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IMF Working Paper

How Does Taxation Affect Hours Worked in EU New Member States?

by Agustin Velasquez and Svetlana Vtyurina

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European Department

How does Taxation affect Hours Worked in EU New Member States?

Prepared by Agustin Velasquez and Svetlana Vtyurina[*]

Authorized for distribution by Khaled Sakr

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Abstract

Hours worked vary widely across countries and over time. In this paper, we investigate the role played by taxation in explaining these differences for EU New Member States. By extending a standard growth model with novel data on consumption and labor taxes, we assess the evolution of trends in hours worked over the 1995-2017 period. We find that the inclusion of tax rates in the model significantly improves the tracking of hours. We also estimate the elasticity of hours (and its different margins) to quantify the deadweight loss introduced by consumption and labor taxes. We find that these taxes explain a large share of labor supply differences across EU New Member States and that the potential gains from policy actions are noteworthy.

CONTENTS

I. MOTIVATION

Given demographic and pension pressures facing many EU28 countries amidst low labor market participation rates together with still high tax wedges, the call to review public policies has gained renewed prominence in the EU political debate (Attinasi et al, 2016). As the recovery from the Global Financial Crisis (GFC) unfolded, unemployment rates declined to historic lows, personal income tax rates decreased, and labor market flexibility improved in EU New Member States (NMS).[1] However, tax wedges remain high and participation rates, while having increased importantly in a few countries over 2000-17 , are still around or below 70 percent in many of them (Figure 1). This hints at the need for addressing structural problems to improve economic fortunes (Krause and Sawhill, 2017).

Figure 1. Tax Wedge and Activity Rate

Tax Wedge, 2015 1/
(Percent of labor cost)

1/ Data for non-OECD countries from Eurostat.
Sources: OECD; and Eurostat.

Labor Force Particpation Rate by Gender, 2017
(Percent)

Source: Eurostat.

Activity Rate: 15-64 Years
(In percent)

Sources: Eurostat/Haver Analytics.

Activity Rate: 15-64 Years
(In percent)

Sources: Eurostat/Haver Analytics.
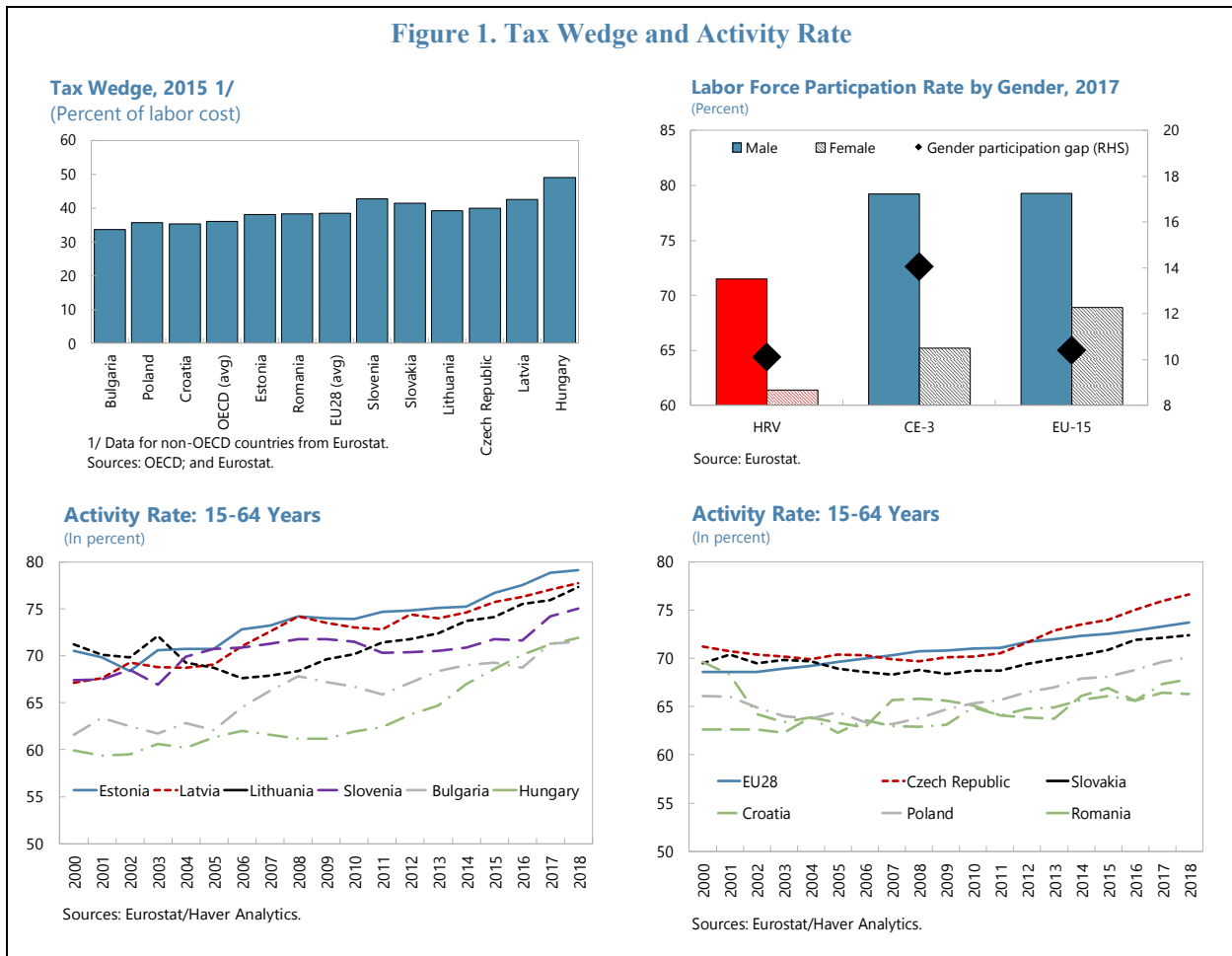
In this paper we focus our attention on hours worked (per working age population).[2] Hours vary substantially across NMS in terms of levels and changes over time. For example, between Estonia,

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[1] NMS refer to Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, which were not a part of the original EU 15 group.

[2] When we refer to hours worked, (or simply hours) we refer to hours worked by population aged 15-64 years old.

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which exhibits the highest number of hours, and Slovakia, which shows the lowest, there are differences of about 200 annual hours per person. In terms of changes over time, we observe a significant rise in hours worked in Bulgaria, Latvia, and Lithuania while other countries staggered. At country level, hours worked reflect labor supply decisions and could be thought of a measure of labor utilization. Long-run changes in labor supply are driven by incentives, of which taxes are perceived to be central. Assessing the importance of taxation on hours is key to provide new insights for potential policy actions (Bakija, 2011).

We study the role of taxes in accounting for differences in hours worked across NMS over the 1995-17 period in three steps. First, we provide some stylized facts showing the evolution of tax rates and hours. Second, we build a neoclassical growth model to evaluate the extent to which changes in taxation improve the tracking of hours over time. Finally, we use an econometric analysis to estimate the elasticity of hours (and its different margins) to different types of taxes. We find that consumption and labor taxes significantly discourage labor supply and can explain close to 21 percent of the observed variation of hours across NMS.

The stylized facts exhibit substantial heterogeneity across NMS both in terms of hours worked and taxation. As a measure of taxation, we build consumption and labor tax rates from national accounts. These represent the average tax rate that households face in each country over the entire time span. To the best of our knowledge, this is the first study to use this measure of taxes for NMS. We document a negative correlation between hours worked and taxes, both in terms of levels and changes.

We calibrate a growth model augmented with taxes to account for time-trends in hours worked following Ohanian et al (2008). The model details the mechanism through which higher taxation leads to lower labor supply. Higher tax rates reduce households' net labor income and real purchasing power, inducing them to substitute consumption for leisure, which cannot be taxed. The empirical predictions of the model indicate that taxes are an important determinant of hours. To isolate the effects of taxes, we contrast the model predictions to one without taxes. A model without taxes performs poorly in tracking the evolution of actual hours worked in most countries. However, we find that the inclusion of taxes significantly improves the tracking of hours. This is especially the case for countries where hours increased the most. For these countries, changes in tax rates can account for close to half of the increase in hours between 1995-13. This accounting exercise is also useful to highlight puzzling events (periods where the model fails to predict trend changes in hours). We identify 2013-17 as one of these.

Mindful of the importance and difficulty in disentangling taxes from other institutional or policy effects on hours worked, we perform an econometric analysis to further explore the effects of taxation on hours. Our analysis has two objectives. The first is to complement the findings of the model by considering other labor market determinants and institutions, such as trade openness, business and labor market regulation, social benefits, remittances, and migration. Our findings show that, conditional on other factors, taxes are an important determinant of hours. Point estimates suggest a high elasticity of hours to taxes (close to 0.5), which is robust to the inclusion

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of other factors. The effect of taxes on hours worked is towards the higher end of the range found in other studies of mostly OECD countries.

The second objective of our econometric analysis is to shed some light on the effects of different taxes on different margins of hours. This allows us to quantify the approximate deadweight loss of taxation at a more granular level and to quantify potential gains from policy actions. First, we estimate the elasticity of aggregate hours with respect to consumption, personal income, and social security tax rates. We find that social security contributions deter hours the most, followed by consumption taxes and, to a lesser extent, personal income taxes. We also show that these taxes have heterogeneous effects on hours along the intensive (hours per worker) and extensive margin (employment rate). Consumption and personal income taxes are found to affect hours per worker, but not employment rates. On the other hand, social security contributions are negatively associated with employment rates, but do not seem to affect hours per worker.

It is well-known that changes in tax policies can affect women's and men's labor market participation in different ways (see for example Bick et al 2018a). We extend our analysis by estimating how sensitive employment rates are to different types of taxes, both for women's and men's employment rates. In line with the literature, we document that women's employment rate is more sensitive to changes in tax policies. We find the elasticity of employment rate to social security contributions to be 7 percent larger for women vis-à-vis men.

This paper contributes to the debate on the role of taxes in explaining cross-country differences in labor supply. In an influential study, Prescott (2004) initiates this literature by studying the divergent evolution of hours worked between the US and G7 European countries. Despite the comparable levels of hours worked in the early 1970s, the European countries observe a declining trend in hours while the US does not. He attributes these differences to changes in taxation. Using a calibrated neoclassical model, Prescott finds that changes in the marginal tax rate account for virtually all variation in hours worked across G7 countries. Ohanian et al (2008) expand Prescott's results by extending the sample to 15 OECD countries over 1956–04 and reach similar conclusions. McDaniel (2011) further corroborates that previous findings are robust to the inclusion of home production. While the effects of taxes on the trend in hours worked has been studied extensively for the US, Canada and EU-15, little is known for other country groups. We contribute to filling this gap in the literature by focusing on NMS.

Other authors have proposed alternative explanations for the decline in hours worked for European countries. For example, Alesina et al (2005) argue that the level of unionization played a more important role than taxation. They see the decline in hours as an outcome of the bargaining between employers and workers. Maoz (2010) claims that differences in labor supply between the US and European countries are due to a stronger preference for leisure in the latter. Rogerson (2007) explains that government investment in non-market activities counterbalances the discouraging effect of taxes. Most recent studies focus on subgroups of the population and refined measures of taxation. Causa (2009) finds that marginal taxes in OECD countries disincentivize women working longer hours, while the effect is almost insignificant for men. Recent studies by Bick et al (2018a),

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Chakraborty et al. (2015) and Bick and Fuchs-Schundeln (2018) focus more on demographics, married couple dynamics, and population subgroups within the labor market with disaggregated data. [3]

The rest of the paper is structured as follows. Section II discusses stylized facts of hours and taxes in NMS. Section III presents the model's methodology and predictions. Section IV provides an econometric analysis of other factors affecting hours worked through different margins of hours, by type of taxes, and by gender. Section V concludes with policy considerations.

II. STYLIZED FACTS

In this section, we present the evolution of hours worked and tax rates across countries and over time. We observe a wide variation in the level of hours across countries. In addition, we document heterogeneity in the time trends of hours. While hours worked have remained stagnant in most countries, some have experienced a significant rise. Low levels of taxation are associated with countries where hours increased the most. As in other studies focusing on high-income countries, we document a negative correlation between hours and tax rates.
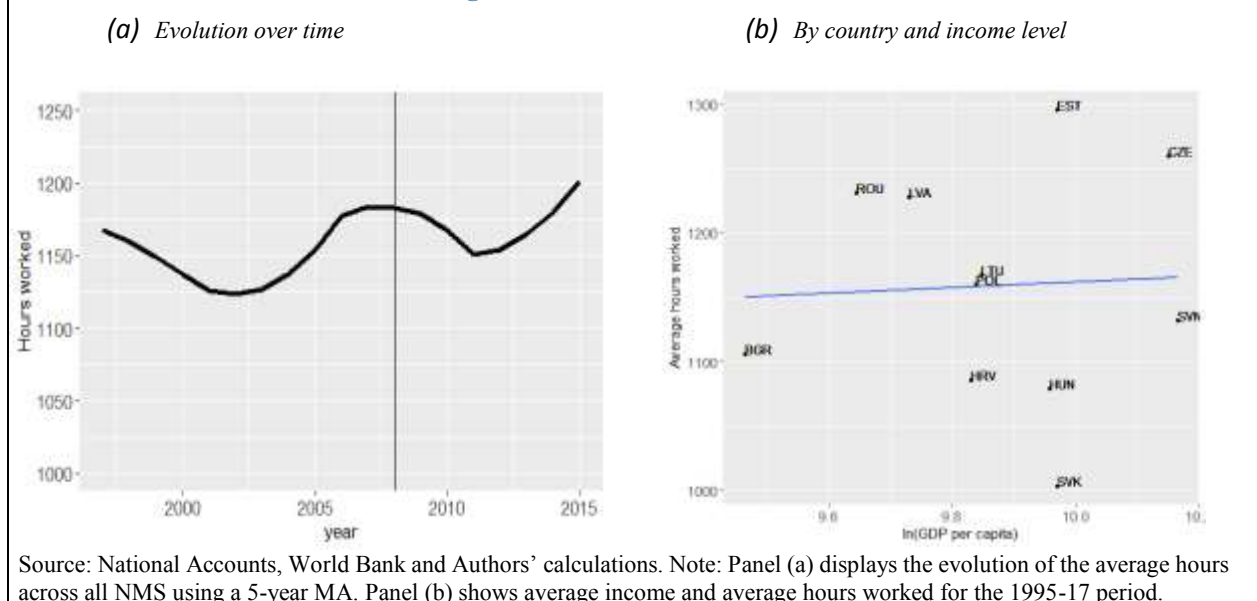
Hours worked in NMS between 1995-2017

Our measure of hours is defined as total hours worked in the economy divided by the population aged between 15 and 64 years old (working age population).[4] Panel (a) in Figure 2 shows the evolution of average hours across NMS, expressed in five year moving averages to smooth the series and attenuate business cycle fluctuations. Overall, hours worked increased between 1995-2017. However, the series show four clear time periods. From 1995-02, hours declined, possibly explained by political instability and economic transformation in the region. Then between 2003-08, we observe the highest growth period reinforced by strong global macroeconomic conditions. Following the GFC (marked with a vertical line in Figure 2 panel (a)), we observe a contraction in hours which lasted five years. Since 2013, the level of hours worked has recovered and has reached historically high levels.

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[3] For a survey on this topic see Keane (2010). A vast literature studies the response of labor supply to tax incentives at a micro level in many countries. Given the cross-country macroeconomic nature of our methodology, we abstract from comparing our results to those from micro studies.

[4] Hours worked include both informal and formal hours of employment (national accounts based their labor data on labor force surveys, not only on administrative data).

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Figure 2. Hours Worked in NMS

(a) Evolution over time *(b) By country and income level*

Source: National Accounts, World Bank and Authors' calculations. Note: Panel (a) displays the evolution of the average hours across all NMS using a 5-year MA. Panel (b) shows average income and average hours worked for the 1995-17 period.

How do NMS compare to other EU members? Eurofound (2008) compared hours worked between EU members and found that NMS work – on average – significantly more hours than EU15, suggesting that since these countries have lower productivity, they compensate by working more hours. In a more recent study, Bick et al (2018b) explore this point further, extending the sample to various developing countries. They find evidence that countries with lower income levels work more hours. While this might be the case across countries with large income differences, this does not seem to be the case for NMS. In Figure 2 panel (b) we plot hours worked and GDP per capita (averages for the 1995-17 period). Different from Bick et al (2018b), we do not observe a negative correlation between hours and income levels. For example, Estonia and the Czech Republic – two high income countries – have worked more hours than any other within NMS. Figure 2 panel (b) also shows substantial variation *in levels* of hours worked across NMS (regardless of income differences).

Now we take a closer look at changes of hours for each country between the beginning and end of our sample – 1995 and 2017 – and decompose hours worked into its intensive and extensive margins:

$$Hours\ worked\ =\ \frac{total\ hours}{population\ 15-64}\ =\ \frac{total\ hours}{employed}\ *\ \frac{employed}{population\ 15-64}$$

$$=\ \underbrace{Hours\ per\ worker}_{Intensive\ margin}\ *\ \underbrace{Employment\ rate}_{Extensive\ margin} \quad (1)$$

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We document changes in hours worked (and its decomposition) for each NMS in Table 1.

Table 1. Changes in Hours Worked between 1995 and 2017 (in percentage points)				
Group	Country	Hours	Intensive margin	Extensive margin
1	Bulgaria	13.6	-2.7	16.3
1	Latvia	11.3	-4.1	15.4
1	Lithuania	15.5	6.2	9.2
2	Croatia	1.7	-3.5	5.3
2	Czech Republic	-1.7	-6.1	4.4
2	Estonia	0.1	-12.2	12.3
2	Hungary	6.2	-12.3	18.6
2	Poland	2.2	-2.7	4.9
2	Romania	-15.9	-2.7	-13.2
2	Slovak Republic	-2.3	-7.9	5.6
2	Slovenia	1.7	-4.4	6.2

Source: Author's calculations. Group 1 is defined as countries where hours increased by at least 10 pp. in the whole period.

Table 1 shows to what extent changes in hours can be attributed to its intensive and extensive margins.[5] The first noticeable feature is the heterogeneity of changes in hours across countries. A significant increase in hours is observed in Lithuania, Latvia and Bulgaria, with the extensive margin driving the change. These countries, which we label as Group 1, are behind the rise in *average* hours worked across NMS in Panel (a) in Figure 2. Except for Romania, where there was a surprising decline in hours, other countries have experienced small changes (mostly increases) in hours.

When decomposing the evolution of hours into hours per worker and the employment rate, we find two clear trends. Hours per worker have declined in all countries, with Lithuania being an exception. On the other hand, employment rates have significantly increased in all countries except for Romania. Part of this improvement has been the rise in female labor force participation (see Grigoli et al 2018). A negative trend in hours per worker and a positive one in the employment rate is a well-documented fact, which is also found in other countries (see Bick et al 2018b, and Boppart and Krusell 2016). As we see, the rise in hours worked due to higher employment rates has been counterbalanced by a decline in hours from those in employment.
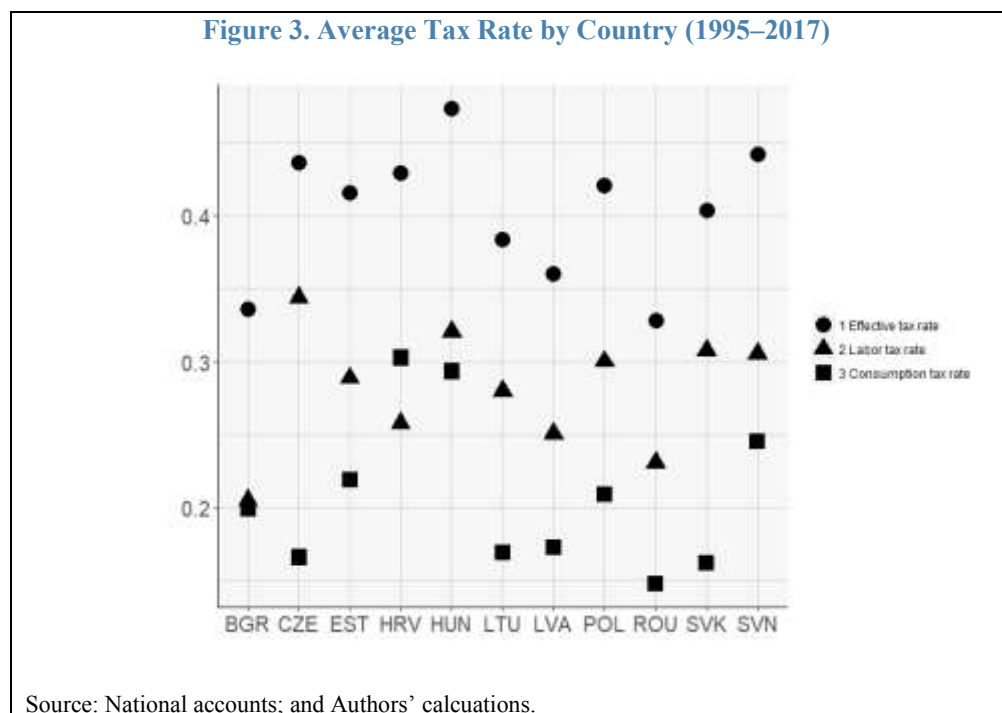
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[5] We decompose changes using $\Delta \log(hours\ worked) = \Delta \log(int.\ margin) + \Delta \log(ext.\ margin)$. The extensive margin combines two other dimensions of the labor market: the unemployment rate and the labor force participation rate.

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Taxes in NMS

We now look at taxation as one of the possible determinants of heterogeneity in hours across NMS. We describe the construction of our novel tax data and show the evolution of taxes over time and with respect to hours worked.

To represent taxes at the macro level, we build consumption and labor tax rates for each NMS. We follow the methodology used in McDaniel (2007) and use national accounts data for the 1995-17 period (Croatia starting in 2001). Each tax rate represents the tax burden at the national level. The consumption tax rate, which includes taxes on VAT, excises, and import duties, embodies the total tax burden on private consumption (total consumption tax revenue over total private consumption). The labor tax rate incorporates all taxes levied on labor income (personal income taxes and social security contributions). It is calculated by dividing total tax revenue by total labor income. In Appendix I, we provide a detailed description of the construction of taxes.

Combining consumption and labor tax rates, we construct an *effective tax rate*, which represents the total tax burden on individuals. If w is the wage, the after-tax wage is defined as: $w(1 - \tau^{effective})$ with $(1 - \tau^{effective}) = \frac{(1-\tau^{labor})}{(1+\tau^{consumption})}$.[6] The effective tax rate embodies both changes in consumption and labor taxation and it will be our main variable of interest in the following sections.

Figure 3. Average Tax Rate by Country (1995–2017)

Source: National accounts; and Authors' calcuations.

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[6] The origins of this definition come from the first order condition of the model, explained in the next section.

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In Figure 3 we show the average level of tax rates for each country. Consumption tax rates are around 20 percent on average, while labor tax rates hover around 30 percent. Furthermore, consumption and labor taxes are not highly correlated. Figure 3 also show a wide disparity in taxation across countries. Croatia and Hungary are the two countries with the highest consumption tax rates, while Czech Republic exhibits the highest labor taxation. However, when calculating effective tax rates, we find that Hungary has the highest rate and Romania the lowest rate.

Hours Worked and Taxes

We now depict some stylized facts of hours worked jointly with taxes. For this analysis it is useful to cluster countries according to their long-run performance by Groups (see Table 1). For Group 1 we defined countries where hours increased by at least 10 percentage points in 1995-17 period. All other countries, with a small increase or decline in hours, are included in Group 2.

Figure 4. Hours and Taxes by Groups
(a) Hours worked by group   *(b) Effective tax rate by group*

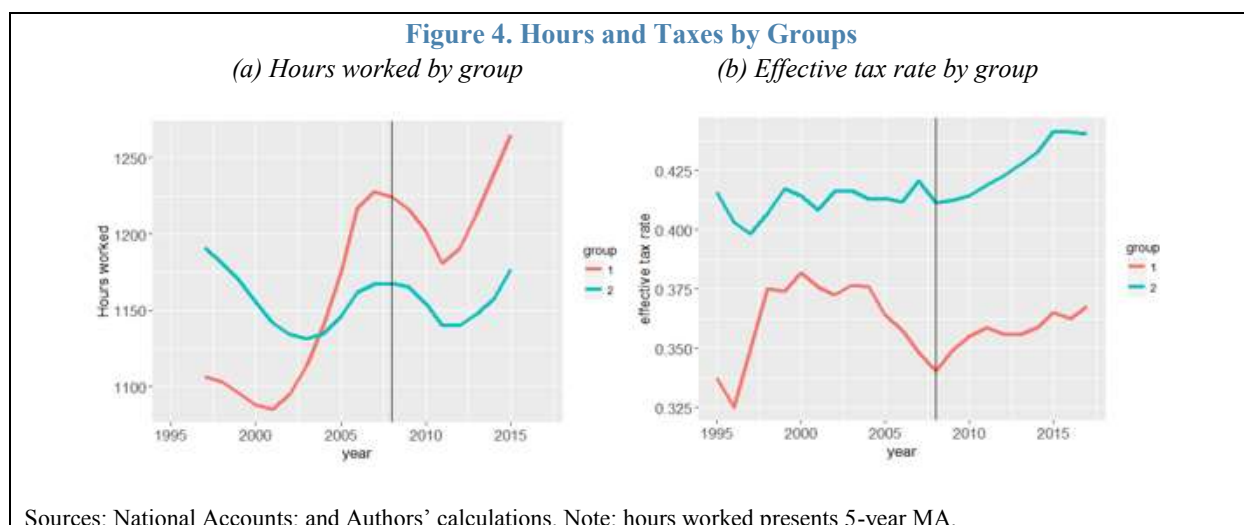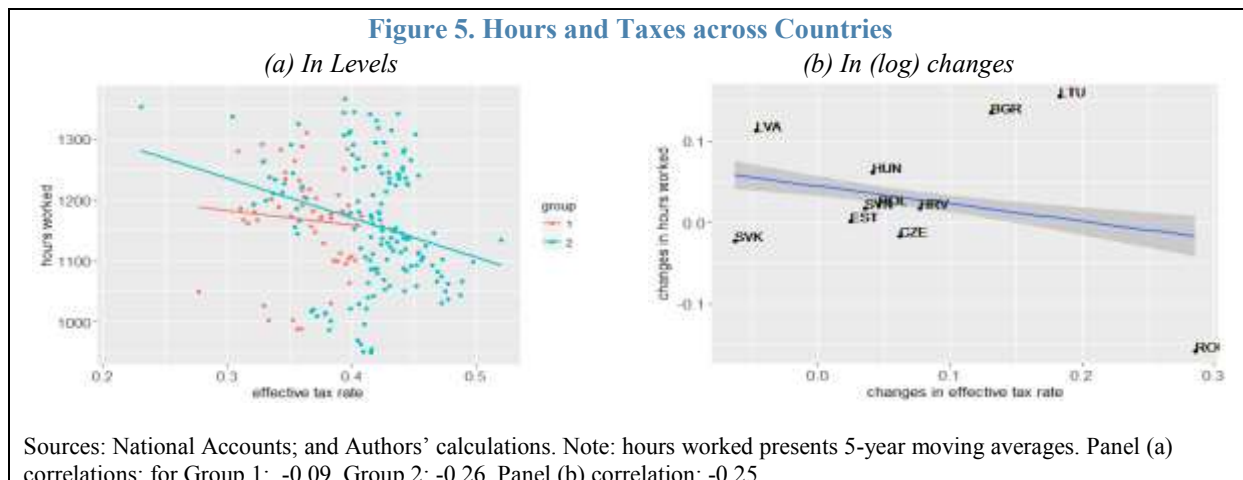Sources: National Accounts; and Authors' calculations. Note: hours worked presents 5-year MA.

Figure 4 shows the evolution of hours and effective taxes. Hours worked increased substantially for Group 1, while it remained stable in Group 2 (Panel (a)). In both groups, the effect of the GFC is noticeable as hours sharply declined after 2008. Panel (b) shows the evolution of the average effective tax rate in each group. Interestingly, countries in Group 1, which observed an increase in hours, had lower effective tax rates (below 40 percent) throughout the period. In addition, we observe a negative correlation between hours and taxes for most of the sample. For Group 1, the large increase in hours - between year 2000 and the GFC - happened at the same time taxes declined.

Figure 5 depicts the relationship between hours worked and taxes across countries. In Panel (a), we observe a negative correlation between hours and taxes in levels for each group, with the negative correlation being stronger in Group 2 than in Group 1 (it has a steeper slope). Panel (b)

shows total log changes in hours and taxes throughout the period. It also displays a negative correlation. However, the relationship does not appear robust to the exclusion of some countries.[7]

Figure 5. Hours and Taxes across Countries

(a) In Levels *(b) In (log) changes*

Sources: National Accounts; and Authors' calculations. Note: hours worked presents 5-year moving averages. Panel (a) correlations: for Group 1: -0.09, Group 2: -0.26. Panel (b) correlation: -0.25.

III.   THE MODEL

In this section, we investigate how much changes in taxes account for trend changes in hours by constructing a neoclassical model extended with taxes (following Ohanian et al 2008). We find that including taxes improves the prediction of the model. Especially in countries where hours increased the most.

This model economy is populated by one representative household which derives utility each period from private consumption C_t and leisure $\bar{H} - H_t$:

$$\sum_{t=0}^{\infty} \beta^t u(C_t, \bar{H} - H_t)$$

where $0 < \beta < 1$ is the discount factor. Each period t, the household is endowed with a stock of hours denote by $\bar{H}$. These hours can be either allocated to work in the market economy H_t or used for leisure or home production. The utility function of the household takes the following form:[8]

$$u(C_t, H_t) = \alpha \log(C_t) + (1 - \alpha) \frac{(\bar{H} - H_t)^{1-\gamma} - 1}{1 - \gamma}$$

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[7] Note that a simple correlation across country groups is not informative about joint evolution of hours and tax rates over time.

[8] Standard neoclassical theory (Prescott 2004, Ohanian et al 2008, McDaniel 2011, Jones 2016) assumes preferences which are consistent with a balanced growth path and yield constant hours worked (in the absence of taxes, this is) with respect to changes in labor productivity (implying that income and substitution effects cancel off). Therefore, the representative's agent has log utility on consumption. In a recent paper, Boppart and Krusell (2016) discuss and challenge this view.

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Utility increases with consumption and decreases with the number of hours worked. It is influenced by two parameters: $0 \leq \alpha \leq 1$ which is a parameter of taste, denoting how much workers like consumption relative to leisure. $\gamma \geq 0$ is the elasticity of substitution between consumption and leisure.

The representative household's budget constraint is defined as:

$$[1 + (1 - \tau_{at})r_t]a_t + (1 - \tau_{lt})w_t H_t = (1 + \tau_{ct})C_t + a_{t+1}$$

a_t refers to a safe asset, r_t is its rate of return and w_t is the real hourly wage. The representative household inherits savings from the previous period and earns labor income, which in turn can be used to save by buying assets a_{t+1} or consume. The budget constraint is affected by different types of taxes: a labor income tax (τ_{lt}), a capital income tax (τ_{at}) and a consumption tax (τ_{ct}).

With respect to the production side, there is a representative firm in this economy which is assumed to have Cobb-Douglas technology:

$$Y_t = F(K_t, H_t, A_t) = A_t K_t^{\theta} H_t^{1-\theta}$$

where K_t is capital, A_t total factor productivity and $0 < \theta < 1$ the capital share. Capital follows the usual law of motion:

$$K_{t+1} = (1 - \delta)K_t + I_t$$

where $0 < \delta < 1$ is the depreciation rate and I_t investment.

Solving the model, we focus on the first order condition (FOC) where the marginal rate of substitution is equal to the tax-adjusted marginal product of labor:

$$\frac{U_2(C_t, \bar{H} - H_t)}{U_1(C_t, \bar{H} - H_t)} = \frac{(1 - \tau_{lt})}{(1 + \tau_{ct})} F_2(K_t, H_t, A_t)$$

As we see the labor and consumption taxes act as a wedge between the FOCs of supply and demand for labor. We define $\frac{(1-\tau_{lt})}{(1+\tau_{ct})} \equiv \left(1 - \tau_t^{eff}\right)$ to be the tax wedge (or one minus the effective tax rate). We replace the combination of FOCs from our utility and production functions and reach the following equality:

This expression shows the relationship between hours, taxes and the consumption share. Before analyzing the comparative statics, we discuss the calibration than will allow us to express the

$$\frac{H_t}{(\bar{H} - H_t)^{\gamma}} = \left(1 - \tau_t^{eff}\right) \frac{\alpha}{(1 - \alpha)} (1 - \theta) \frac{Y_t}{C_t}$$

equation above in simpler terms.

In terms of the elasticity of substitution between leisure and consumption γ, we set it to 1, which is a conservative value of this parameter (Keane and Rogerson, 2012). The value γ has spurred a heated debate in the literature after Prescott (2004) presented his controversial findings (Chetty et al, 2011; Rogerson and Wallenius, 2009). The main source of this debate has been the reconciliation between the magnitude of the elasticity estimated using microeconomic data and the one calibrated in macroeconomic models (Peterman, 2015). The higher γ the more hours would respond to changes in taxation. Therefore, a precise parametrization is needed to correctly assess the role played by taxes. The literature has reached a consensus suggesting the use of values ranging between 1 and 2 for models such as the one employed here (Chetty et al, 2011 and Keane and Rogerson, 2012). Replacing the elasticity of substitution and rearranging, we reach the following expression:

$$H_t = \frac{\frac{(1-\theta)\alpha}{1-\alpha}}{\frac{(1-\theta)\alpha}{1-\alpha} + \frac{C_t}{Y_t}\frac{1}{(1-\tau_t^{eff})}}\bar{H} \tag{2}$$

As we can observe, two variables affect the trend in hours: the effective tax and the consumption share. Higher effective taxes (through either consumption or labor taxes), lead to a higher tax wedge and disincentivize households supply of working hours. The mechanism is straightforward, an increase in taxation lowers real consumption therefore making leisure more appealing. The representative household reacts then by reducing its supply of labor. The consumption over output ratio captures intertemporal decisions regarding fiscal policies and future expected taxes, and it is an adjustment mechanism to smooth consumption over time. For example, if workers expect taxes to increase in the future, they would react by saving more (thus reducing consumption) and supplying more working hours today.

We also address the role of government spending in the model. The government uses tax revenue to purchase goods and services. The optimal reaction by households will depend whether public spending enters the representative agent's utility function. If this is the case - meaning that private consumption and public spending are substitutes - the negative impact of taxes would be smaller. More on this below.

It is worth noting that this simple neoclassical model overlooks some important features of the labor market. For example, it does not include employment/non-employment decision making, search and matching, or heterogeneity across agents. Also, it abstracts from different measures of income and financial risks (see Blundell et al. 2015, Hoffman and Malacrino 2019, and Guvenen et al 2015).

For our modeling exercise, we assume $\bar{H} = 14 * 365 = 5110$, $\alpha = 0.37$ and $\theta = 1/3$ as in Ohanian et al (2008).[9] The source for hours, consumption, and output are the AMECO database.

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[9] $\theta = 1/3$ follows from Gollin (2002).

While the model requires a measure of marginal taxes, due to limited data availability, we use average taxes. McDaniel (2007) shows that both measures follow similar trends. We use the definition of effective tax rate – based on consumption and labor tax rates - presented in the previous section. The model has complete data for all 11 NMS for 1995-17, with tax data only missing for Croatia for the 1995-01 period.

Model results

We present the results across different groups of countries according to their trend in hours (as discussed in the previous section). Group 1 includes countries where hours increased the most in the whole period, while Group 2 includes countries where hours stagnated or declined. To present the results we proceed as follows. First, we build equation (2) by replacing parameters and variables for each country over the entire time span.[10] Then, we compute the average predicted trend of H_t across each Group and plot its evolution together with the evolution of the trend in *actual* hours worked. To gauge the importance of taxes, we first show the model without taxes and then the model with taxes. We normalize the predicted and actual series to one in the year 2000, which has better data quality than previous years.
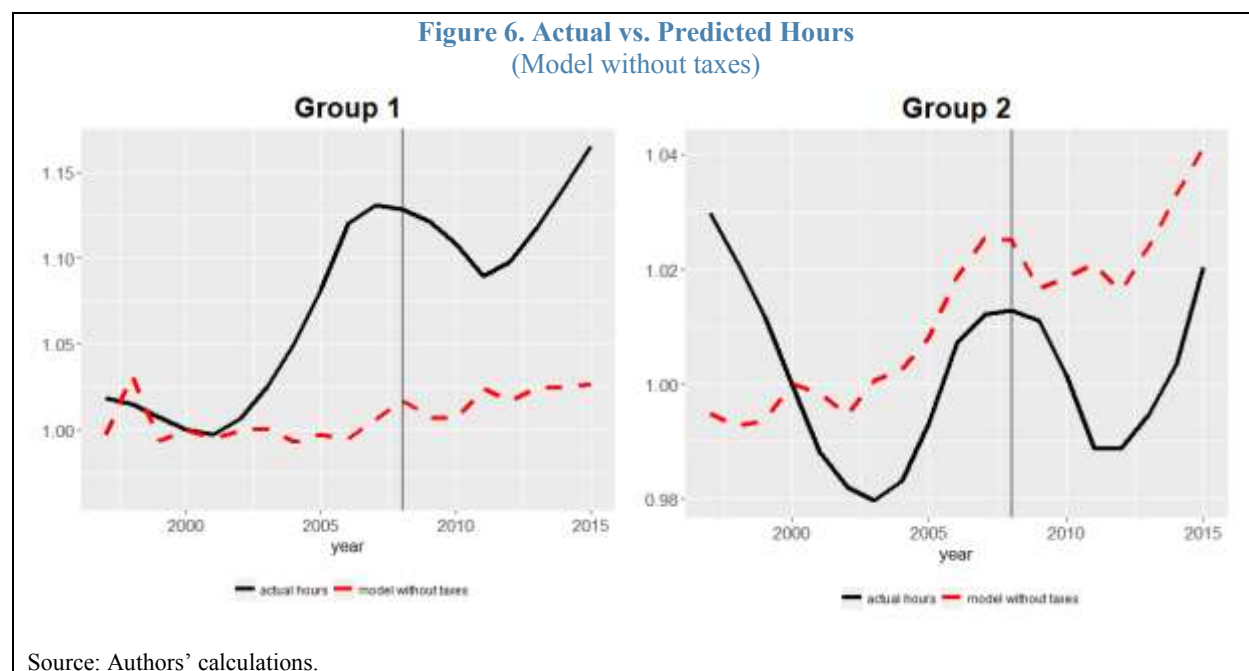
By groups

Figure 6. Actual vs. Predicted Hours
(Model without taxes)

Source: Authors' calculations.

Figure 6 shows the predictions of the neoclassical model without taxes.[11] The model does not explain the stark growth in hours in Group 1. While actual hours worked grew by 15 percent

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[10] Just to be clear, we do not solve for the entire model. As is usual in this literature, we focus on the evolution of (2) which tells us how well can taxes explain the wedge of the combined FOC in this model economy.

[11] We set the rate of effective taxes to zero in equation (2).

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through the whole sample, the model without taxes only predicts a 2.5 percent increase in this period. Furthermore, it does not capture the rise and fall of hours around 2008.

For Group 2, the model without taxes predicts a positive trend between 1995-17. However, hours did not increase in this period. Also, the model does not capture how hours declined between 1997 and 2000. Between 2000 and 2015, hours increased by only 2 percent while the model overpredicts growth in hours at 4 percent. The decline in hours following the GFC is also not captured. Overall, we observe that a standard growth model fails to follow the long-run trend in actual hours worked for both groups, and especially so in Group 1.

Next, we show the results for the model including taxes. Figure 7 shows the predictions of the model with and without taxes, and actual hours worked. Comparing the series with taxes to one without helps isolate the actual role of taxation in the dynamics of hours.

For Group 1, we observe that taxes improve the prediction of hours worked. The model with taxes predicts an increase in hours of 7 percent for the 2000-08 period, while the model with no taxes predicts a 2 percent rise. Actual hours increased about 13 percent in this period. Between the beginning of the sample and 2013, the model with taxes alone can help explain close to 50 percent of the growth in hours worked. However, its predictions do not track the trend in hours after 2013.
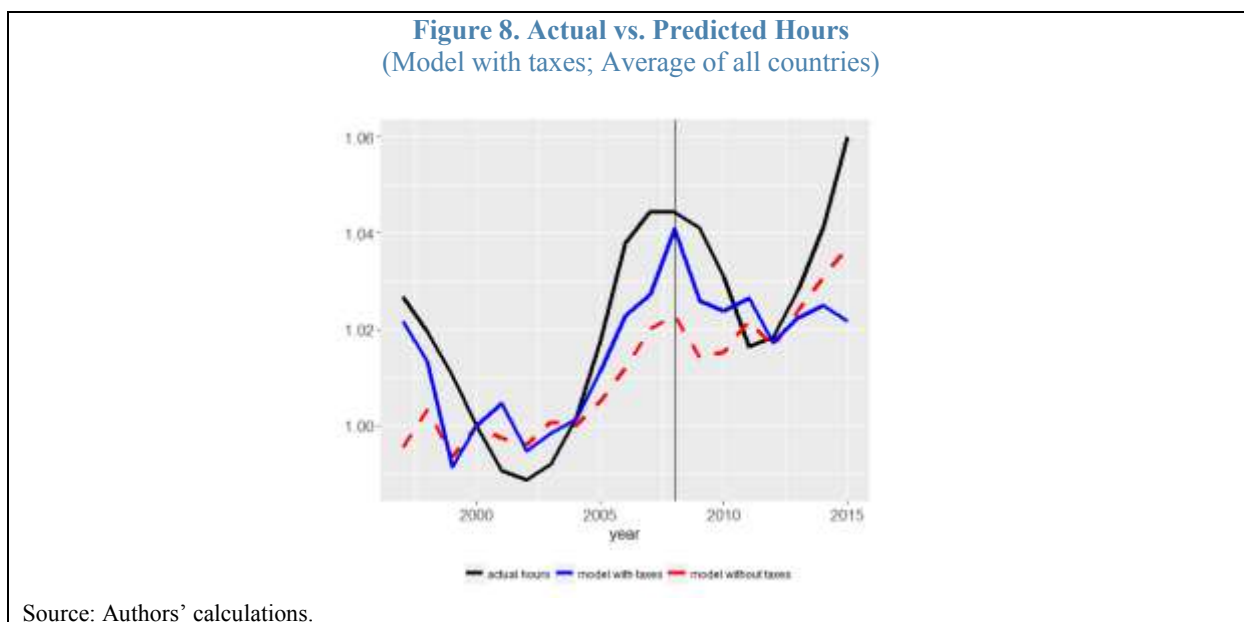
For Group 2, the model with taxes tracks quite well the evolution of hours worked throughout the sample, especially the rise and fall around the GFC. While hours only rose by 2 percent for the entire sample, the model with taxes predicts an increase of 1 percent. Excluding taxes leads to an overprediction in the rise in hours of 4 percent. One difference between the two groups is the rise in hours before 2008. In Group 2, the models with and without taxes predict the same increase in hours, suggesting taxes did not play a role in those years. For Group 1, we find a different story. Taxes are an important factor behind the rise in hours.

Figure 7. Actual vs. Predicted Hours
(Model with taxes)

Source: Authors' calculations.

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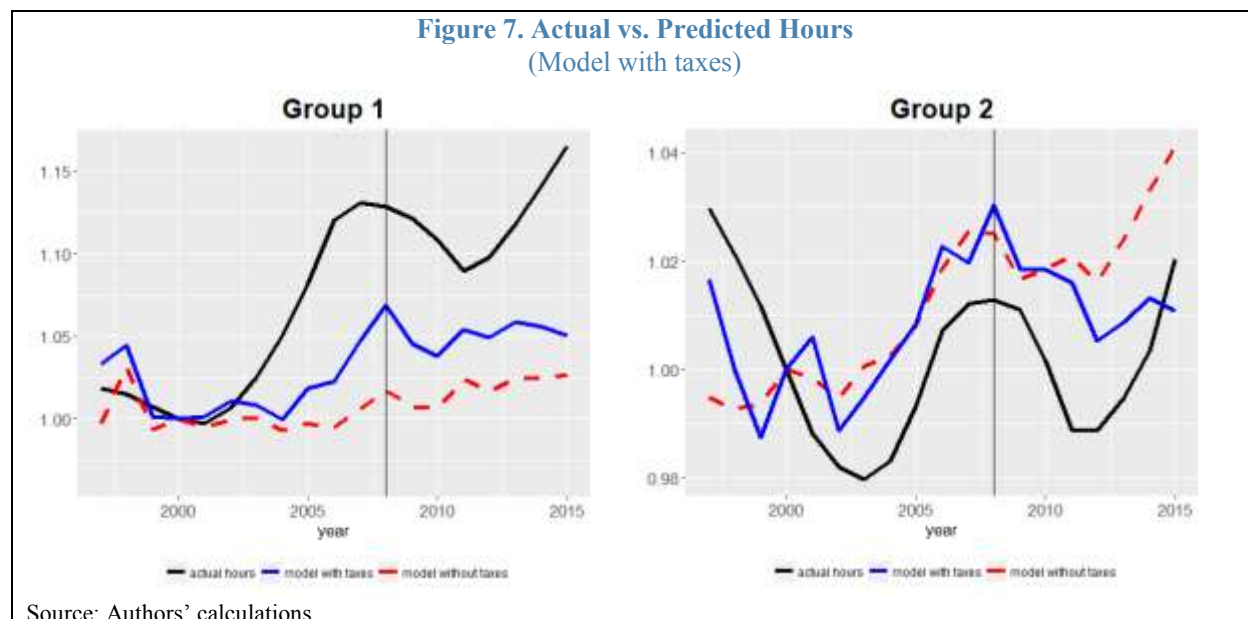
For all countries

We group the predictions for the 11 NMS together in Figure 8. The series is a weighted average of the results depicted in both panels of Figure 7. We observe that incorporating taxes into the model improves the prediction of hours worked for the average country. However, we document a substantial break between the predictions of the model and hours worked after 2013. Actual hours present a significant rise, which our model does not capture, partly due to the increase in effective taxes after the GFC documented in Figure 4 Panel (b). This suggests that other factors are behind the rise in hours during the recovery from the GFC.[12]

As already mentioned, one concern that could be raised is that the increase in taxation could be accompanied with higher government spending. Then it could be the case that the effect of taxes may be crowded out by an increase in public spending (assuming workers value public goods as much as private goods).[13] As a robustness exercise, we extended the definition of private consumption to include government spending on goods. We find that the predictions of the model with this modification are not significantly different from the ones presented here.

Figure 8. Actual vs. Predicted Hours
(Model with taxes; Average of all countries)

Source: Authors' calculations.

This section showed that that both labor and consumption taxes can be important factors in affecting trend changes in labor supply. In the Appendix II, we test which of these is more

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[12] Ohanian et al 2008 also identify several episodes where their model does not predict accurately trend changes in hours, they refer to these as "puzzling events". Finding which are the causes of this "puzzling events" should carry a careful analysis and it is outside of the scope of our research, but it may be an interesting avenue for future research.

[13] Rogerson (2007) highlighted that if government invests in non-market activities, which do not have close market substitutes, the negative effect of taxes on hours would be lower. For example, he argues that this explain the jointly high level of taxation and hours in Scandinavian countries.

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important for the tracking of hours. We study this by re-running the analysis in this section but keeping one type of tax fixed at a time. We find that for Group 1, labor taxes have a more prominent role than consumption taxes. On the other hand, a rise in consumption taxes contributes to explaining the decline in hours in the aftermath of the GFC for countries in Group 2.

To summarize, augmenting the model for taxes improves the prediction of hours worked. This is the case for both groups and when pooling all countries together. This highlights the importance of both labor and consumption taxes as important factors affecting trend changes of aggregate labor supply.

IV. ECONOMETRIC ANALYSIS

In this section, we carry out an econometric analysis with two objectives in mind. The first one is to confirm the relevance of taxes by ruling out other possible confounding factors that were omitted in the modelling exercise. The second one is to dig deeper into the effects of taxation on hours through a semi-aggregate analysis. We disaggregate hours by margin and taxes by type to quantify the deadweight loss of taxation at a more granular level and assess potential gains from policy actions.

Empirical strategy

Following the structural determinants of taxes derived from the model (eq. 2), we build the following econometric specification:

$$\log(H_{it}) = \beta\log(\tau_{it}^{eff}) + \delta'X_{it} + \varphi log(C_{it}/Y_{it}) + c_i + \mu_t + \varepsilon_{it} \qquad (3)$$

where H_{it} denotes hours worked over working age population and τ_{it}^{eff} the effective tax in country i in year t. The ratio C_{it}/Y_{it}, as discussed in the previous section, controls for any changes in hours due to intertemporal decisions. X_{it} is the vector of institutional covariates that may affect hours worked. c_i and μ_t are country and year fixed effects, respectively, and ε_{it} is the error term. Country fixed effects control for all country-specific characteristics which do not vary over time (or within sample years) such as work culture, labor legislation, or historic preferences towards leisure.

Our main parameter of interest β measures the percentage increase in hours worked following a one percentage point increase in the tax rate. This parameter, also known as the elasticity of hours to tax rates, has an additional interpretation. β captures the fraction of government revenue lost due to the decline in hours (Bakija, 2011). For example, a one percent increase in the tax rate (imagine from 40.0 percent to 40.4 percent) would lead to an increase in government revenue of $1+ \beta$ percent.[14] In this way, β (which is expected to be < 0) is a measure of the deadweight loss introduced by taxation.

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[14] To see this, define total government revenue as $R = \tau\bar{\omega}h$, with τ the tax rate, $\bar{\omega}$ the pre-tax wage and h hours worked. Assuming a constant pre-tax wage, then $\frac{\partial log\ R}{\partial log\ \tau} = 1 + \frac{\partial ln\ h}{\partial log\ \tau} = 1 + \beta$.

As controls for institutional and policy changes X_{it}, we chose to include openness, business and labor market regulation, social benefits, remittances, and migration. Greater openness, lower business regulation, and less rigid labor regulation should help promote more business entrepreneurship, further investment, lower hiring costs, and thus increasing demand of workers. Social benefits (as a share of GDP) are expected (if anything) to discourage labor market participation. It is possible they raise workers' reservation wage, thus, creating disincentives for working more hours or even participating in the labor market at all. Remittances, for the same reasons as social benefits, may also deter labor supply. They are closely linked with migration. NMS have faced high levels of emigration after joining the EU, significantly affecting participation (Atoyan et al 2016). To account for this, we include net emigration as a share of population aged 15-64 years old as a control variable. Appendix III provides more details on the construction of these variables. We want to re-emphasize that the purpose of this exercise is to control for other labor market variables that might confound the effect of taxes, and not to draw any concrete conclusions of possible effects of these covariates on labor supply.

When thinking about the determinants of hours worked, wage level and/or labor productivity would appear as natural candidates. However, it is important to highlight that this is not the case in a macro study of hours consistent with a balanced growth path. While abundant research shows that that changes in the wage level (for example due to an increase in productivity) modify workers' labor supply at the individual level (see Giannis 2014, Booth and Katic 2010, Evers et al 2008, among many others), the effects in these studies is only micro and should not be extrapolated to infer dynamics of macro variables. The reason is that micro level studies usually focus on the intensive margin of hours, often ignoring changes in the employment rate, or the hiring behavior of firms (Chetty, et al 2013, Keane and Rogerson 2012).[15]

One possible concern regarding specification (3) is the endogeneity of taxes. Our measure of taxes is built from national accounts and may be subject to business cycle fluctuations, which also affect hours worked. We address this concern by filtering both hours and taxes with 5-year moving averages to remove short-run fluctuations. In addition, we provide a robustness analysis by using an alternative measure of taxes, computed by the OECD, on a subset of our sample of countries (see Appendix IV). We show that the estimates of the elasticity between hours and taxes is not dependent on the construction of tax data.[16] Regardless of this adjustment, the econometric results presented in this section should be taken with caution as we are not instrumenting for taxes.

Our measure of hours worked includes both informal and formal hours of employment (national accounts gather labor data from labor force surveys). While labor taxes affect workers in the formal sector of the economy, consumption taxes may affect all or different segments of the working population. This fact would likely influence the magnitude in which taxes affect hours. It is

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[15] The measure of hours we use is stationary in most countries (for example see Figure 2, panel (a)), while labor productivity and real wages are clearly not.

[16] In addition, if tax revenue (and income) are a constant proportion of hours worked then shocks to hours would not be driving the results.

expected that taxes would have a higher elasticity in countries where the informal sector is smaller. Therefore, we believe that, if anything, our point estimates may be biased towards zero.

Exploratory analysis

Taking advantage of the construction of novel data, we carry out a semi aggregate analysis on the effects of taxes on labor supply. Following specification (3), we decompose hours by margin into hours per worker and the employment rate (see eq. 1). Then, we replace effective taxes with the product of the consumption and labor tax rate. The new specification becomes:

$$\log(y_{it}) = \beta_1 \log(\tau_{it}^{cons}) + \beta_2 \log(\tau_{it}^{labor}) + \delta' X_{it} + \varphi \log(C_{it}/Y_{it}) + c_i + \mu_t + \varepsilon_{it} \tag{4}$$

Here y_{it} represents hours worked, hours per worker, or employment rate. The coefficients associated with consumption tax τ_{it}^{cons} and labor tax τ_{it}^{labor} will allow us to estimate how sensitive hours (and its two margins) are to these types of taxes.

Moreover, we decompose labor taxes into the share of personal income tax accrued to labor income (τ_{it}^{PIT}) and social security contributions (τ_{it}^{SSC}).[17] The labor tax rates we used so far are the sum of these two (see Appendix I). Estimating the elasticity of hours with respect to personal income taxes and social security contributions can shed light on which one is relatively more important in deterring labor supply. Similarly, to (4), we set the following specification:

$$\log(y_{it}) = \beta_1 \log(\tau_{it}^{cons}) + \beta_2 \log(\tau_{it}^{PIT}) + \beta_3 \log(\tau_{it}^{SSC}) + \delta' X_{it} + \varphi \log(C_{it}/Y_{it}) + c_i + \mu_t + \varepsilon_{it} \tag{5}$$

Substantial differences of labor market outcomes between men and women have been documented in the literature and they are at the center of recent studies (see Bick et al 2018a). Given well-known differences of these outcomes by gender (especially in terms of labor market participation), we expand our analysis to investigate if there are heterogenous effects of taxes through this channel. We do not have a measure of total hours by gender for NMS as, for instance, Bick et al (2018a) have for OECD countries.[18] Therefore, we can only study differences on the extensive margin of hours. Using data from Eurostat based on labor force surveys, we build the employment rate for men and women in each country. Many countries, including NMS, have seen women's employment rate increase in the last 20 years. However, in most of them, women still lag men's employment rates.

To study differences across gender, we replicate specifications (4) and (5) and regress the extensive margin (for men and for women) on consumption and labor taxes, and a vector of controls. We decompose taxes by type to take a closer look at which taxes are more relevant in influencing employment decisions.

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[17] Note that τ_{it}^{PIT} refer to the tax rate solely on labor income and not to other sources of income. See Appendix I.

[18] Bick et al (2018a) study differences in hours worked between men and women across countries based on a comprehensive labor force survey data.

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Estimation results

We present our estimation results in three tables. In the first one we show the estimation of total hours worked on effective taxes and other labor market determinants (eq. 3). In the second one we show the association of different margins of hours with consumption and labor taxes. The results highlight heterogenous effects of taxation (eq. 4 and 5). In the last table, we show how taxes affect employment rates by gender.

Table 2 shows the estimation results of specification (3). As expected, the effective tax negatively affects hours worked. This finding is robust when controlling for other factors, either individually or collectively. From column 1 to column 8 the estimate of β ranges between -0.390 and -0.543. This elasticity implies that if the average NMS increases its effective tax rate by one percent, then hours worked would decline by close to half percent. This value indicates a substantial deadweight loss due to taxation. As discussed above, it implies that tax revenue would increase only by 0.5 percent following a one percent increase in tax rates (being the other 0.5 percent the deadweight loss). β is close to other estimates found in the literature. Bakija (2011) replicated regressions in Ohanian et al (2008) and Alesina et al (2005) for 15 OECD countries from 1960 through 1995, in a similar specification, and found β between -0.123 and -0.462.[19] [20]

In column 8, we find that other labor market determinants matter for hours worked. As previously discussed, we find social benefits and higher levels of business regulation to be negatively associated with hours. On the other hand, higher degree of openness leads to more hours worked. Interestingly, the size of the elasticities of other factors is much smaller than the one of taxation. Different from the model presented in the previous section, the consumption-output ratio does not appear to play an important role determining the variations in hours. This is partly due to the stationary nature of the data and the inclusion of two-way fixed effects (which was absent in the modelling exercise in the previous section). Taxes and consumption/output can explain up to 21 percent of total variation of hours (column 1), while when including all covariates, we find that this amount increases to 51 percent (column 8).

To quantify the deadweight loss of taxation at a more granular level, we disaggregate hours by margin and taxes by type. In Table 3, we show the results of specification (4) in columns 1, 3 and 5 and the ones from specification (5) in columns 2, 4 and 6. All regressions include country and year fixed effects, as well as other controls previously used.

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[19] The main difference with our specification is the control variables. He included union density and an employment protection measure as sole controls.

[20] One concern is the sensitivity of the estimates to the small number of countries in the sample. In Appendix IV we use an alternative measure of taxes based on OECD data which excludes two countries. It shows that the results hold to both changes tax source and sample. In addition, we carried out a Breusch Pagan test and found no evidence of cross-sectional correlation of errors.

Table 2. Results for Hours Worked

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Dependent variable:				
				log(hours worked)				
log(effective tax)	−0.400***	−0.390***	−0.419***	−0.482***	−0.505***	−0.444***	−0.398***	−0.543***
	(0.062)	(0.062)	(0.066)	(0.066)	(0.067)	(0.067)	(0.061)	(0.081)
log(openness)		0.046						0.121**
		(0.031)						(0.051)
log(social benefits/GDP)			−0.087***					−0.086***
			(0.030)					(0.031)
log(business regulation)				−0.129***				−0.113**
				(0.046)				(0.052)
log(labor mkt regulation)					−0.057*			0.029
					(0.032)			(0.042)
log(remittances/GDP)						0.006		0.007
						(0.004)		(0.006)
migration							0.0003	−0.0004
							(0.005)	(0.001)
log(C/Y)	-0.031	-0.076	-0.300**	-0.050	-0.019	0.029	-0.052	0.008
	(0.119)	(0.122)	(0.134)	(0.125)	(0.128)	(0125)	(0.120)	(0.152)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	190	190	143	160	160	190	180	120
R^2	0.211	0.222	0.375	0.345	0.323	0.223	0.222	0.507

Note: Cluster robust standard errors in parentheseis.
See Appendix III for description of variables.

*p<0.1; **p<0.05; ***p<0.01

Table 3. Results by Type of Tax

Dependent variable:

	log(hours)		log(hours per worker)		log(employment rate)	
	(1)	(2)	(3)	(4)	(5)	(6)
log(tax cons)	−0.138***	−0.141***	−0.159***	−0.154***	0.022	0.014
	(0.036)	(0.037)	(0.020)	(0.020)	(0.030)	(0.031)
log(tax labor)	−0.335***		−0.026		−0.310***	
	(0.063)		(0.035)		(0.052)	
log(tax PIT)		−0.071*		−0.054***		−0.017
		(0.036)		(0.019)		(0.029)
log(tax SSC)		−0.260***		−0.042		−0.219***
		(0.055)		(0.029)		(0.045)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	120	120	120	120	120	120
R^2	0.556	0.539	0.548	0.583	0.514	0.504

Note: Cluster robust standard errors in parentheses. PIT is the personal labor income tax rate and SSC refers to social security contribution rate. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Both consumption and labor taxes are important determinants for hours worked (column 1). Labor taxes show a larger coefficient than consumption taxes: suggesting that direct taxation on labor income disincentivizes labor supply than indirect taxation. When we decompose labor taxes (in column 2) we find that both personal income taxes and social security contributions matter. While a one percent increase in personal income taxes is associated with a 0.07 percent decline in hours worked, this effect is 0.26 percent for social security contributions. We observe the elasticity of hours to taxes to be the largest for social security contributions followed by consumption taxes, with personal taxes on labor income playing a smaller role.[21] This is partially consistent with low levels of personal income tax rates in many NMS.

In addition, we document heterogenous effects of taxes through the intensive and extensive margin. While consumption tax rates are associated with lower average hours per worker (columns 3 and 4), we do not find such effects on employment rates (columns 5 and 6). It is possible the indirect effects of consumption taxes are not strong enough to affect labor market participation. Regarding labor taxation, we observe that the effect of personal labor income taxes on hours is only through the hours per worker. On the other hand, social security contributions are not statistically significant on hours per worker but have a substantial effect on the employment rate.

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[21] One disadvantage of national accounts-based data is that it is not possible to know which share of social security contributions is paid by the employer and how much is paid by the employee.

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In summary, the analysis suggests that both consumption and labor taxes matter for hours worked, with consumption taxes and personal income taxes disincentivizing average hours per worker and social security contributions through lower employment rates.

Table 4 presents the results of the effects of taxation on men's and women's employment rates. Comparing columns 1 and 3, we see that labor taxes discourage both men's and women's supply of hours through the extensive margin. However, women's elasticity of employment rate with respect to labor taxes is slightly higher (around 5 percent) than the one for men (statistically significant at the 5 percent level). This provides further evidence that taxes disincentivize women's participation in the labor market more than men's (de Boer 2018 and Causa 2009). When disaggregating labor taxes (columns 2 and 4), we find that the effect of social security contributions on women's employment decision/status is around 7 percent higher than the one for men.

Table 4. Results by Gender and Type of Tax

	Dependent variable:			
	log(employment rate)			
	Men		Women	
	(1)	(2)	(3)	(4)
log(tax cons)	0.027	0.018	0.021	0.013
	(0.032)	(0.032)	(0.033)	(0.034)
log(tax labor)	−0.312***		−0.327***	
	(0.055)		(0.056)	
log(tax PIT)		0.002		−0.012
		(0.031)		(0.039)
log(tax SSC)		−0.217***		−0.232***
		(0.047)		(0.050)
Controls	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	120	120	120	120
R^2	0.544	0.556	0.437	0.411

Note: Cluster robust standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01

Usually, social security contributions are charged independent of gender, leading us to think that the higher discouragement for women in paid employment is a consequence of intrahousehold decisions. For example, when faced with the same social security contributions rate, a household's second earner may also be facing a higher marginal rate. When tax rates change, members of a household accommodate their labor supply accordingly by adjusting either at the intensive margin or at the extensive margin. The extent to which one is more dominant would depend on the level of taxation, but also on other factors, such as tax deductions for married couples and childcare options and costs.

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V. CONCLUSIONS AND POLICY CONSIDERATIONS

This paper studies the importance of taxation in explaining differences in hours worked for NMS. In line with other studies based on G7 countries and EU-15, our empirical findings support that tax rates play a significant role in explaining hours worked across countries. Our modelling exercise shows that taxes influence the long-run trend in hours and our econometric exercise shows that the findings are robust to the inclusion of other labor market determinants. Furthermore, we document an elasticity of hours to overall taxes close to 0.5. We find that differences in tax burden can explain up to 21 percent in the variation of hours worked across NMS. The main takeaway of this study is that excessive tax burden, either in the form of consumption or labor taxes, can lead to substantial deadweight losses in terms of labor supply. Next, we highlight some important key points of this study that may be useful for policymakers and provide avenues for future research.

Our findings exhibit that taxation causes a substantial deadweight loss in labor utilization which is substantially larger than that of other selected labor market determinants. This suggests that the latent welfare gains from a well-design tax system with minimum discouraging effects can go a long way and should be present for any country thinking about boosting their labor outcomes.

Consumption taxes are important. While the idea that labor taxes discourage labor supply may be apparent, the discouragement from consumption taxes is less so. As documented above, prima facie evidence shows that long-term growth in hours was observed in those NMS that had effective (combined labor and consumption) tax rates below 40 percent. Furthermore, our econometric analysis associates consumption taxes with lower hours per worker. Thus, overall tax burden – and not only labor taxes - should be considered when thinking about incentives from tax schemes.

In our last section, we brought attention to the gender dimension. Our finding that social security contributions affect women's employment rate significantly more than men's is a reminder of underlying gender disparities still present in these countries. Any potential reform should address the gender dimension and consider the overall incentives and disincentives women face to participate in the labor market.

Since rigidities in the labor market, to a large extent, stem from policy making, there should be a holistic approach to structural reform implementation. For example, we document that social security contributions lead to lower employment rates but do not affect the number of hours of those already in employment. On the other hand, consumption and personal income taxes disincentive hours per worker, with no apparent effect on employment rates. This complexity calls for avoiding a one-size-fits-all approach to reforms as each NMS has their own idiosyncratic challenges. With the population aging and longer life spans in the region, policy-makers must recognize that spending pressures, especially in pensions and health, are likely to increase. Thus, while taxes matter, wider fiscal implications should be considered when deciding on any changes to labor taxation. To be clear, there is no simple link between taxes and employment. And, since fiscal policy is the main economic policy instrument in many NMS, there is a need for careful calibration.

Suggestions for further research could include breaking down social security contributions by employer and employee shares (which is absent in national accounts), evaluating differences between cash and in-kind social benefits or differentiating between poverty-targeted social spending and unemployment insurance. Also, expanding the study to micro-determinants of labor market participation (e.g. unemployment insurance, childcare opportunities), especially for women. In fact, the effects of taxes across gender remain a highly relevant topic to study for NMS.

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We follow McDaniel (2007) to compute average labor and consumption tax rates based on the national accounts data for 11 NMS. We use data from the AMECO database for the period 1995-2017 with the following definitions:

Value	Variable
GDP	Gross domestic product
TPI	Taxes on production and imports
Sub	Subsidies
W	Compensation of employees
OSMI	(hh) Gross operating surplus & mixed income
C	Private final consumption expenditure
I (private)	Gross fixed capital formation – (gov) gross fixed capital formation
HHT	(hh) Current taxes on income & wealth
SS	(gov) Social contributions received

Note: Variables in parentheses denote specific accounts. Source: AMECO database.

Construction of labor income tax:

Tax revenue on labor income has two sources: household income tax and social security contributions (SS). While the latter is readily available from the national accounts, the former one needs to be divided into labor and non-labor income tax revenue. To calculate labor income tax revenue, we perform the following steps. First, we calculate the average household income tax rate. We do this by dividing current taxes on income and wealth, *HHT*, on *GDP* minus net of taxes on production and imports, *TPI - Sub*:[1]

$$\tau^{income} = \frac{HHT}{GDP - (TPI - Sub)}$$

Next, we calculate the labor share. Let α be the share of income attributed to capital and $(1 - \alpha)$ the share attributed to labor. Labor income is comprised by compensation to employees, *W*, and income earned by self-employed workers, *OSMI*. We assume that the share of *OSMI* attributed to labor is the same as in the aggregate economy. If this is the case, the following accounting identity holds:

$$W + (1 - \alpha)OSMI = (1 - \alpha)(GDP - (TPI - Sub))$$

Solving for the labor share yields:

$$(1 - \alpha) = \frac{W}{GDP - (TPI - Sub) - OSMI}$$

Then, total labor taxes paid by households are:

$$HHTl = \tau^{income}(1 - \alpha)(GDP - (TPI - Sub))$$

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[1] We omit country and year subscripts for simplicity.

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In our calculation of average tax, we include *SS* as taxes on labor income. Finally, the average labor tax rate is total labor income taxation over labor income:

$$\tau^l = \frac{SS + HHTl}{(1 - \alpha)(GDP - (TPI - Sub))}$$

From here it is clear to see that the labor tax can be divided into a social security contribution tax (SSC) and a personal labor income tax rates (PIT):

$$\tau^l = \tau^{SSC} + \tau^{PIT}$$

With:

$$\tau^{SSC} = \frac{SS}{(1 - \alpha)(GDP - (TPI - Sub))}$$

$$\tau^{PIT} = \frac{HHTl}{(1 - \alpha)(GDP - (TPI - Sub))}$$

Construction of consumption tax:

Taxes on production and imports, *TPI*, represent all tax revenue collected from consumption and investment taxes. This variable includes, taxes on value added (VAT), excise taxation, import duties and property taxes. This last can be interpreted either as consumption taxes (if levied on households) or as capital taxes (if levied on businesses). For our calculations, we assume that all property taxes should be allocated to consumption taxation (property taxes are already a small share of TPI and are unlikely to significantly modify the results). Next, we should separate how much of net taxation on production and imports, *TPI -Sub,* is collected from either consumption or investment. Unlike McDaniel (2007), we do not have disaggregated information to split it into the two categories. Therefore, we will assume a unique treatment across time and countries. Let λ be the share of taxation which relies only on consumption goods, while $(1-\lambda)$ relies on both consumption and investment. We calculate total tax revenue levied on consumption as:

$$TPIc = (\lambda + (1 - \lambda)(\frac{C}{C + I}))(TPI - Sub)$$

In this formulation, a $\lambda = 1$ would indicate that all tax revenue is based on consumption taxation. This would represent an extreme and an overestimation of the consumption tax revenue (there would be no taxation on investment). On the other extreme, if we would set $\lambda = 0$ and calculate tax revenue according to the relative share of consumption, this would lead to an underestimation of the consumption tax revenue (some taxes, like excise taxes, mostly affect consumption but not investment, unless there are taxes on certain intermediate inputs). Following Prescott (2004), we assume $\lambda = 1/3$. This value is very close to what McDaniel (2007) calculated for the continental EU countries. Finally, we calculate the average tax on consumption as the *TPIc* over taxable consumption, *C-TPIc*:
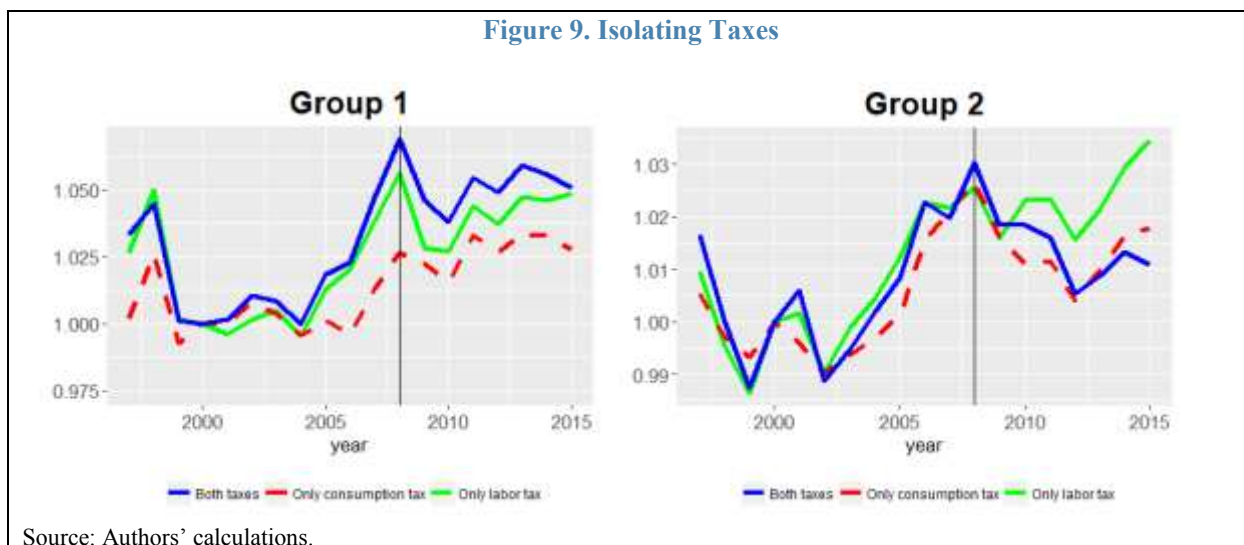
$$\tau^c = \frac{TPIc}{C-TPIc}$$

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One of the advantages of our counterfactual predictions in Section 2 is that we can isolate the role of consumption and labor taxes to assess which ones had more weight in the trend predictions of hours. In this section we set labor taxes to zero for all countries and all periods when constructing the effective tax in equation (2). This allow us to observe how much the tracking of hours are due to changes in consumption taxes only. Then, we repeat the exercise but keeping consumption tax equal to zero to gauge the importance of labor taxes. The results are presented in Figure 9 together with the predictions of the model with both consumption and labor taxes as a benchmark.

For Group 1, we observe that the labor tax only series predicts a higher level of hours than the consumption tax only. This means that labor taxes carry more weight than consumption taxes into explaining the rise in hours in this group. However, we can observe that changes in consumption taxes are also important in explaining the rise in hours, especially after 2006.

For Group 2, there is not much difference between the consumption and labor tax only series before the GFC. Which means that both taxes carry similar weight. After 2008, we observe something interesting. The labor tax only predicts a rise in hours while the model with consumption tax only predicts a decline. What we can infer from this counterfactual is that consumption taxes should be rising in order to drag the evolution of hours downward in the series with both taxes. Therefore, we could deduce that the increase in consumption taxes in the post-GFC has had important negative consequences for labor supply in these countries.

Figure 9. Isolating Taxes

Source: Authors' calculations.

Variables:	Description	Source:
Hours worked	Total hours divided by population aged 15-64 years old	AMECO
Hours per worker	Total hours divided by total employment	AMECO
Employment rate	Total employment divided by population aged 15-64 years old	AMECO
Effective tax	It is the interaction between labor and consumption tax rates. See Appendix I for construction of all taxes.	AMECO
Openness	Total exports plus total imports divided by GDP.	World Bank
Social benefits	Amount of social benefits divided by GDP. Transfers in cash or in kind to protect specific segments of the population against certain social risks.	WEO
Business regulation	A higher number indicates more business regulation. It is based on a comprehensive index including: (i) administrative requirements, (ii) bureaucracy costs, (iii) starting a business, (iv) extra payments / bribes / favoritism, (v) licensing restrictions and (vi) cost of tax compliance.	Fraser Institute
Labor mkt. regulation	A higher number indicates more regulation in the labor market. It is based on a comprehensive index including: (i) hiring regulations and minimum wage (ii) hiring and firing regulations (iii) centralized collective bargaining (iv) hours regulations (v) mandated cost of worker dismissal (vi) conscription.	Fraser Institute
Remittances	Personal remittances as a percentage of GDP.	World Bank
Migration	Total emigrants minus immigrants divided by population aged 15-64 years old.	Atoyan et al (2016)
Consumption/Output	(Private consumption + Government spending)/GDP	AMECO
Employment rate by gender	Total (wo)men employed divided by total (wo)men aged 15-64	Eurostat and AMECO

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APPENDIX IV. ROBUSTNESS ANALYSIS

We provide a robustness check of our main results by replicating our econometric analysis using an alternative data source to show that the effect of taxes on hours worked is not highly sensitive to the construction of tax data. For this we use tax rates from the OECD. The OECD collects data from national statistical offices and computes tax rates on goods and services, personal income tax and social security contributions as a share of GDP. These are, in spirit, similar as our measures of consumption tax, PIT tax and SSC tax, respectively. The main difference in its computation is the origin. The OECD carefully gathers data from labor force surveys, computes average wage income and different types of taxes at a more micro level for a representative household in each country. OECD (2018) describes the methodology in detail. However, the OECD database does not include data for Bulgaria, Croatia and Romania (non-OECD members).

To show the sensitivity of our results to the change of tax data, we first replicate the results obtained in Table 4 where we regress hours worked, hours per worker and employment rate on both consumption and labor tax rates, but excluding Bulgaria, Croatia and Romania to have a benchmark to compare. The results are shown in columns 1, 3 and 5 of Table A1. Compared to the results obtained in Table 4, we observe that consumption taxes have a slighter higher elasticity with respect to hours worked (column 1), a similar estimated coefficient on hours per worker is maintained and now there is a negative and statistically significant effect on the employment rate (whereas before was not significant). The elasticity of hours to labor taxes is slightly smaller than the one obtained in Table 4. This shows that dropping three countries from our sample does not substantially change our main results.

In columns 2, 4 and 6 we perform the same econometric specification but using the OECD measure of consumption taxes (which they name *taxes on goods and services*) and labor taxes (*personal income taxes* plus *social security contributions*) and compare them to the benchmark (columns 1, 3 and 5). When comparing the first two columns, we observe that the coefficient of OECD consumption tax is slightly larger than the one using national accounts data. On the other hand, OECD labor tax is smaller in magnitude. Both estimates are statistically significant at the one percent level. The results presented in column 4 corroborate the fact that consumption taxes have a significant impact on hours per worker, and that such effect is not apparent from labor taxes. Finally, column 6 shows that labor taxes play a larger role than consumption taxes through the employment rate. The magnitude of labor taxes is somewhat smaller when employing the OECD data.

Overall, the results of the econometric exercise presented in section IV are not particularly sensitive to the source of tax data or the sample of countries.

Table A1. An Alternative Measure of Taxes

Dependent variable:

	log(hours)		log(hours per worker)		log(employment rate)	
	(1)	(2)	(3)	(4)	(5)	(6)
log(tax cons – National Accounts)	−0.236*** (0.034)		−0.154*** (0.020)		-0.084** (0.038)	
log(tax on goods and services - OECD)		−0.336*** (0.046)		−0.260*** (0.041)		−0.077* (0.043)
Log(tax labor – National Accounts)	−0.295*** (0.069)		−0.026 (0.072)		−0.273*** (0.078)	
log(tax labor - OECD)		−0.189*** (0.064)		−0.077 (0.057)		−0.116* (0.059)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75	91	75	91	75	91
R^2	0.792	0.720	0.573	0.544	0.591	0.625

Note: Cluster robust standard errors in parentheses.

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

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