created and distributed, and how wellness is increased.	Traditional economics has not come anywhere close to eliminating poverty. It is truly enigmatic that economics can do so much for ten percent of the world and yet so little for ninety percent. Economists suggest that a critical difference between astronomy and economics is that the economic universe can be potentially re-created by economic policy. That economic policy can shape the course of growth and development. If that is true it is high time that economic policies help the poor. So, it is time to reexamine economic growth

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		theory, its descriptive properties and its prescriptive properties.
Question number 5	**Extant theory**	**CDR Theory**
What is the role of natural resources on GDP?	Historically, natural resources were the main source of wealth, but not anymore. Natural resources, both renewable and non-renewable, and ecosystem services are a part of the real wealth of nations. They are the natural capital out of which other forms of capital are made. They contribute towards fiscal revenue, income, and poverty reduction. Government plays the essential role in putting into place policies that ensure that resources contribute to the long-term economic development of nations, and not only to short-term revenue generation.	Natural resources contribute 6% to GDP. Intangible *C*, *D* and *R* contribute thirteen times more to *G* than do tangible natural resources. Due to Dutch disease or natural resource curse, they can and do cause currency misalignment, poverty and social crises.
Question number 6	**Extant theory**	**CDR Theory**
What is the role of capital stock on GDP?	The most likely impact of an increase in capital stock will be an increase in GDP and a decrease in the price level. This is because an increase in the capital stock will result in an increase in aggregate supply.	Capital stock comprises machines, knowledge, training, computers, recording devices, etc.
Question number 7	**Extant theory**	**CDR Theory**
What is the role of entrepreneurial capital on GDP?	The most prevalent and compelling views of entrepreneurship focus is on the perception of new economic opportunities and the subsequent introduction of new ideas in the market.	Entrepreneurial capital is the source of wealth from human ideas of imagination and creativity. New ideas contribute approximately six times that of capital stock from old ideas.
Question number 8	**Extant theory**	**CDR Theory**
What is the role of market capitalization on GDP?	In the capital market, there are risks associated with transactions that are made. The market offers financial instruments that enable economic stakeholders to exchange, pool and price risk. As the asset values increase, such as in the form of capital acquisition and stocks, financial savings are enhanced.	Total market capitalization is the sum of entrepreneurial capital and capital stock.
Question number 9	**Extant theory**	**CDR Theory**
How does the capital to GDP conversion vary from country to country and from time to time?	Those countries that make a more efficient use of capital, produce a greater GDP.	Capital to GDP conversion is global time invariant. It obeys the laws of natural science. The CDR model places economic growth on a sound scientific footing.
Question number 10	**Extant theory**	**CDR Theory**
How does country size affect GDP?	Generally, the greater the country the greater the GDP, because a bigger country has more natural resources, production factors and capital.	Country population size effect on GDP is negligible.
Question number 11	**Extant theory**	**CDR Theory**
How does country location affect GDP?	Proximity to markets and good climatic conditions promote macroeconomics conditions and GDP growth.	Location effect on GDP is 4%. Location effect on *C* is negative. Life is a maximum at the equator and so is *C*. Furthermore location is not a policy variable.
Question number 12	**Extant theory**	**CDR Theory**

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How does country culture affect GDP?	Culture affects economic activity through the choices that people make about how to allocate scarce resources. In other terms, while culture may be a fundamental determinant of economic activity, it acts through proximate factors like (but not exclusive to) the accumulation of capital, the adoption of technology, or labor market participation decisions. So, if we are going to describe how culture influences economic activity, we need to describe how culture influences those proximate factors.	Culture effect on GDP is negligible. Corruption and lack of democracy lower GDP.
Question number 13	**Extant theory**	**CDR Theory**
How does country population affect Per Capita GDP?	There is no clear relationship between population and Per Capita GDP.	Population physical characteristics effect on *G* is negligible.
Question number 14	**Extant theory**	**CDR Theory**
As one country's wealth increases what happens to the wealth of other countries?	Depending of their trading relationship, both countries may increase their respective GDPs.	If anywhere in the world a product is produced with the same quality at a lower price or at the same price with a higher quality, the size of the world economic pie increases. Furthermore, wealth is unlimited.
Question number 15	**Extant theory**	**CDR Theory**
What is the role of economics in entrepreneurship?	Entrepreneurship is a simple career choice between a job and self-employment in pursuit of profit incentive versus wages.	Entrepreneurship is the process of starting a business, typically a startup company offering an innovative product, process or service. It distinguishes itself from the expansion of routine business for which the outcomes are already well known. Contrary to the standard economics curriculum, it cannot be reduced to a simple career choice between a job and self-employment in pursuit of profit incentive versus wages. To do so would be to ignore the human spirit that is involved. When successful, the rich entrepreneur continues to innovate. This is despite their inability to eat more than three meals daily, drive more than one car at a time, live in more than one house at a time, etc. This is evidence that ultimate entrepreneurship is an act of giving rather than one of taking. Students that lack an entrepreneurial family background and who think that the only source of wealth is always already established in existing factories and distribution networks might easily see no relationship to their life and be discouraged from entrepreneurship. Adam Smith said that the real tragedy of the poor is the poverty of their aspirations. The CDR model identifies the source of wealth as being the human idea of imagination and creativity. There are trace amounts of entrepreneurship in everybody. Therefore, even the poorest person is a carrier of the source of wealth and might more easily see themselves as a potential entrepreneur when so exposed through a modified educational experience.

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Student Entrepreneurship Publications

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Wealth

explained by

Capitalism.Democracy.Rule of law

Wealth & Poverty Demystified Econometrically

General theory of economics

CDR supply side scientific growth law unveiled
From confusion to clarity

One source of wealth watches over another

CONCEPTUAL
GOODS & SERVICES
Ideas and imagination

Human capital

Market
Capitalization

Human labor

CATALYSTS
Macro – economic
Democracy
Rule of Law

Corrupt dictatorship

CAPITAL
distribution to
micro-economic
production units

CAPITAL to GDP
micro – economic
production processes

ACTUAL
GOODS & SERVICES
aggregate GDP

THE SOURCE OF WEALTH

The only source of capital (C) is the intangible human ideas of imagination and creativity.

Rule of Law (R) is an intangible catalyst that attracts capital.

Democracy (D) is an intangible catalyst for the optimal deployment of capital.

Wealth derives from the conversion of intangible capital into tangible products of goods and services.

High CDR countries are where ideas go to fly.

Low CDR countries are where ideas go to die.

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