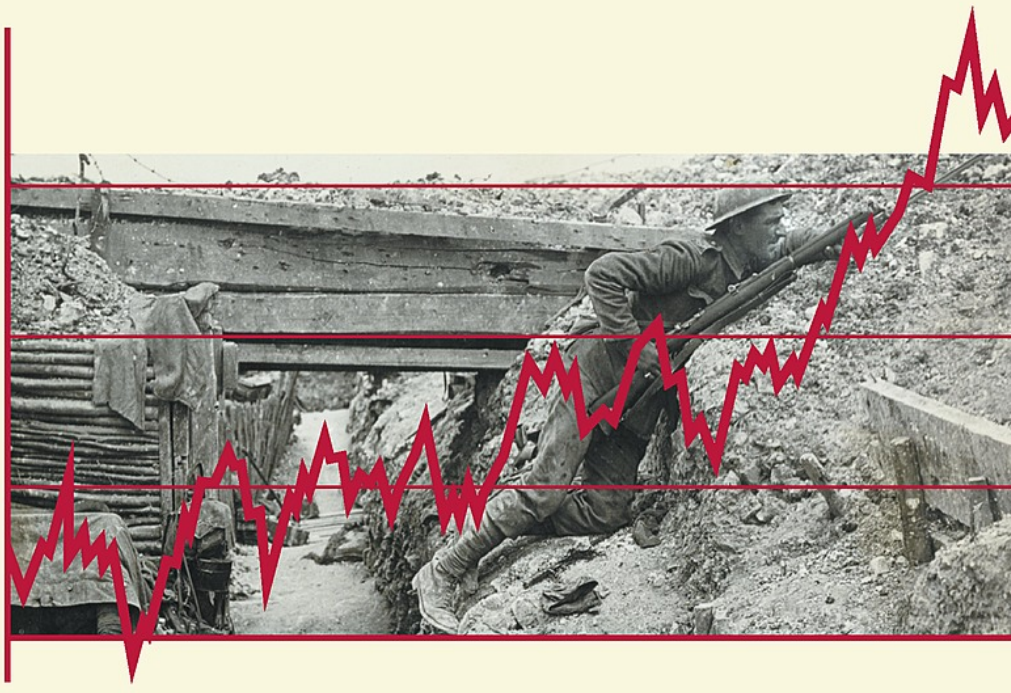
Tobias A. Jopp

War, Bond Prices, and Public Opinion



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Mohr Siebeck

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2

Tobias A. Jopp

War, Bond Prices, and Public Opinion

How Did the Amsterdam Bond Market Perceive the Belligerents' War Effort During World War One?

Mohr Siebeck

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Preface

The present monograph is a revised version of my habilitation thesis that was accepted by the Faculty of Philosophy, Art History, History and Humanities at *Universität Regensburg* in November 2019. In its published form, it consists of two parts: the printed version containing the argument; and an additional online Appendix providing necessary detail on the data and on technical matters.

A scientific study like the present one is a team effort, after all. It would not have been possible for me to accomplish this study if it was not for a number of people along the way, who believed in the study's feasibility and relevance and who, thereupon, generously lent their professional and emotional support to my efforts. First of all, I would like to express my deepest gratitude and appreciation to my supervisor, Prof. Dr. Mark Spoerer, who enabled me to pursue the idea that is at the center of this study and who showed great dedication and patience. However, his nudge to bring this study to a successful end came at exactly the right time.

I am also deeply indebted to Prof. Dr. Bernhard Löffler and Prof. Dr. Jochen Streb who acted as co-supervisors, and to Prof. Sibylle Lehmann-Hasemeyer, PhD, who, together with Mark Spoerer and Jochen Streb, took on the task of formally reviewing my habilitation thesis. The suggestions I received from both my supervisors and reviewers – on preliminary versions of my study as well as on the final product – were invaluable for preparing the version to be published eventually.

I also wish to express my deep appreciation to my colleagues at the Chair of Economic and Social History at *Universität Regensburg*, who have been important companions to me; Dr. Michael Buchner, Lino Wehrheim, MSc., Wolfgang Höflinger, M. A., Kathrin Pindl, M. A., Sebastian Pössniker, M. A., and Alfred Reichenberger, M. A. I owe a special thanks to my long-time office mate Michael Buchner who always had a sympathetic ear for my questions; his answers contributed significantly to giving shape to this study. Moreover, I am very thankful to our (former) student assistants for their support; in particular, Vera Drescher, Arthur Haberlach, Johannes Kiechle, Silvana Hofmeister, and Julia Langholz.

Furthermore, I would like to thank the editors of the series *Economy and History* at Mohr Siebeck, especially Mark Spoerer, for incorporating my study. I also would like to thank Martina Kayser, Klaus Hermannstädter, Tobias Stäbler, and Tobias Weiß, who monitored the publication process on behalf of Mohr Siebeck.

Above all, I cannot express in words how crucial the endless and unfettered support by my mother has been for me and for accomplishing the project "habilitation". This study is devoted to her.

Regensburg, July 2020 Tobias A. Jopp

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List of abbreviations

AEG	Augmented-Engle-Granger (pre-test on cointegration)
AIC	Akaike information criterion
AP	Allied Powers
AUT	Austria
BRA	Brazil
BUL	Bulgaria
CHN	China
CINC	Composite index of national capabilities
CP	Central Powers
CUB	Cuba
CUSUM	Cumulated sum of squares (test)
CY	Current yield
DFGLS	Dickey-Fuller generalized least squares (test)
ENG	England
FRA	France
GDP	Gross domestic product
GER	Germany
HAC	Heteroscedasticity-and-autocorrelation-consistent (standard errors)
H. K.	Hoogste koers
HUN	Hungary
I(…)	Integrated of order …
ITA	Italy
JAP	Japan
L. K.	Laagste koers
LOT	Lesmond, Ogden and Trzcinka (-measure of liquidity)
MAIC	Modified Akaike information criterion
NED	Netherlands
NIC	Nicaragua
OHL	*Oberste Heeresleitung* (Supreme Army Command)
OLS	Ordinary least squares (estimation)
POR	Portugal
POW	Prisoner-of-war
ROM	Romania
RUS	Russia
SER	Serbia

SIC	Schwartz information criterion
S. K.	Sloetkoers
TUR	Turkey (Ottoman Empire)
UK	United Kingdom
US	United States
VAR	Vector autoregressive (model)
VEC(M)	Vector error correction (model)
V. K.	Vorige koers
WWI	World War I
WWII	World War II
YTM	Yield-to-maturity

I. Introduction

1. World War One as a study object of the economic historian

For manifold reasons, the Great War[1] certainly is a watershed in the evolution of warfare, politics, economics, and the social sphere. For one, the belligerents set out to revolutionize warfare. The modern, industrialized war emerged providing the pre-condition for hitherto unprecedented numbers of soldiers killed, wounded, and taken prisoner-of-war (POW). This holds for World War One itself as well as for many other wars and conflicts to follow. While exact World War One casualty figures are still subject to debate, we may well estimate total casualties among the belligerent countries' military forces at some 32 million, give or take, including around nine million dead. In terms of deaths civilian populations certainly suffered on an equal scale.[2] Moreover, the various territorial adjustments in the aftermath of the war re-shaped the economic and political geography of Europe and provided the roots for new conflicts while keeping old ones alive. This was due to the dissolution of the Ottoman and Habsburg Empires as well as the territorial losses imposed on the German Empire, but also due to the various local conflicts about boundaries decided under the veil of the Great Powers' hegemonic struggle.[3] Finally, to point to only one further aspect of many more that could be mentioned, World War One triggered economic regress in that it led countries everywhere to turn back to protectionism and also to bilateralism, a problematic combination that fundamentally confused the world market and impacted negatively on many countries' economic growth path well into the second half of the nineteenth century.[4]

---

[1] Henceforth, I will be referring to the war as "World War One".

[2] Cf. e. g. Ferguson (1998: 282–317, esp. 299), Winter (2012), and Prost (2014) on casualties among soldiers. Prost (2014) and Millward (2018) also discuss estimates of civilian losses; and Prost (2008) provides an example of a country-specific evaluation (here for France). Fundamental sources on POWs taken on both sides include Rachamimov (2002), Oltmer (2006), and Spoerer (2006, 2007). A fundamental source that all casualty estimates rely on in some way or another is the British War Office's *Statistics of the Military Effort of the British Empire During the Great War – 1914–1920* published in 1922. Moreover, Wilson/Prior (2001) and Little (2014) discuss the industrialized war; and Neiberg (2001, 2004) takes a broader perspective on World War One's place in the history of warfare.

[3] Cf. e. g. Garber/Spencer (1994), Wolf et al. (2011), and Rauchensteiner (2014).

[4] Cf. e. g. Eichengreen/Irwin (2010), Eloranta (2010), Wolf et al. (2011), Hynes et al. (2012), Jacks (2018), and Jacks/Tang (2018). Tooze/Fertik (2014) provide a somewhat deviating story

Figures 1 to 3 illustrate the point made on growth. Depicted in Figure 1 is the long-term evolution of real gross domestic product (GDP) per capita for three regions – Western Europe, the so-called Western offshots (including, especially, the United States), and Latin America.[5] A look at these regions, which comprise the majority of war parties, suffices to get a good impression of World War One's short-term as well as long-term effects on economic growth. While panel (a) depicts average GDP per capita over the long stretch of time between 1870 and 2016, panel (b) zooms into the period 1870 to 1950. This is for the obvious reason that post-World War Two growth rates were higher on average than pre-1950 growth rates. Any depiction of long-term economic growth up until the present, thus, visually marginalizes what was going on in the two world wars and the period in-between. Note that the period of World War One itself is grey-shaded.

On the one hand, the figure illustrates that the depicted regions experienced secular positive economic growth until 1914, yet on different levels of GDP per capita. Here, the First Age of Globalization – to refer to the widely accepted view among economic historians – leaves its aggregate imprint.[6] On the other hand, the figure also illustrates that Western European countries as a whole suffered considerably from fluctuations in economic growth – which is actually equal to saying: they suffered in terms of living standards – well up until 1950. The Western offshots – here, the US-development shines through, though, in the first place – faced their growth crisis between 1929 and 1933/35, in the time of the Great Depression.

---

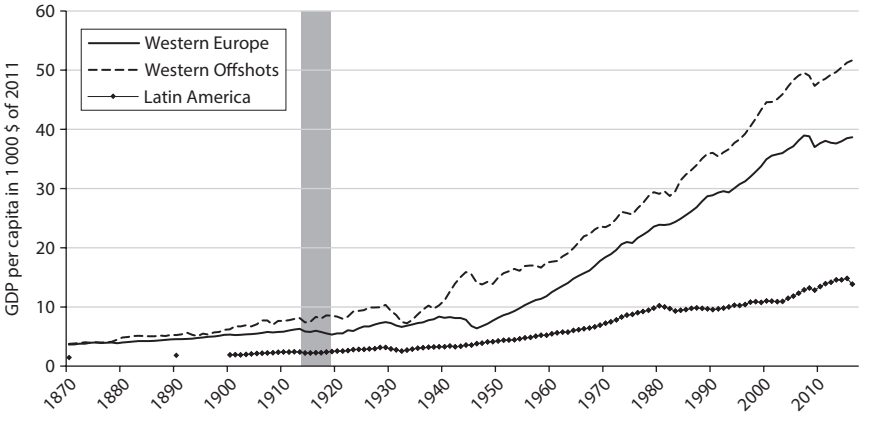
of the usual picture. It is certainly debatable whether commodity and financial markets saw the same degree of protectionism. From the angle of interwar German economic history, the fact alone that a considerable amount of foreign, and especially US-American capital flowed into the country after the implementation of the Dawes-Plan in 1924 suggests that financial markets were less impacted by protectionism; cf. Ritschl (2002) on the topic. When it comes to assessing World War One's effect on the global economy as well as on specific countries, Jordà et al. (2019) is an excellent source one should not miss. The paper's title – "The rate of return on everything, 1870–2015" – is pretty much self-explaining.

[5] The reason why I do not show series on regions like Africa or Asia is data quality; cf. the discussion of the Maddison Database, from which I took the data, in Bolt et al. (2018).

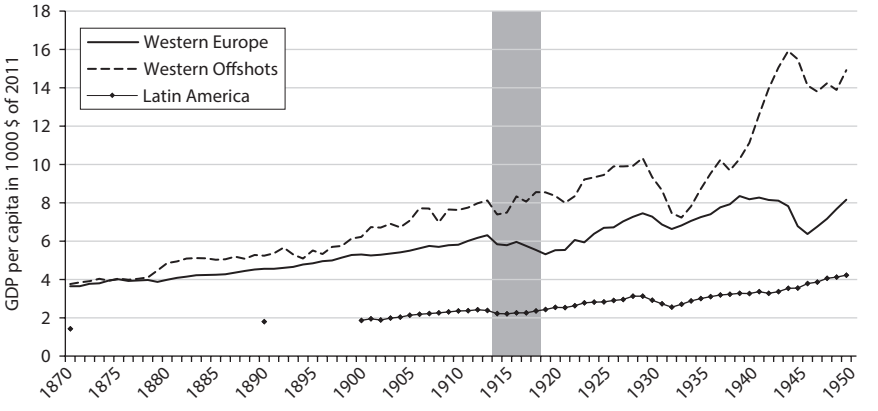
[6] Economic historians tend to locate the beginning of globalization at around 1820. The main argument is that since then, in the aftermath of the Napoleonic Wars and the Congress of Vienna, we observe what economic historians say is the essence of globalization (as a process, not as a state), namely that price differences for the same goods between markets all over the world began to fall. While we observe long-distance trade relationships to emerge and increase in number well before the nineteenth century, prices of (essentially) the same goods between two marketplaces far away from each other had not sufficiently converged, though. This view on the timing and essence of globalization is, of course, not unchallenged; cf. for example, Findlay/O'Rourke (2003, 2008), O'Rourke (2005), Choi/Dupont (2007), Dobado-Gonzalez et al. (2012), and especially the controversy between O'Rourke/Williamson (2002a, 2002b, 2004) and Flynn/Giráldez (2004).

Figure 1: Real GDP per capita for selected regions in the long term

(a) GDP per capita over 1870–2016



(b) GDP per capita over 1870–1950

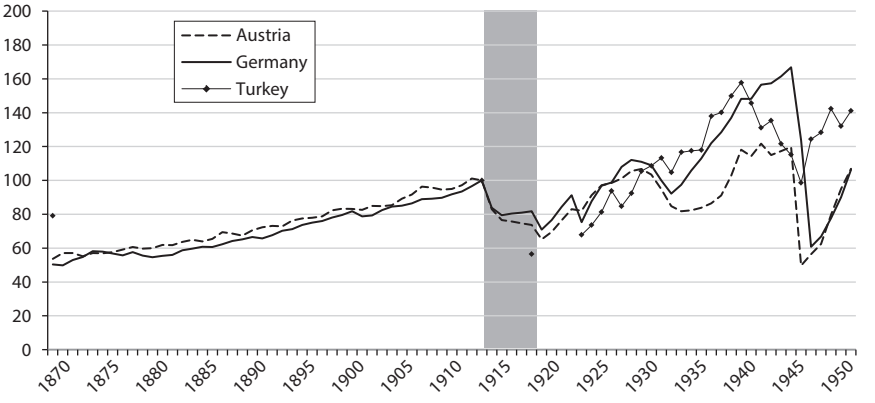


Sources: Maddison database available at https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2018, as updated and described by Bolt et al. (2018); accessed: 3 May 2019.
Notes: Depicted are the GDP series labelled "rgdpnapc".

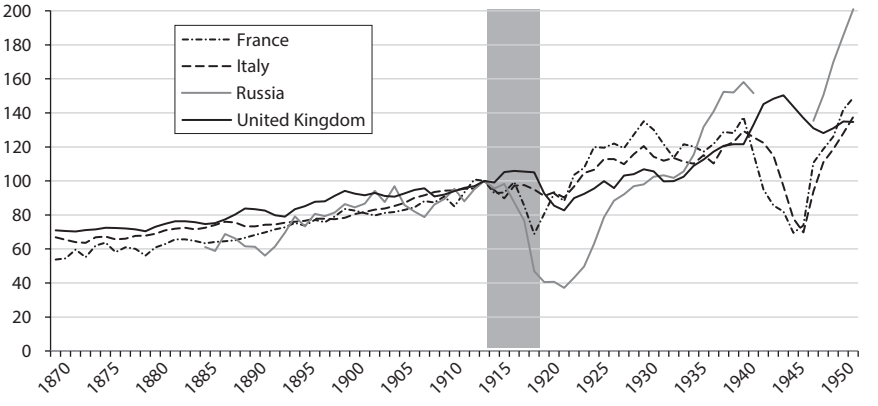
Figure 2 details the picture emerging for selected European countries. Panel (a) illustrates the fundamental break in the trend of economic growth coinciding with World War One for selected Central Powers, and panel (b) does so for selected Allied Powers. Turning to the upper panel first, the graphs imply that World War One was connected to decreasing economic growth in the short term and further stagnation in the long term. Germany, as one of the world's leading

Figure 2: Real GDP per capita for selected countries over 1870–1950 (1913 = 100)

(a) Selected Central Powers



(b) Selected Allied Powers



Sources: Cf. Table A.1 in online Appendix 1.1.
Notes: The underlying series are expressed in constant 2011 $.

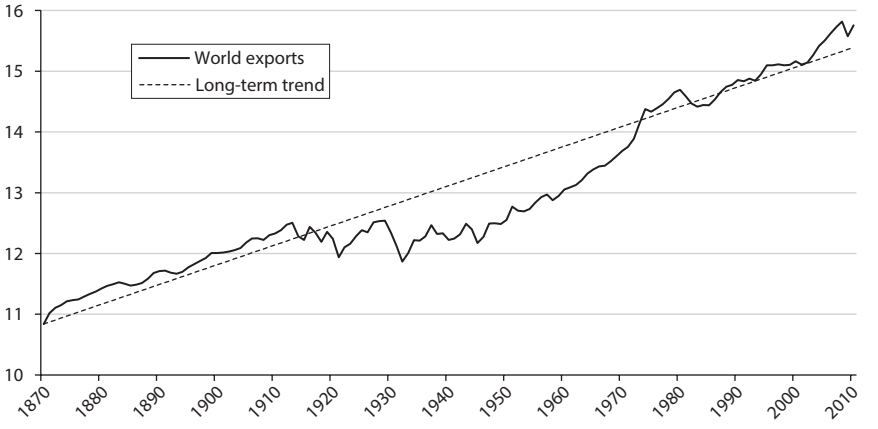
economies then as now, reached its long-term growth trend only in 1944, but with a highly deformed economy under the Nazis.[7] Regarding the lower panel, the victorious Allies like France and the United Kingdom also saw a break in trend growth that lasted for a long time.

Using recent data provided by David S. Jacks and John P. Tang, Figure 3 shows World War One's effect on world export volume.[8] In the short term, world

[7] Cf. Spoerer (2005) and Buchheim (2011).
[8] Cf. Jacks/Tang (2018).

export volume fell severely due to immediate trade disruptions caused by protectionist policies as part of the transformation of peace time economies into war economies, the Allied Naval Blockade of Germany, and German submarine warfare impacting on merchant shipping. In the long term, it took the world economy until the early 1970s to recover from the initial shock to the system, which was reinforced by the Great Depression and the even more devastating World War Two.[9]

Figure 3: World export volume over 1870–2010



Sources: Data are from Jacks and Tang (2018). Data available at: http://www.sfu.ca/~djacks/data/publications/index.html; accessed: 8 May 2019.
Notes: Export volume is logged and in constant 1990 $. Note that the y-axis is cut.

Now, zooming in on World War One, its outbreak in late July 1914 put the European Great Powers, struggling for hegemony, to the ultimate test. The traditional view among historians, but also political scientists focusing on alliance research, is that it was primarily the mechanics of the international system of alliances established over the past decades that dragged so many countries into war. While this view has many times been challenged and does no longer reflect the mainstream, it is still a (simple) fact that alliances did form – two major ones with the Central and Allied Powers, and many more in detail – and that these alliances exhibited their very own dynamic over the course of the war, propelled by each player's very own geopolitical and economic interests.[10] Following the assassination of Archduke Ferdinand on 28 June 1914, which many may not have

[9] Cf. Jacks (2018) for a more detailed discussion. Kenwood/Lougheed (1999) provide a long-term view.

[10] Cf., among others, Kennedy (1976, 1980, 1984, 1989), Levy (1981, 1990/91), Sagan (1986), Williamson (1988), Geller/Singer (1998), and Levy/Thompson (2010).

expected at the time to cause more than another localized conflict in the Balkan, the world witnessed the ultimate escalation of persistent, latently smoldering hostilities. According to recent work of Christopher Clark and Roger Ransom, in particular, a mix of negligence and inclination to gamble on collective and personal ego may best explain the sudden switch from peace to war mode.[11] The pre-war "arms race" had equipped the Great Powers with enough military capacity to at least take that initial step and hope, individually, for a quick victory.[12] Breaking down the pre-war odds of winning the war to a comparison of the alliances' resource endowments, the victor seems to have been fixed from the start.

Table 1 illustrates this reasoning by assembling some basic statistics on the major powers' starting positions around 1913/1914. Presented are figures on economic performance in the form of GDP per capita, public debt, population, and peacetime strength of land as well as naval forces. The latter is approximated by the count of existing plus projected (super-)dreadnoughts.[13] The degree of a state's indebtedness, for example, gives an impression of the players' room for financial maneuvers – the UK and Germany certainly had the greatest. However, in terms of the peacetime strength of military forces, which is indicative of what pressure a player may immediately put upon its opponents, and of population, which is indicative of the potential to levy an army in the medium term, the Allied Powers clearly dominate the picture.[14]

Considering that many more countries would enter into the war on the side of the Allied Powers than would on the side of the Central Powers, the Allies' odds of winning could only rise alongside the growing resource base. Thus, it can be argued that the Allied Powers' victory did not, and does not, come as a surprise at all.[15] However, what principally does come as a surprise to us looking back is the war's length of more than four years; this element of self-perpetuation it has shown. Not only does this come as a surprise to us, thereby triggering immense academic effort to come up with explanations, but it also came as a surprise to the belligerents' ruling political and military elite who indulged in a "short-war illusion" based on, obviously, all kinds of wrong assumptions on

[11] Cf. e. g. Clark (2013) and Ransom (2016, 2018a, 2018b). Offer (1995) brings in "honor" which may be a reasonable addition to negligence and ego (or confidence).

[12] Cf. e. g. Geyer (1984), Herrmann (1996), Reinschedl (2001), Stein (2007), Eloranta (2013: 71–81, 2018).

[13] On the importance of the dreadnought as a "breakthrough technology", cf. Herwig (1991).

[14] Cf. Thies (1987: 308–309), Broadberry/Harrison (2005: 7–10), and Broadberry (2018: 77–82) for similar overviews. Offer (2018) extends the view on energy, food, and technology. On the link of maritime warfare with coal, cf. specifically Goldrick (2014).

[15] We may ask ourselves whether this setting was already known to the political and military leaders at the time – if not to the public as a whole. I think, at least, political and military leaders had a good chance to know about that, because my source for population figures and the military forces' strength, which is *The Statesman's Year-Book*, is a contemporary source.

Table 1: Main belligerents' characteristics before the outbreak of World War One

Player	GDP per capita (1999 Int. $)	Public debt (in percent of GDP)	Population (in 1 000)	Peacetime strength of land forces (no. of soldiers in 1 000)	Peace time strength at sea (no. of [super-] dreadnoughts)
United Kingdom	4 921	27.9 %	46 090	730	26
France	3 485	66.3 %	39 602	705	4
Russian Empire	1 414	48.8 %	128 865	>1 200	4
			214 557	*>2 791*	*34*
German Empire	3 648	38.5 %	67 812	623	17
Austria-Hungary	3 465/2 098	63.3 %	49 883	368	2
Ottoman Empire	1 213	n/a	21 280	230	1
			138 975	*1 441*	*20*

Sources: GDP: Maddison database available at https://www.rug.nl/ggdc/historicaldevelopment/maddison/re-leases/maddison-project-database-2018, as updated and described by Bolt et al. (2018); accessed: 3 May 2019. Public debt: Abbas et al. (2010) and Historical Public Debt Database available at https://www.imf.org/external/datamapper/datasets/DEBT; accessed: 14 May 2018. Population and strength of military forces: The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1913 and The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1916 (1913/1916: 53–55, 616–617, 796–798, 871–872, 1 201–1 203, 1 309–1 311).
Notes: GDP and public debt figures are for 1913. Population figures are for 1914/15. Colonial population is excluded. Population of Russia and strength of Russia's land forces refer to its European part. Peacetime strengths refer to 1912/1913.

political, diplomatic, military, and economic matters. The widespread belief that war would be decided rather quickly did not prove to be successful. The war developed into a "war of attrition" characterized by trench warfare and a long-term deadlock.[16]

Besides exploring economic factors that may have had an effect on the belligerents' decision to go to war[17] and besides putting World War One in a long-term perspective regarding economic growth and development[18], explaining the length of the war has been a third natural endeavor for the economic historian. For the war has impressively shown that relying on a comparatively richer (smaller) resource base – with resources defined broadly – does not automatically lead to quick victory (defeat). Rather, what matters is the ability to effectively draw on

[16] Cf. e. g. French (1988) on attrition, and Farrar (1973), Herwig (2002), and Lambert (2012) on the short-war illusion.
[17] Cf. e. g. Offer (1989, 1995, 2018), Ferguson (1994), Crafts (2018), Eloranta (2018), James (2018), and Milanovic (2018).
[18] Cf. e. g. Dub (1920, 1922), Winkler (1940), Markevic/Harrison (2011), Foley-Fisher/McLaughlin (2014), Smith et al. (2016), Rockoff (2018), and Vonyó (2018).

the resource base, that is, the ability to efficiently allocate whatever resources to their best uses. In other words, it is a matter of installing and operating well-working war economies under numerous resource constraints. Economic historians have shown that the Great Powers' economies, when war broke out, were not up to the task, were economically not prepared for war. They also have shown that, apart from initial ad-hoc measures like suspending the gold standard and thereby empowering central banks that had formerly been restrained by the gold cover and convertibility rules to endlessly print money, states exerted serious efforts on transforming the peace into war economies only since the turn of 1914/1915. The belligerents were realizing that they had been taken in by a "short-war illusion".[19]

So far, these are the more obvious points at which economic historical research can connect with general historical research. The latter has produced a vast amount of literature we may conveniently reduce likewise into three main subjects, namely literature on why World War One happened at all[20], literature on how the belligerents managed to keep it going and make it so bloody a war[21], and literature on how the war was perceived in contemporary public opinion which, in turn, might well have impacted on political and military decision-makers and -making. Much of economic historical scholarship falls into the first two main subjects. However, a maybe not so obvious point, at which economic history – or more precisely: economic historical research grounded more rigorously in economics – can also connect with general historical or also political science research on World War One is the third main subject. To explore such a way is what this study is about.[22]

The war in public opinion is a persistent topic in the historiography of World War One. However, scholars have been interested especially in how the public perceived the outbreak of the war. Regardless of whether or not war had come as a surprise to the general public, there is a consensus that it provoked ambiguous feelings on all sides, ranging from sheer enthusiasm to the greatest

[19] Two fundamental works on the economics of World War One are the collective volumes edited by Broadberry/Harrison (2005, 2018). Regarding this paragraph, cf. e. g. Broadberry/Howlett (2005) on Britain's war economy; Galassi/Harrison (2005) on the Italian one; Gatrell (2005) on the Russian one; Hautcœur (2005) on France's one; Ritschl (2005) on the German one; Pamuk (2005) on the Ottoman one; Rockoff (2005) on the US one; and Schulze (2005) on Austria-Hungary's one. Further literature on the subject matter include, among others, Feldman (1966, 2008), Wegs (1979), Hardach (1987), Zilch (1987), Wrigley (2000), t'Hart (2014), Plumpe (2015), Wixforth (2015), Ziegler (2015), Harrison (2016, 2018), Seligman (2017), Jopp (2018b), and Markevich (2018).

[20] Cf. e. g. Berghahn (1973, 2013), Farrar (1981), Sagan (1986), Henig (1993), Ferguson (1994), Remak (1995), Rotte (1998), Fromkin (2004), McMeekin (2011), Clark (2013), MacMillan (2013), Neiberg (2013), and Hamilton (2014).

[21] Cf. e. g. Hardach (1987), Wehler (1994), Herwig (1997), Ferguson (1998), Keegan (1999, 2003), Chickering/Förster (2000), Stevenson (2005, 2012), Beckett (2007), and Neiberg (2007).

[22] Recent surveys of research on World War One include Thiemeyer (2007), Chickering (2009), Angelow (2011), Meteling (2011), Eloranta (2013), Kramer (2014a, 2014b), Epkenhans (2015), Neitzel (2015), and Müller (2016).

anxiety. One much debated topic is the seemingly widespread phenomenon of *war fever* among the populations in the initial phase. Beyond the "spirit of 1914" phenomenon, to refer to the main title of Jeffrey T. Verhey's study of 1991 on Germany[23], the literature has been debating on the more general questions as to what extent a population's confidence in its own country's ability to win the war changed as time passed and of how the efforts of "enemy populations" were assessed.[24] The historical picture emerging in this context depends on the type of historical source evaluated – a point taken up again in a few lines – and the class of population addressed.

As yet, it has not been attempted to any significant degree to *quantitatively* measure: (i) how the public perceived the course of the war and the belligerents' war effort; (ii) which single war or political event made – expectedly or unexpectedly – a large or little impression, especially over the "stalemate period";[25] (iii) how the alliances' publicly perceived odds of winning, so to say, changed with certain events; and (iv) at which point in time the public began to expect the end of the war to be near.[26] Indeed, this is pretty much impossible to measure for any country's population as a whole when aiming at maximum representativeness. However, it might be possible for sub-entities of the population. Here, this study comes into play. It sets out to assess public perception of the war through the lens of the capital market. It uses a hitherto largely neglected source for public opinion, namely the prices at which sovereign debt – specifically: the belligerents' sovereign debt – was traded *during* the war. Historical bond prices certainly are a natural study object of the economic historian/economist.[27] Yet, as far as public opinion research on World War One is concerned, their potential is, for the most part, unexploited.

I will be looking into the development of sovereign bonds traded at one of the few trading places that actually offer useful data for the period of World War One, at all. This will be the trading place of Amsterdam, located in the Nether-

[23] Verhey (1991). Cf. also Tuchman (1962, 1964), Dülffer/Holl (1986), Kruse (1991), Van der Linden (1991), Van der Linden/Mergner (1991), Joll (1992: 199–233), Fries (1994), Geinitz (1997, 1998), Hirschfeld et al. (1997), Raithel (1997), Rohkrämer (1997), Ferguson (1998: 174–211), Sanborn (2000), Bruendel (2003), Gregory (2003), Pennell (2012), and Becker (2015).

[24] Cf. Recktenwald (1929), Hicks (1949), Mommsen (1969), Dahlin (1971 [1933]), Hanak (1962), Flood (1990), Daniel (1993), Krumeich (1993), Quandt/Schichtel (1993), Schichtel (1993), Fries (1995), Buschmann (1997), Kruse (1997), Ziemann (1997), Glant (1998), Stöber (1998), Paddock (2004), Silbey (2005), Ziemann (2007), Gregory (2008), and Walker (2008).

[25] The literature generally agrees that this was the stretch of time between early to mid-1915 and late 1917 to early 1918.

[26] The little effort spent on this as yet comes in the form of economic historical studies to be discussed in more detail later; cf. Hall (2006), Oosterlinck/Landon-Lane (2006), Christodoulaki et al. (2012), Jopp (2014, 2016, 2018a), Adams (2015), Hanedar et al. (2015), Oosterlinck (2016), et al. Hanedar et al. (2016), Hanedar/Yaldiz-Hanedar (2017), Duarte et al. (2018), Hanedar et al. (2018a, 2018b), and Schaltegger/Schmid (2019).

[27] Cf. Ferguson/Schularick (2006), Flandreau/Flores (2009, 2012), Sicotte et al. (2010), Edlinger et al. (2013), Weller (2015), Reinhart/Trebesch (2016), and Basile et al. (2017).

lands which remained neutral throughout the war. By the turn of 1913/1914, Amsterdam had grown into *the* national financial center of the Netherlands, outperforming Rotterdam, and was about to become a major international financial center, too, thanks to the war;[28] the stock exchange, which is quite old, formed the financial center's core. If we follow Lodewijk Petram (2014), its origins can be traced back to the seventeenth century making the Amsterdam Stock Exchange, in fact, the world's oldest *permanently* operated stock exchange.[29]

Sovereign bonds represent a form of tradable credit supplied by the general public to states. The prices quoted at the Amsterdam Stock Exchange over a considerable stretch of time during the war can be interpreted as a real-time opinion poll conducted among contemporary investors or, respectively, bondholders as to how the debtor countries were faring in their eyes. This measure of public opinion has certain advantages over the historian's principal sources on the subject matter, the probably biggest one being that it condenses the perception of a principally large number of (anonymous) market participants into a single measure, readily observable for Amsterdam on a *daily* basis. Hence, we are dealing with a sort of true mass data on public perception.

This begs the question of which people's perception we are exactly dealing with here. Who were the investors that traded sovereign debt at the Amsterdam Stock Exchange? I will address this question in more detail in Chapter II, as part of a source critique on my quantitative data. However, to give a preview, we can, with some certainty, say this: (i) Securities – stocks and bonds – made up a larger proportion of Dutch people's wealth than we find elsewhere, for similarly developed economies; (ii) Thus, there likely were relatively more individuals among the investors (in distinction to institutional investors); (iii) These individuals were likely made up to a larger extent of middle-class households (in distinction to upper-class households); (iv) The proportion of foreign investors (in distinction to domestic investors) actively trading securities decreased, compared to the pre-war situation; (v) But there still were foreigners active, not the least because Amsterdam served as a safe haven for foreign capital. Beyond that, and

[28] This section is fundamentally based on Brenninkmeyer's account of 1920 which, to the best of my knowledge, is still the most comprehensible (non-Dutch) account on the Amsterdam Stock Exchange as of 1914. According to Brenninkmeyer's (1920: 48) assessment, the Amsterdam Stock Exchange represented a "strongly English influenced transition stage" ("[…] stark englisch orientierte Übergangsstufe […]"), that is, it resembled the London Stock Exchange in organization.

[29] Cf. e. g. Petram (2014). The literature on the Amsterdam Stock Exchange includes Brenninkmeyer (1920), Neal (1987), Euwe (2009, 2010), Koudijs (2015), and Norman/Wills (2015). On the rise of stock exchanges in the nineteenth century and in the first half of the twentieth century, cf. e. g. Croner (1923), Snowden (1987, 1990), Häuser (1988), Gömmel (1992), Michie (1999, 2004a, 2004b, 2006a, 2006b, 2010), Hickson/Turner (2005), Grossman/Shore (2006), Kiehling (2006), Van Nieuwerburgh et al. (2006), Oosterlinck (2010), Le Bris (2012), White (2013), Mikkelsen (2014), Buchner (2017, 2019), Grossman (2017), Hannah (2017), and Odlyzko (2017).

most importantly, there is suggestive evidence that the specific major players' sovereign bonds that I will be analyzing in detail were, indeed, traded by domestic investors rather than by foreign investors. This is to say, by tendency, we do get the intended neutral's view on the course of the war.[30]

Up to here, this study's objective, which is based on the basic premise that sovereign bond prices help us explore public perception, certainly is all but self-evident. The remainder of this introductory chapter is intended to clarify the points brought up so far before the actual empirical analysis starts with Chapter II. The following Subchapter I.2 briefly reviews the sources historians have consulted to assess contemporary public opinion on World War One. We actually do find a capital market-related source in the array of sources applied, namely war loans and the corresponding documentation. But the material on them has not been used in a fashion comparable to the one put forward here. Knowing the standard sources from which to construct public opinion is the basis for discussing the nature of sovereign bond prices as a completely different source in Subchapter I.3. Its usefulness follows from the specific economic logic behind sovereign bond prices in contrast to the logic behind other sorts of securities. Put differently, we do need an economic model of thought telling us how to interpret bond prices *most basically*. This analytical frame will also help us to identify the principle pros and cons of the approach that have to be kept in mind. I will also discuss how to deduce perception from sovereign bond prices in a practical-statistical way. The basic idea of the whole approach is "to let the prices speak for themselves" as to when events occurred that mattered for investors. This approach stands diametrically opposed to the *classic* event study, where events of interest are fixed beforehand and where the researcher then looks at how prices behaved around the pre-specified event dates and whether they show some extraordinary pattern. Finally, in Subchapter I.4, I will lay out the plan for the remainder of this study. As part of outlining the study's design, I will briefly discuss why the marketplace of Amsterdam is actually a reasonable, if not the best, choice as supplier of the required data. The chapter closes with placing this study in the relevant literature.

2. The war and sources on how it was perceived by the public

The subject of public opinion, or perception, is not easy to grasp. Beyond more technical questions like how large the proportion of a group of people has to be in order to be seen as a reflection of *public* opinion, it is not easy to grasp because

[30] It goes unmentioned here that analyzing the bonds that were more likely traded by foreigners than by domestic investors, in contrast, may give us a less biased picture of their opinion, too, since foreign traders did not face the same trading restrictions in Amsterdam than they would have at trading places in the belligerent countries, like London, Paris, or Berlin.

many concepts can be subsumed under it. These concepts overlap to a large extent but they also, each, bring in a distinct element at the same time. We can infer this from the terms used in the literature: "morale", "mood", "mentality", "propaganda", and "experience".[31] The common trait of all studies using one of these terms or the term "public opinion" is that what is under scrutiny is the views of an explicitly defined and clearly distinguishable group of the population, or of a somewhat diffuse yet representative part of it, on the war and on what it does to one's living conditions, to one's person, and to the society. There are, however, differences in the detail. Regarding the topic "propaganda", for example, weight is put on the aspect of how the ruling elite or, respectively, the government wants to influence views held by the public in its own interest. And while the topics of "morale" and "mood" rather center on ad-hoc emotions, the topic of "mentality" rather explores long-term pre-dispositions prevalent in a population as a whole towards thinking and feeling in a certain way (which determines how a population may react in the short term to some event; cf. the "spirit of 1914" discussion).[32]

Following Ebba Dahlin's early study of 1933 on French and German public opinion on declared war aims, we may say that

> [p]ublic opinion is a variable and changing thing. It is even difficult to say whether public opinion exists as such or whether it may not be better to say public *opinions*, since there are very few issues on which an entire people become united. Instead, different groups within a nation hold different views on the same issue in accordance with the particular bundles of prejudices and ideals which severally dominate them.[33]

We may also say that "[o]nly in times of great stress and for short periods can it be said that a nation is united in its views on a particular issue. Unanimity is apt to exist in war time more than under any other circumstances. […]."[34]

Basically, we may define public opinion, or perception, as the views held by a large part of the population on matters of public interest. It is not necessary for public opinion to exist in a way that implies unanimity in views across all groups of the population. Different views may exist, but each is characteristic for a considerable number of people. Public opinion is about the views held

[31] Cf. e. g. Dülffer/Holl (1986), Höffler (1997), Stöber (1998), Watson (2008: 140–183), Bauerkämper/Elise (2010), Monger (2012), Becker (2015), Ermacora (2015), and Demm (2017).

[32] Cf. e. g. Verhey (1991) and Van der Linden (1991). In this context, it seems reasonable to take the distinction between "opinion" and "attitude" into account following, for example, Benson (1969: 25). While "opinion" "[…] always connotates a *position* on some specific government action or general course of action [;] an attitude represents a persistent, general *orientation* toward some individuals, groups, institutions, or public processes, but it does not necessarily result in a specific position on specified public issues." Insofar, the issue of mentality might be seen as something completely different as it is basically about such attitudes. However, once these attitudes are reflected in opinions on whether the outbreak of war is to be welcomed or not, mentality certainly has an effect on public opinion.

[33] Dahlin (1971 [1933]: 9).

[34] Dahlin (1971 [1933]: 9).

as well as about the ways in which these views are controlled or influenced by some authority. Or, to use Kann's (1969) definition, which he labels the "simplest workable formulation of its [i. e., public opinion's; the author] meaning": "Public opinion is the aggregate of the views men have held regarding the evolution of their social institutions and the current matters that affect or interest the community."[35]

Historians have consulted an array of different sources to assess the views held on World War One. What principally complicates the matter of deducing views held by a group of people from any source is that we may separate for analytical purposes between the formation of public opinion, the distribution of public opinion, and the impact of public opinion upon the authorities.[36] There may be sources which affect more than one of these aspects, making their interpretation an especially challenging task. Newspapers or, more generally, press releases, for example, seem to come with that basic challenge, because they distribute views held in the population just as they create views that the wider public may adopt.[37]

Common sources of the historian to assess public opinion on the course and impact of World War One may include such diverse written sources as: (i) Newspapers and other journalistic products, addressing civilians or meant to address soldiers, in particular.[38] (ii) Poetry, as a means to study opinion among intellectuals which, in turn, may affect the opinion of the "final consumer".[39] (iii) Individual, or ego, records such as letters, postcards, diaries, and memoirs produced by civilians but also by soldiers.[40] Or (iv) official publications by the authorities as, for example, pamphlets or posters to advertise war loans, or minutes of parliamentary debates.[41] Principally, this enumeration can be expanded by non-written sources like photos and film and voice recordings.[42] The range of societal subgroups addressed may follow some baseline concept of social stratification (e. g., rural versus urban; or white-collar versus blue-collar workers versus intellectuals), or may follow a "functional division" like civilians versus soldiers versus politicians.[43]

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[35] Kann (1969: 65).

[36] Cf. Benson (1969: 32).

[37] Cf., exemplarily, the discussion in Schulz (2000) on the ambivalent nature of the press.

[38] Cf. e. g. Rudolph (1997), Stöber (1998), Paddock (2004), and Nelson (2010).

[39] Cf. Hüppauf (1984: 155–230) and Fries (1994, 1995).

[40] Cf. e. g. Fischer (1993), Reimann (1997), Ullrich/Ziemann (2010), Didczuneit et al. (2011), Hanna (2014), Lengel (2015), and Isherwood (2016).

[41] Cf. e. g. Kilian (2008), Bruendel (2010), Aulich (2014), and Badsey (2014).

[42] Cf. e. g. Stöber (1998) and Roberts (2014).

[43] Cf. Lipp (1997) for a focus on soldiers. The typical source mix is to be found, for example, in the bibliography to Ebba Dahlin's (1971 [1933]: 8) study. Among others, it contains works subsumed under "Parliamentary Debates", "Newspapers", "Humorous Periodicals", "Society Publications", "Personal Accounts", and "Works of Statesmen, Diplomats, and Military Authorities".

There is one source that historians have examined to some extent to get a hold of public opinion that principally falls into the range of "capital-market-related sources of perception" and, thus, links especially up with this study, namely war bonds. It is fascinating to see that contemporary observers from Germany, for example, already interpreted the subscription results of the nine war bond issues between September 1914 and September/October 1918 as a mirror of the "persistently good" mood in the population.[44] In their eyes, the "long-term morale" of the German population – the home front, so to say – was still intact until very shortly before Germany's defeat. For reasons of propaganda or because they truly believed so, contemporaries predominantly highlighted the "outstanding success" of the war bonds, only interpretable as showing widespread confidence among the population in its political and military authorities and in the path those few had chosen for the many.[45] Take as an example Walter Klebba's statement of 1920 as part of his important contemporary publication on the Berlin Stock Exchange and the German capital market during the war: "On closer consideration of war bonds, it is the incredibly high amount subscribed in this class of security that arouses our attention. National wealth has been mobilized to a hitherto unknown extent."[46]

Another contemporary, Heinrich Charles, secretary of the German-American Chamber of Commerce by trade, had commented on that phenomenon already in 1916, reviewing the first four issues: "The increase in the number of subscribers shows that the bonds, issue by issue, become more popular; proof that the German people's confidence in victory and the will to make sacrifices rises as war proceeds."[47]

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[44] Excellent contemporary sources on the major European powers' war bond issues are the articles by H. Köppe published in *Weltwirtschaftliches Archiv*; cf. Köppe (1916a, 1916b, 1916, c, 1916d, 1916e, 1918a, 1918b, 1918c, 1919). For further overviews on German and other war bonds, cf. Hantos (1916), Mrha (1916), Rademacher (1916), Fontanari (1918), von Mises (1918), Reichsbank/Nachrichtenbüro für die Kriegsanleihen (1918), Hinnen (1923), Pessina (1923), John (1924), Wanner (1979), Winkelbauer (2004), Kang/Rockoff (2006), Kimble (2006), Butkiewicz/Solcan (2016), Hanedar et al. (2018a), and Fast (2019: 59–66); on war finance, cf. also Landmann (1915), Winkler (1940), Ruedorffer (1968), Kindleberger (1984a, 1984b), Balderston (1989), Neal (1994), Kool (1995), Voth (2000), Burhop (2011), Lampe (2012), and Hardach (2014, 2015).

[45] I abstain from citing from each and every contemporary publication on German war bonds to prove this point. The way of seeing the subscription results is overwhelmingly positive no matter if the publication is by a politician or some other observer; cf. Helfferich (1914), Riesser (1914a: 4, 1914b, 1914c) Kleindienst (1915: 276, 279), von Roy (1915: 8–9), Vogel (1915: 747), Wolf (1915: 3), Köppe (1916b: 321–322), Ottsen (1916: 2), Vogel (1916/1917: 247), Waltershausen (1916: 16) von Roy (1917: 7, 13), Erler (1918), Köppe (1918c: 167–168), Bendixen (1919: 21), Schmitt (1922: 53–54), and Hinnen (1923: 60–63).

[46] Klebba (1920, 141). This is my own translation of the German original: *"Bei der Betrachtung der Kriegsanleihen erregt in erster Linie unsere Aufmerksamkeit die ungeheure Höhe der Beträge, die in dieser Effektenart verkörpert sind. Das Volksvermögen ist in einem bisher nicht gekannten Maße mobilisiert worden."*

[47] Charles (1916: 12). This is my own translation of the German original: *"Die Steigerung*

Table 2: Subscription results of German war bond issues

War bond	Issued over…	# of pieces subscribed	Nominal amount in marks	Real amount in marks
I.	10 Sep – 19 Sep 1914	1 117 235	4 460 701 400	4 360 411 926
II.	27 Feb – 19 Mar 1915	2 701 060	9 060 000 000	7 341 977 310
III.	4 Sep – 22 Sep 1915	3 966 418	11 984 000 000	8 185 792 350
IV.	4 Mar – 22 Mar 1916	5 529 645	10 712 914 400	6 797 534 518
V.	4 Sep – 5 Oct 1916	3 809 976	10 651 726 200	5 379 659 697
VI.	15 Mar – 16 Apr 1917	7 063 347	13 122 069 600	6 278 502 201
VII.	19 Sep – 18 Oct 1917	5 530 285	12 625 660 200	5 372 621 362
VIII.	18 Mar – 18 Apr 1918	6 896 901	15 001 425 400	5 080 062 784
IX.	23 Sep – 23 Oct 1918	2 742 446	10 443 012 300	4 501 298 405
Total		*39 167 313*	*98 061 509 500*	*53 297 860 551*

Sources: Number of subscriptions and nominal amount subscribed: Lotz (1924a: 236–238, 240) and Lotz (1924b). Cost-of-living index: Morawietz (1994: 346).
Notes: Nominal values are deflated with the respective monthly cost-of-living index (1913/1914 = 100). In case the subscription period covers two months, the cost-of-living index was arithmetically averaged beforehand.

For illustrative purposes, Table 2 informs on the aggregate subscription results of the nine German war bond issues.[48] The size of the pieces ranges from 200 marks or less up to single pieces of one million marks or more. In all, cumulatively, Germans subscribed for pieces of 98 billion marks in current prices, and the amount per bond issue indeed rose up until the eighth issue of 1918 which coincides with the start of the German spring offensive. In real terms, however, the extent of wartime inflation strips the success story of German war bonds stylized by contemporaries a bit of its success; note the column on the far right.[49]

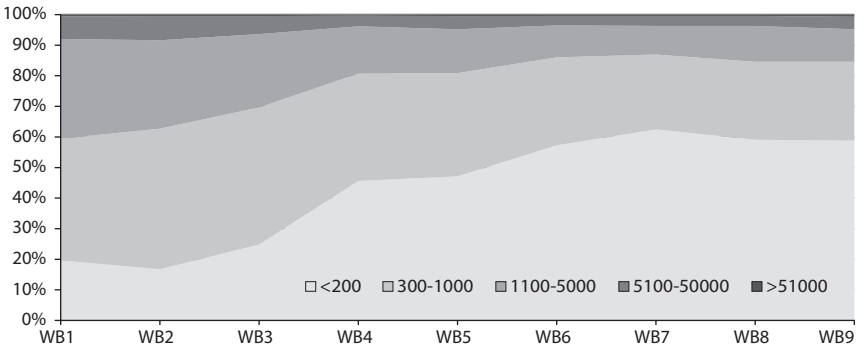
Principally, another way of assessing the war bond issues' meaning for the mood in the population is to trace the evolution of nominal amounts of the bonds subscribed over time or of the relative share of the number of subscriptions for the lowest denomination – i. e., that of less than 200 marks per piece. I opt for the second measure, as the sheer amount subscribed in that size class surely depended on the subscribers' economic circumstances and might thus not be too informative at all. What is informative is that the proportion of subscriptions

der Zahl der Zeichner zeigt, daß die Anleihen von Ausgabe zu Ausgabe volkstümlicher werden; ein Beweis, daß die Siegeszuversicht und die Opferwilligkeit des deutschen Volkes über das Fortschreiten des Krieges zunimmt."

[48] To the best of my knowledge, the war bonds' prices – apart, of course, from the initial offering price – were not published. However, we know from Kronenberger's (1920) seminal study that a lively grey market emerged as a substitute for official trade via the stock exchange during its closure. So, it is not too far-fetched to assume that part of German bondholders effectively traded the war loans. Unfortunately, there are no sources left to verify; cf. Kronenberger (1920) and this study's Chapter II.

[49] Cf. Fast (2019: 61–66) for a brief discussion of the war loans' characteristics.

Figure 4: The proportion of subscriptions by size of piece



Sources: Cf. Table 2.
Notes: "WB" is "war bond". The periods over which the bonds were issued are given in Table 2. Size classes are based on the denomination of the pieces in mark. Originally, Lotz (1924a) reported 12 size classes of pieces.

of 200 marks and less did increase enormously over the nine war bond issues. This development is depicted in Figure 4.

One might indeed interpret the subscription results as drawing a positive picture of confidence, at least until before the very last war loan issue. This works as long as we can assume that this size class, in particular, somewhat reflects the engagement of the low- and medium-income masses. If we take Konrad Roesler's assessment seriously that "[...] virtually all parts of the population were involved in the raising of funds"[50], then it indeed seems as if the mass was gaining evermore confidence in Germany's ability to be victorious.[51]

Some observers hastened to add that subscribing war bonds was not a matter of force by the authorities, but rather must be considered an act of voluntariness.[52] We might use the term "patriotism" here which, by all accounts, is biased perception when it comes to generate an unemotional, level-headed picture of how the course of the war was perceived by the public in real-time. Here, recent

[50] Roesler (1967: 166). This is my own translation of the German original. However, note that, according to Burchardt (1974: 89), members of the working class should not be considered part of the "mass" since they predominantly abstained from subscribing. Since living conditions deteriorated as war proceeded, this should not be surprising, at all.

[51] To be fair, a piece of bond of 200 marks nominal equals around a fifth of the average employee's annual wage in 1914. If we follow Hohls (1991: 89, Table 2.11), the average employee across all sectors earned 1 010 marks in 1914; the average employee in industry 1 064 marks. Broken down by status, the average blue-collar worker earned 845 marks, and the average white-collar worker 1 634 marks. For sure, buying only one small piece of bond already implied a serious financial transaction that the ordinary employee had to make to act patriotically. Insofar, we may indeed doubt that especially the low income masses were part of the greater effort.

[52] Cf., for example, Riesser (1914c).

historical research on war bonds comes into play. For research on advertisement of German war bonds in combination with research on war-induced financial regulation suggests that "visual persuasion", at least from the fourth war bond issue onwards, and the simultaneous cutting of investment alternatives (e. g., stock exchange closures!) definitely played an important role in giving people the necessary nudge, so to say, to act patriotically and help finance war by lending to the empire.[53] This reasoning certainly puts the assumed "act of voluntariness" into perspective.

3. Capital market data as an alternative indicator of perception

3.1. Bond prices – how new an indicator?

What all presented sources have in common, if we leave out quantitative information on war bonds, is that they are qualitative in nature. Except for the few attempts to measure perception of the course of World War One coming from the economics/economic historical literature (cf. below and Subchapter III.2), *statistical sources* of the historian have not yet been explored as to the possibility of measuring public perception of World War One.[54] But even if we started from qualitative data, it would principally be possible to analyze them in a quantitative framework, so as to condense qualitative information into a quantitative index of perception of some subgroup of the population. Research on World War Two has shown how this issue can be approached and that there principally is a desire for quantitative measures of perception among historians.[55]

In contrast to the common source base, this study uses capital market data – specifically: sovereign bond prices – to an unprecedented amount to infer public opinion on, or perception of, the course of World War One. At face value, there is actually a long-standing interest in analyzing sovereign bond prices as reflecting condensed historical information on capital market players' perceptions of war as well as political and economic events. Therefore, it is all the more surprising that this kind of source has been largely neglected in recent research on World War One.

[53] Cf. Kilian (2008) and Bruendel (2010) for the German case; and Kimble (2006) for the US case.

[54] Cf. Jopp/Spoerer (2017: 11–13) for a definition of the term "statistical source".

[55] Here, one may think of Aly's (2006) collection of essays putting forward ways in which public opinion on World War Two can be quantitatively measured departing from qualitative data. The approaches presented in Aly (2006) certainly benefit from the fact that the Third Reich was pervaded through and through by ideology such that contrasts – i. e., deviations from the way the authorities wanted people to see things – have been easier for the historian to spot. Cf. also Wolffsohn/Brechenmacher (1999) on the "first name approach" to measuring public opinion; their long-term study also covers World War One and provides the basis for one essay in Aly (2006).

The use of bond prices to infer investor opinion can be traced back to at least the middle of the nineteenth century. In the introduction to his *Manuel du Spéculateur à la Bourse* (1857), Pierre-Joseph Proudhon, the well-known liberal socialist and intellectual opponent of Karl Marx, relates price changes of a 5 % French sovereign bond to events around the reign of Napoléon Bonaparte; to the Napoleonic Wars, Napoléon's interim exile on the island of Elba, his unsuccessful return to power, and his final exile on the island of St Helena. What is more, he argued that capital market players had perceived Napoléon to be increasingly intolerable which was reflected in falling prices. In fact, the evermore skeptical capital market had helped to effectively undermine the foundation, on which a further reign would have rested. According to Proudhon, it had been the bad mood in the capital market that helped induce Napoléon's ultimate fall.[56]

Another example of an early bond price event study is Eleanor Kerr's of 1917 in which she relates nineteenth and early twentieth century bond prices of countries around the world, including the great European players and the United States, to measures of the governments' indebtedness, especially during periods of war.[57]

As a third example, take Willy Krebs's study of 1919. He likewise linked up changes in bond prices – prices of Prussian government and of *Reich* bonds – with special events in the nineteenth century, such as the period of the Napoleonic Wars, the revolutionary year 1848, the final year of the Austro-Prussian War 1866, and the Franco-Prussian War of 1870/71.[58] He commented on the usefulness of bond prices in the following way:

> The price of government securities is such a tremendously sensitive yardstick of a population's morale that it instantaneously reacts, climbs up, or plummets with the least event that alters morale. Let this event be a domestic or foreign policy measure, or a financial or economic measure taken by the government, or an economic process. As the pulse beat of a population's political and economic life constantly strides up and down, the price is hardly stationary, but rather is subject to fluctuations.[59]

This view pretty much matches the idea that is at the center of modern *turning points analyses* which make use of statistical tools and computer power. All examples nicely show that taking specifically bond prices as a kind of real-time

[56] Cf. Proudhon (2009 [1857]: 18–19).
[57] Cf. Kerr (1917).
[58] Cf. Krebs (1919).
[59] Krebs (1919: 5). This is my own translation of the German original: "*Der Kurs der Staatspapiere ist ein so ungeheuer empfindlicher Gradmesser der Stimmung der Bevölkerung, daß er mit dem kleinsten, diese Stimmung ändernden Ereignis, sei es eine inner- oder außenpolitische oder finanzielle oder wirtschaftliche Maßnahme der Regierung, sei es ein wirtschaftlicher Vorgang, ebenfalls sofort sich ändert, steigt oder fällt, je nach der Art des Ereignisses. Und da der Pulsschlag des politischen und wirtschaftlichen Lebens eines Volkes ständig auf- und niedergeht, so steht auch der Kurs kaum still, sondern ist ebenfalls ständigen Schwankungen unterworfen.*"

opinion poll involving, by tendency, a mass of "interviewed" traders is not just a recent trend in economic history or economics, but a way of exploring historical phenomena that already fascinated (some) scholars long ago.

3.2. What do bond prices say?

A sovereign bond is a credit by the subscriber to the issuer, a certain country. In exchange for the credit granted to the borrower, the lender receives regular interest payments and, principally, receives back the amount of money lent due to stepwise or one-time redemption of the credit debt. More precisely, all bonds that are issued by a national government qualify as sovereign bonds. The bonds I will be analyzing in this study were almost all issued by the central government, the highest governmental level. A few were also issued by a sub-national entity that we may call "state", one level below the national level – e. g., the state of Prussia (German Empire) or of Minas Gerais (Brazil). What is below these highest levels of government is, in the terms of historical stock exchange handbooks, "provincial debt" or "municipal debt".[60]

Following from the discussion of early bond price studies in the previous subsection, we already get an impression of what sovereign bonds' prices say. They principally reveal information on the past development of underlying economic fundamentals: a country's financing capacity (e. g., absolute or relative tax revenue) which, in turn, depends on economic growth; the amount of accumulated debt and the modalities of debt service; a country's willingness to honor its debts;[61] domestic inflation; and exchange rates with foreign currencies, depending on, among other things, differential inflation, trade flows, and currency restrictions. Observing the past development of a country's economic fundamentals is important for an investor in order to form expectations on how fundamentals would develop in the nearer or farther future. In forming their expectations, investors certainly react to news on all kinds of events that may, in the end, affect the (*ex-ante*) probability with which sovereign debts would be served.[62]

A straightforward pricing model imposing some substance on what the economic and historical *subtext* of changes in bond prices might be will

[60] Cf. Ertl (1957) and also Schulz/Wolff (2009) for a focus on modern sub-national bonds.

[61] The literature distinguishes between a country's "capacity to pay" and its "willingness to pay", and both may well deviate from one another; cf. e. g. Ritschl (2002) on the reparation question after World War One.

[62] A point that I will touch on below is the efficient-market hypothesis. It basically says that in an efficient (securities) market, future price changes cannot be inferred from past price observations. To what extent present and historical markets can be called "efficient" is a persistent topic in economics and economic history. However, some readers may agree when I say that no human being, especially not an investor, is likely to stop trying to analyze the past for a clue on the future because there is that "efficiency issue" lurking around the corner which may formally render that undertaking obsolete.

help. Formally, a bond is a fixed-income security issued by the bond seller to obtain credit, (usually) assigning the bondholder entitlements to fixed regular interest payments over a certain time span.[63] We can take bond prices as saying something about the underlying asset – a corporation's or a country's long-run financing capacity, for example. Using the textbook definition, consider the price of a country's bond, *P*, at issuance as reflecting the net present value of all cash flows it will generate over its duration. Assume that the bond will be redeemed after a finite number of periods denoted by *t* so that it has a fixed duration of *T* years before it matures – e. g., thirty years after the initial issue. The price may be written as

$$P_0 = \sum_{t=0}^{t=T} \frac{(c * N) * (1-\beta^c)}{(1+r)^t} + \frac{N * (1-\beta^N)}{(1+r)^T}, t = 0, \ldots, T \qquad \text{(Equation 1)}$$

where *c* denotes the interest- or coupon-rate, *N* denotes the nominal value redeemed at maturity, and, consequently, *c* times *N* is the interest payment due at regular intervals. To make the time-displaced payment streams comparable, the discount rate *r* is applied.[64] Of course, the logic of discounting remains the same if one focuses on any one point in time after the initial period. Principally, all future cash flows have to be discounted back to *t* over the remaining duration of the bond.

In a perfect world, the borrowing country will always make its payments, including the principal at maturity. Yet, in a not-so-perfect world, especially if a country is at war, bondholders cannot be sure that the country will be able or willing to maintain its debt service in the future. Whether the country will be or not depends on the future state of government finances as well as on political factors which, in turn, are usually highly affected by the fact that a country had actively participated in a war. It is especially the outcome of the war that determines the likelihood with which bondholders may or may not receive payments – that is, if the borrowing country is victorious, it might shift some war costs (in the form of reparations) onto the defeated country (or countries) to take pressure off its own government finances or, if being the defeated, would instead be forced to pay.[65] Therefore, it appears reasonable to incorporate prob-

[63] A zero-coupon bond does not bear interest in the form of regular payments over the holding period. Rather, it pays interest since the price at issuance contains a discount relative to par value. The realization of the difference at maturity can be captured as a one-time interest payment. For exemplary textbook descriptions of the matter, cf. Martellini et al. (2003: 41–45), Brown (2006), and additionally Choudry (2010: 18–19).

[64] Note that this formulation formally refers to a bond with exactly one coupon payment per period. If a bond pays coupons semi-annually, as was the case with many bonds hitherto analyzed, Equation 1 would need to be adjusted. However, the basic implications remain the same which is why I abstain from complicating the matter formally.

[65] In historical perspective, it is a persistent feature of wars that the victor draws on the resources of the vanquished – to compensate for past war costs, to increase wealth at the van-

abilities of default regarding the coupon payment (β^c) and the principal (β^N) into Equation 1. Both the probabilities assigned to each future payment and the discount rates assigned to each period may vary over time. Bondholders' confidence in (or expectations of) a country's ability or willingness to settle debts may be reflected in these probabilities of default. Thus, a decrease in the price of a bond from t to t+1 may be interpreted *ceteris paribus* as having been caused by increasing probabilities of default that bondholders implicitly assign to the future payments they are entitled to.[66]

However, apart from adjustments of probabilities of default, a change in price might well signal three other, different sorts of adjustment on the bondholders' side: (i) Changes in the subjective discount rates triggering a change in the average discount rate across all bondholders. There is no reason to believe that economic agents equally discount payments occurring in different periods;[67] (ii) Changes in the bondholders' inflation expectation. Suppose that a country will service its debts, but that the value of interest payments and principal will decrease in real value due to the way the war economy is regulated and financed. Given an internal debt nominated in domestic currency, a country may well be able to print money to free itself of debts through inflation in the long term; Finally, (iii) positive or negative accidental shocks that we have to take into account once we turn away from the efficient-market hypothesis. Yet, without reasonable presumptions and a more detailed formal model, it is not possible to separate the effect of events and of such shocks on prices.[68]

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quished country's costs beyond pure war costs, or for morale reasons. Referring to White (2001) and Oosterlinck et al. (2013), who investigate France after the Napoleonic wars, and Occhino et al. (2008), who look at World War Two, it may suffice to make the point that the vanquished country is very likely to face horrendous costs which will have an impact on debt service.

[66] Cf. e. g. Weidenmier/Oosterlinck (2007: 11). Note that this simple model to organize thoughts says nothing about how bondholders' expectations are formed precisely; cf. also Oosterlinck et al. (2013: 2). Hull et al. (2005) and Catão/Mano (2015) provide a theoretical background on the "default premium" – the premium (i. e., the additional interest) bondholders ask for when willing to hold a riskier sovereign bond. Bekaert et al. (2014) somewhat generalize on this premium as they propose a political risk premium. Cf. also Stone (1991) and Hilscher/Nosbusch (2010) on macroeconomic fundamentals as determinants.

[67] The discount rate or, precisely, the rate of time preference can be thought of as giving a clue on how important it is for someone to receive money now compared to receiving it in the future. More generally, this is about what economists call the trade-off between consumption now versus consumption later. Someone who borrows money to buy something evidently prefers consumption now while someone lending money prefers consumption later; insofar credit (besides saving) is *the* means of deferring consumption along the time line. So, if bondholders perceive a war event to be disastrous since it could bring about defeat and reparations, they may, technically, adjust implicit default probabilities as well as their time preference.

[68] There is a large body of economic literature on what moves bond and stock prices. While the theoretical approaches and empirical models vary, there seems to be a consensus that political risk – and we may put war under this kind of risk factor – generally plays a significant role in determining prices. For studies on bonds, cf. Campbell/Ammer (1991: 6), Fama (1993),

For our purposes, it suffices to think of inflation expectations, or the inflationary potential of monetary policy, as being captured by the probabilities of default. Inflation risk and default risk are certainly highly correlated.[69] In the extreme, although a payment – even partially or completely worthless – is made in the one case and none is made in the default case, the economic outcome seems to be quite the same for bondholders: they would hold a worthless security in their hands. Moreover, a way to operationalize bondholders' subjective and unknown discount rates would be to assume that they form them according to the risk-free rate of return in the money market that they could earn if they had not invested their money in bonds. I will make use of this thought in the empirical analysis below. Bear in mind that, in effect, the game of supply and demand causes bond prices to rise or to fall. Adjustments on the side of sellers and demanders of bonds – in probabilities of default assigned to future payments, as a reaction to changes in short-term interest rates, or in inflation expectations – are expressed in the act of buying or selling bonds, condensed into a single price statement.

To close this primer on sovereign bond prices with a quote from Stephen Haber et al. (2014): "Sovereign bonds are one type of asset with such a pay-off structure that has the potential to yield real-time insights into regime changes such as rebellions, coups d'états, secessions, and civil wars."[70] In their words, a sovereign bond is a "contingent claim [on debt service; the author] dependent primarily on the conflict's outcome."[71] This feature of sovereign bond prices – to include the bondholders' idea of (difficult to measure) default probabilities which they have good reason to form an idea about – makes them a very useful measure of contemporary thinking in the sense of a real-time opinion poll on the issuing country's performance. This holds especially when applied to a great war, as war news are arguably very dominant news. Even without trying to disentangle price movements exactly regarding the different effects mentioned above, we have a nice indicator at hand of how well or badly bondholders thought belligerents and non-belligerents are making it through all the fighting, as there is a direct link between war effort and the probability of debt repayment or, respectively, default.[72]

Following Stephen Haber et al. (2014), one may suspect other forms of securities to have similar desirable properties. But in my view, there is no other type of fixed-interest bearing security that is so directly linked with the state's financing

Fleming/Remolona (1997), and Jones et al. (1998); for studies on stocks, cf. Cutler et al. (1989: 4–12), Fama (1993), and Shleifer (2000: 1–8).

[69] On (historical) inflation expectations and their measurement, cf. e. g. Abildgren (2004) and Binder (2016).

[70] Haber et al. (2014: 2).

[71] Haber et al. (2014: 2).

[72] In a more general sense, sovereign bond markets can be thought of to be excellent, what economist call, prediction markets; cf. Leigh/Wolfers (2003), Wolfers/Zitzewitz (2004, 2006, 2009), Manski (2005), and Snowberg/Wolfers (2011).

capacity like sovereign bonds. Depending on the historical case, there may be a stronger or weaker link between bonds of state entities on the sub-national level – provincial or municipal bonds – with the central government's finances. Yet, this link is indirect in nature and arguably strongly affected by local or regional economic factors, so that resorting to this level of debt is no real option to evaluate perception of a great conflict. The other big category of securities one may think of is securities related to private business – stocks, but also corporate bonds. But these kinds of securities are largely dependent on firm-specific and industry-specific factors, which may or may not be influenced by world-market and geopolitical developments. Compared to sovereign bonds, there is this basic question: Is an event that is bad for the state's repayment capacity automatically bad for firms (more precisely: firm value)?[73]

In other words, market perception based on sovereign bonds and market perception based on firm-related securities may well be diametrically opposed. A possible solution might be to turn to stock market indices – that is, an aggregation of the market for firm stock – as it is known that stock markets do react to extraordinary events like wars.[74] But the question remains whether the two sorts of perception do align.[75]

3.3. Agnostic event analysis

Sovereign bonds have desirable properties. The *direct* link with a sovereign issuer's ability as well as willingness to service its debts makes it a useful measure to explore the capital market's perception of World War One. Most basically, this study aims at conducting an event analysis of war. Principally, we could measure bondholders' real-time perceptions of the significance of events for the course of the war in one of two ways. The first way is to conduct a *classical event analysis* by predefining events of interest and then using the statistical tools of financial economics to explore whether a sovereign bond price series (or another financial time series, for that matter) shows some (significant, abnormal) reaction on or, respectively, around the pre-specified date. A widespread approach among economists, which economic historians have adapted, is to look for so-called abnormal returns in a share price series around an event. As share price series relate to firms, events of interests will likely constitute standard

[73] Cf. e. g. Brune et al. (2015) on contradictory effects regarding the war-stock value-link; and also Schneider et al. (2009) on stock market reactions to wars that may well be in opposition to what bond markets say. Cf. also Lehmann-Hasemeyer/Opitz (2019) who study the value of political connections in interwar Germany, and Ferguson/Voth (2008) who study the value of political connections to the Nazi movement for firms. Moreover, cf. Lehmann-Hasemeyer et al. (2014) and Opitz (2018) for examples of economic historical studies that look at stock prices to infer investor opinion on political and war events.

[74] Cf. e. g. Choudry (1995) and Charles/Darné (2014).

[75] Cf. e. g. Baskin (1988) for a historical overview of the British and US American corporate financial markets.

corporate events like a merger, dividend, or miscellaneous announcement. If the event has significance for the market, one should observe abnormal returns. Significance implies that the announcement of a merger or, respectively, of a dividend payment comes as a true surprise. If returns do not show any significant deviation from an assumed normal pattern, this either means the capital market does not care or it has already factored the event's meaning for the firm's future cash flow/firm value into share prices.[76] The very characteristic of this kind of event analysis is that the investigated event has to be pre-specified according to some baseline reasoning. Such reasoning, governing the selection process, may be fueled by historians' opinion about the significance of the event. Regarding World War One, we would have to select events of interest – calendar dates, to be precise – suggested by historians to have mattered for the course of the war and the belligerents' war effort; maybe for a general economic reason, maybe for a completely non-economic reason.

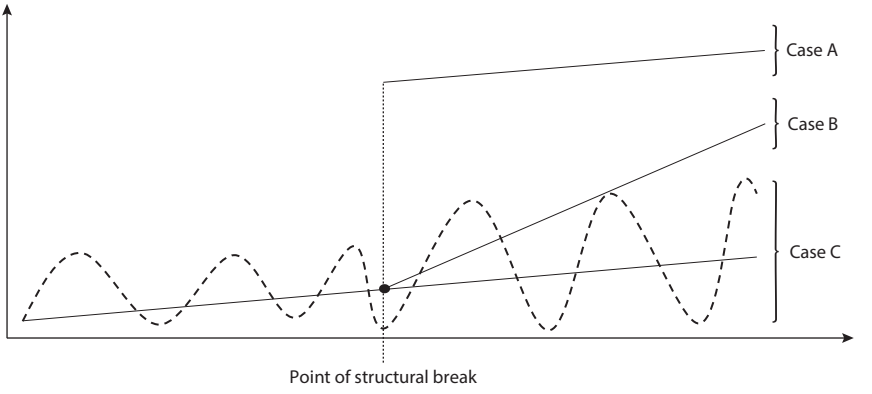
The other way to conduct an event analysis is taking a financial time series and letting the series speak for itself about which events mattered in the actual market participants' eyes. Pre-selection of dates is not necessary. Rather, what is involved is a basic decision on the filter to be applied on the series in order to let it speak for itself. This kind of event analysis is *agnostic* as it identifies what mattered in the eyes of capital market players, and what did not, *endogenously*. It does not require a (value) judgment as to where to look first. There certainly is a judgment of another sort involved, namely which filter to use – that is, which statistical method on the market one should be applying.

One class of such filters commonly used in economics and adapted by economic historians is *structural break tests*. Let us have a look at Figure 5 to grasp the basic logic of such tests. The figure shows a stylized financial time series.[77] A time series can be decomposed into its long-term trend – depicted by the lower straight line – and its volatility – depicted by the dashed line. Note that putting a trend into a time series like, for example, is done in Figure 3 is a way to highlight the series' long-term pattern. Focus here is on the trend's slope. A trend can be a linear function with a certain slope, as is implied in Figure 5 by the straight line. But it can principally also be a non-linear function. The volatility of the series is the deviation of the actual observations (not depicted in that figure) from the computed mean of the series.

[76] In case of a merger announcement, the absence of an abnormal reaction could mean that some information leaked out to the market beforehand; cf. e. g. Banerjee/Eckard (2002). On the methodological basis of the classical event history in finance, cf. fundamentally Brown/Warner (1985), Armitage (1995), MacKinlay (1997), and Maul/Schiereck (2017). Moreover, Schneider et al. (2009: 34–46) provide a discussion from the angle of the political science and McCammon (1998) from the angle of the historical science.

[77] Introductions into historical time series analysis are provided by, for example, Mills (2000), Feinstein/Thomas (2002), Jacobs/Smits (2006), and Hudson/Ishizu (2017).

Figure 5: Detecting structural breaks



Sources: Author's own depiction loosely based on Zussman et al. (2008: 87).

The basic idea of a break test is to search for a point in the series where either the trend – cases A and B – or the volatility – case C – breaks. The black dot indicates the "point of structural break". In case A, the series changes its pattern in that its long-term trend makes a jump upwards. Here, the slope remains the same, but the level of the trend changes. In case B, the underlying series' slope changes. In case C, the underlying series changes its pattern of volatility. It gets more volatile, as suggested by the increased amplitude. In effect, a change in volatility likely is linked with a break of type A or B.[78]

Structural break tests allow for determining the point where the underlying series breaks. The standard assumption of all tests is that a break of type A occurs. More formally, in case A, a shift occurs in the conditional mean of the time series process or – spoken even more technically – a shift occurs in its intercept. For the purpose of this investigation, and in line with the empirical literature, I am interested in such sudden shifts. In connection with a sovereign bond price series as the underlying financial series, these shifts – upwards or downwards – may conveniently be interpreted as a surprise reaction of the market or, what is equal, of the average bondholder. What happens at that point is simple: Given that the supply of the bond is fixed in the short term, an upward shift signals that the demand in the bond has increased. The increasing price means the perceived risk attached has declined. This is equal to perceiving the ability or, respectively, willingness of the sovereign issuer to serve its debts to have increased. One may be tempted to ask which event or, respectively, which news prompted that bet-

[78] For the sake of completeness, a break in the mean may well be a combination of cases A and B – that is, a level change combined with a change in the slope of the long-term trend. That would give a case D.

tering of expectations.[79] Whatever it was, it came as a true surprise to the average investor and, thus, implies the event was significant.[80] The case of a downward shift is to be seen analogously.

The agnostic event analysis I will be performing as the core of my study is geared at exactly this: take a financial time series, use a structural break detection method to screen the series for breaks of type A, and let the series – or, for that matter, the average investor – identify which events were important to him or her.[81]

3.4. Pros and cons of the "capital market data approach to perception"

The basic *assumption* put forward previously is that sovereign bond prices are reliable predictors of investor opinion especially vis-á-vis diplomatic, political,

[79] As I said earlier, how investors exactly formed their expectations is difficult to assess. If there are no historical records on a particular investor explaining how exactly he had come to his expectations, we have to make an implicit assumption as to how the average investor formed expectations. Most basically, economists distinguish between three forms of expectations: The first is "static expectations"; taking the example of inflation, one expects the inflation rate in period t to be equal to the historical realization in period t–1. The second is "adaptive expectations"; one expects the inflation rate in t to be equal to a weighted basket of historical realizations in t–1, t–2, …, and so on. The weights would specify how strongly the inflation rate expectation is determined by the nearer past vis-à-vis the further past. Both ways would exclusively use the time series of historical inflation rates to model expectations. However, the third way – "rational expectations" – is based on collecting as much potentially useful (and publicly available) information as possible to create an expectation that would not merely reflect a transformation of the time series of historical inflation rates. So, if one implicitly assumes that news on war events informs investors' expectations on how the war will develop and belligerent countries will end up, one implicitly assumes that expectations are formed somehow rationally. Strictly speaking, "rational expectations" imply that expectations turn out to be correct ex post facto; cf. e. g. Arnold (2009: 131).

[80] This consideration, I believe, is what the efficient market hypothesis suggests: asset prices change only due to the arrival of new information. I am aware that this view is no longer the mainstream. Turning points might also have been related to some accidental shock or irrational behavior of bondholders. However, in this particular framework, I am not able to evaluate turning points according to those categories. What one has to bear in mind, though, is that the access to viable information was certainly crucial for bondholders in making somewhat rational buying or selling decisions. So, the quality of the news reports in the newspapers should have played a key role. My impression is that news quality had not deteriorated much over the period I am concerned with, but I am not absolutely certain. To my knowledge, Dutch newspapers were not censored, neither at the beginning of the war nor at some later time. But this does not mean that they had not been negatively affected by censored information streaming in from the belligerent countries; cf. e. g. Shiller (1981).

[81] Principally, the term "average investor" deserves more discussion. As we are not able to observe all investors' individual beliefs – beliefs on the significance of an event which may well differ among investors –, we have to make statistical assumptions as to the distribution of these unobservable beliefs. This distribution depends on the basic design of the prediction market. Given a particular design, investor beliefs may be thought of as approximately normally distributed, meaning that the price itself or, respectively, the price change would indeed be interpretable as the mean belief among the investors. This "mean belief" can be thought of as describing the belief of most investors in terms of their sheer number. Cf. Wolfers/Zitzewitz (2006) on the basic idea.

and military events. This holds *if*, and *as long as*, investors see a connection with the sovereign issuer's financing capacity. Once endogenously determined structural breaks are known, it is actually not even necessary to try to reconstruct exactly what the link to the sovereign issuer's financing capacity looks like. Investor opinion itself seems to be important because it not just provides an, assumingly, unemotional yardstick of how people might have thought, on average. But, what is more, investor opinion likely determined a state's financing options in a very material sense. For example, had investors become reluctant to buy sovereign issues, a state would have had difficulty to introduce new debt in the market.

That said, the potential and limitations of the capital market data approach as applied to World War One may be summarized as follows: Firstly, the meaning of contemporary observers ascribed to a particular event may well differ from the meaning historians ascribed to it retrospectively. So, analyzing bond prices may lead to a correction of hitherto maintained historical findings. Doing so at least carries the potential of contributing to a more integrated historical picture regarding the perception of a country's prospects while fighting World War One. A related problem certainly is "hindsight bias". If not concerned with the most actual events, historians usually know how the story ended. Knowing how the story ended, in turn, may influence which events the historian deems more important than others. This is because historical causation becomes only obvious from the distance.[82]

Secondly, since investors lose money if they make the wrong decisions, they are arguably prone to assess the situation rationally, having the risk they take in mind. This does not mean that all decisions would be, in effect, rational. But prices as manifestations of investors' actions might be more reliable as many a written source on an individual's *ex-ante* or *ex-post* beliefs which might be biased by hidden intentions. Such a written source could be a particular investor's memoirs or a newspaper article by a journalist specialized in the capital market. In contrast to individuals, contemporary investors as a whole are not likely to have intended to mislead the posterity about their true perceptions by buying or selling bonds without actually wanting to. We thus have a source at hand which regulates for a principle bias inherent in ego-documents (or maybe in every written source as long as the author does not have to fear material consequences by writing this or that), namely *cheap talk*.[83]

Thirdly, we can rely on a form of mass data on perception. Sovereign bond prices condense the opinion of a principally large mass of market actors into a measure that can be analyzed with the tools of statistics. One can certainly discuss about the basic pros and cons of a statistical approach to history, and public perception in particular, but the appeal is evident.[84]

[82] Cf. e. g. Kucher/Frey (1999a: 364) and Oosterlinck (2012: 101).
[83] Cf. e. g. Kucher/Frey (1999a: 365–366).
[84] For such a discussion, cf. e. g. Hudson/Ishizu and Jopp/Spoerer (2017).

However, regarding limitations, I must admit, in line with every agnostic event study carried out so far, that we cannot be sure that a major change in prices is always due to an important event. There might be chance or, respectively, noise at work, too. And we cannot be sure that the event to be taken as implied by the break in price is in fact the event investors had in mind when becoming active as sellers or buyers. The "structural break tester" has to make a selection based on the dates detected as breaks, and this *ex-post selection* has to be as transparent and plausible as possible.

4. Study design

4.1. Research questions

This study contributes to answering the question of how the public perceived the war efforts of the principal belligerents that fought World War One. Given how we can interpret a sovereign bond's price most basically, this is equal to examining investors' opinion of the different war parties' odds of winning (or losing).

I am breaking down this broad question to two sub-questions which can be conveniently answered by examining sovereign bond prices for the marketplace of Amsterdam:

1) How did bondholders active in Amsterdam perceive the war efforts of the Central and Allied Powers – that is, which war events did matter?
2) How credible were the alliances forming ad-hoc or based on existing treaties, when war broke out, in investors' eyes?

Most basically, regarding question one, World War One can be separated into three "regimes" according to the inherent dynamic of the fighting that took place in each. Firstly, the phase up until the turn of 1914/1915 when the belligerents were initially laboring under the assumption – and militarily proceeded accordingly – that quick victory was more than possible but realized, as time flew by, that this notion was flawed. Secondly, the long phase of deadlock until the turn of 1917/1918; a phase in which certainly much happened, but with no great impact on the "stalemate equilibrium". Thirdly, finally, the phase from January/March 1918 to the end of the war, when the great offensives were happening on the Western Front blowing the "stalemate equilibrium" to pieces. Against the background of this highly aggregate view, a look at how the capital market assessed the different dynamics is a worthwhile undertaking, because we are still lacking a big picture that would integrate perceptions of as many belligerents as possible. Here, an agnostic event – or, alternatively put, *turning points* – analysis on *ten* belligerents will serve to determine the events that were major events

in investors' eyes, as they fundamentally altered their their assessment of the belligerents odds of winning (or losing).

Concerning question two, it was mentioned the traditional view that the international system of alliances' functioning was responsible for the outbreak of the war, as it automatically dragged player after player into the war. This is no longer the mainstream in historical research, though. Yet, alliances did form – not only in the form of the superstructure "Central Powers-Allied Powers" – but also in the form of (occasionally quite strange) bilateral ad-hoc alliances (e. g., Bulgaria and the Ottoman Empire). Like we observe this process in retrospect, bondholders observed that process in real-time. So, assessing whether the capital market assessed the emerging bilateral alliances and, after all, the superstructure as being credible is a worthwhile undertaking, too, as it allows broadening the picture of investor opinion beyond major events.

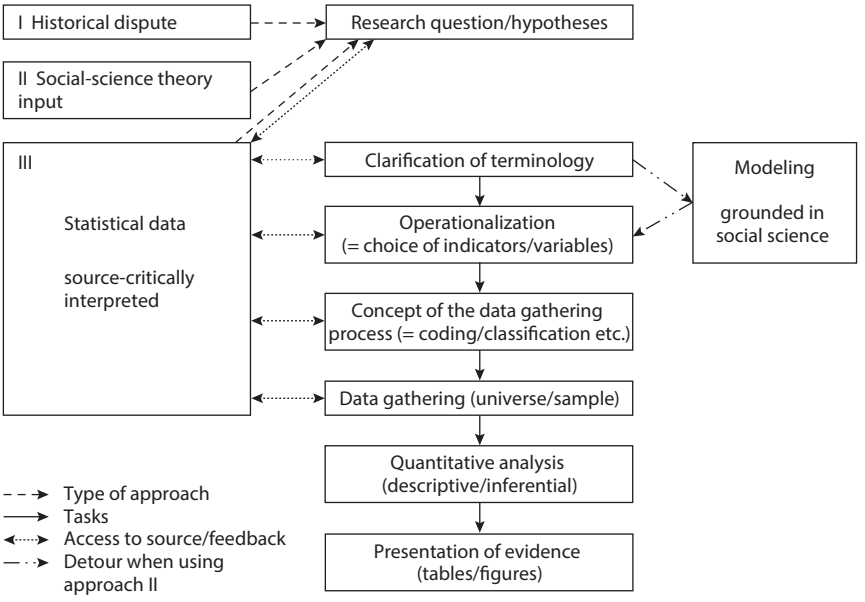
The principle source applied is the prices of sovereign bonds as forming at the Amsterdam Stock Exchange. The choice of Amsterdam certainly warrants justification; I will motivate this choice in the following subsection. Turning points analyses rely on high-frequency data – that is, at least weekly, but even better daily data. To the best of my knowledge, there has not yet been made an attempt to create a wartime sovereign bond price database at daily frequency for any bond market for which this would be feasible. Building such a database therefore suggested itself as a third aim of this study. Consequently, I built a database on the *entire* sovereign bond market in Amsterdam stretching from 1 January 1914 to 31 December 1919. This database contains all available prices on all domestic and foreign sovereign bonds traded in that period (288 bond series of 38 different countries yielding 161,000 price observations). This core database is augmented with another 32,000 originally gathered observations. According to my design of the turning points and credibility analyses, it was inevitable to gather the entire 1914–1919 cross-section of sovereign bonds, as only a look at daily prices per bond in combination with a look at all bonds' prices enabled me to assess certain aspects properly – e. g., the market development or market and bond-specific liquidity.

My approach is quantitative in nature. In the typology of quantitative research put forward by, for example, Tobias A. Jopp and Mark Spoerer (2017), my approach is informed by a historical dispute in combination with an untypical historical *statistical source* not yet exploited (cf. Figure 5).[85] Analyzing an intrinsically *statistical source* like securities prices unavoidably comes with the application of statistical methods – descriptive as well as inferential methods. Given the vast amount of economic literature on securities markets and public debt in combination with the state of econometrics/statistics in general, there is principally no upper limit for methodological and methodical complexity.

[85] Cf. Jopp/Spoerer (2017). On the general stance of quantification in German historiography, cf. Buchner et al. (2020).

However, in order for my study to offer a decent take-away for the non-specialist in the first place, I attempted to implement econometric tools (like structural break regression and cointegration analysis) in a way that historical plausibility or, respectively, interpretability of my results is ensured. Therefore, I cut down on technical complexity.

Figure 6: The typical quantifying research approach



Sources: Adapted from Jopp/Spoerer (2017: 40).

4.2. Why Amsterdam?

We can principally investigate the issue of capital market players' (changing) confidence in a specific country's ability to be victorious in a war from four angles. For illustrative purposes, let us presume we want to assess contemporary perception of how the German Empire fared. To do so, we require prices for a German government bond, preferably an issue dating back to peacetime. Firstly, we could try to gather prices on German bonds quoted at home, at a financial hotspot somewhere in the German Empire itself – e. g., at the Berlin Stock Exchange as *the* most important German trading place at the time. This approach assessed perception "from within". Secondly, we could try to gather prices for German bonds formed at a location in friendly or enemy territory – e. g., at the Vienna or the London Stock Exchange. Thirdly, we could try to gather prices

formed at a location in neutral territory. The approaches two and three offer perceptions "from the outside". Fourthly, we could try to combine all three angles which certainly has a special appeal as the picture evolving would somewhat be *encompassing*.

Yet, with regards to the example of Berlin, angle one is just impossible to take because all German stock exchanges were shut down right with the outbreak of war with the intention to end the sudden and sharp fall in securities prices occuring as a consequence of rising panic among investors. The exchanges remained closed for a considerable period of time. While trade would be resumed in stocks after a while – sometime in 1917 –, trade in sovereign bonds would not be resumed until 1919 (cf. Table 3, on Berlin specifically).[86] In fact, we know of a more or less functioning unofficial – "grey"– market that quickly established as a substitute on the streets (and even in the stock exchanges' rooms!), organized by the commercial banks. But this market is not well-documented since especially the unofficial price lists said to have been published by the commercial banks seem to not have made it into the twenty-first century. The few prices documented in the literature are not helpful because they do not come in high frequency and are very probably not representative.[87] This picture holds for other market places and, thus, "within angles" as well (e. g., for Austria). This can be inferred from Table 3 which reports the closing status for the most important stock exchanges in Europe and the world.

But even if we had the possibility to take a "within angle" for England and France, for example, which, according to Table 4, is possible from a pure data availability point of view, we would have to deal with severe capital market restrictions quickly imposed from August 1914 onwards (cf. Subchapters II.1 and II.4) and with the risk of inherent patriotic bias. Both aspects are potentially biasing the information content of bond "market" prices when it comes to taking a "within angle" for any belligerent.[88]

Regarding the second angle, which is possible to take in the form of the "enemy view" for all Central Powers due to the fact that the London and Paris Stock Exchanges resumed trade relatively quickly (cf. Table 3), we would still have to deal with the biases introduced by capital market restrictions and alleged patriotism.[89] Needless to say that angle four is already out of reach by now if the aim is to document opinion on not only one or two belligerents, but on all major and also minor belligerents.

[86] Cf. e. g. Michie (2006b: 157–159), on stock exchange closures.

[87] I take up this point again in Chapter II. On, for example, the regionally important stock exchange of Munich, cf. Siegmann (1922: 63–75).

[88] Hanedar et al. (2018a) take this angle when examining bonds traded at the Istanbul Stock Exchange.

[89] Adams (2015) does so for France by taking the angle of investors in friendly London.

Table 3: Stock exchange closures on the occasion of World War One

Stock exchange	Closure	Resumption of official trade
Amsterdam[a]	29 July 1914	9 February 1915 in stocks and bonds
Basel[b]	29 July 1914	7 January in government bonds, between 1 December 1915 and 26 June 1916 in stocks and miscellaneous bonds
Berlin[b]	31 July 1914	3 December 1917 in stocks, 1 September 1919 in bonds
Geneva[b]	Officially never closed, though frictions until 19 August 1914	20 August 1914 in spot market trade in bonds, 15 January 1915 same in stocks
Johannesburg[c]	End of July (?)	January 1915
London[b]	31 July 1914	4 January 1915 in bonds and stocks
Madrid[c]	Remained open throughout the war	–
New York[b]	31 July 1914	28 November 1914 in bonds, 15 December in stocks
Paris[b]	1 August 1914	Mid-August until 2 September 1914, then again from 7 December 1914 on in bonds and stocks
St. Petersburg[d]	End of July 1914	For two months in 1917
Sydney[c]	End of July (?)	January 1915
Tokyo[c]	Remained open throughout the war	–
Toronto[c]	End of July (?)	January 1915
Vienna[c]	End of July	April 1915
Zurich[b]	1 August 1914	15 May 1916 in bonds, 10 July 1916 in stocks

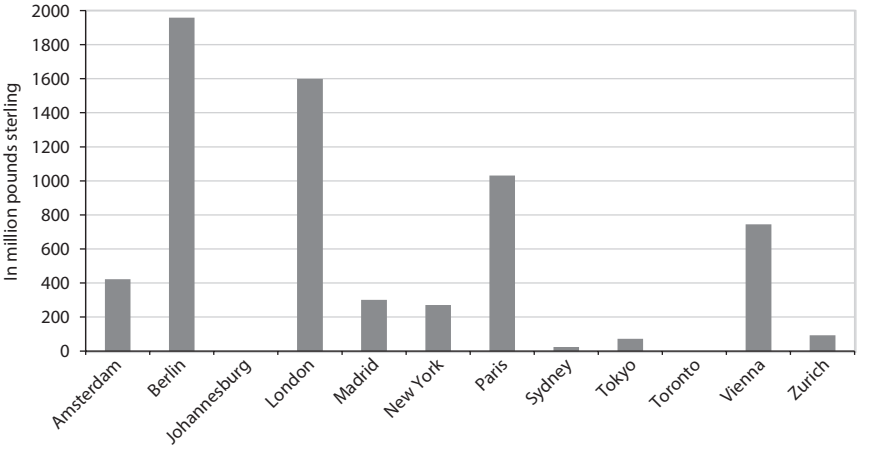
Sources: [a] My database. [b] Stucki (1924: 26). [c] http://lyndonmoore.yolasite.com/resources/Stock%20Market% 20Integration.pdf. [d] Borodkin/Perelman (2011) and https://som.yale.edu/faculty-research-centers/centers-initia-tives/international-center-for-finance/data/historical-financial-research-data/st-petersburg-stock-exchange-project.

Inevitably, angle three comes into play. We may therefore take up the lead of related studies on World War Two focusing on the neutral trading places of Zurich or Stockholm in the first place. Most promising for an analysis, when looking at World War One, is the trading place of Amsterdam. The Netherlands stayed neutral throughout the war despite considerable political and, even more so, economic pressure exerted by Germany and England alike to join sides.[90]

[90] Cf., fundamentally, De Jong (2005) and Tames (2012). I will take up the neutrality feature in Chapter II.

Besides the neutrality feature, Amsterdam is well suited for the purpose of this study for three reasons: Firstly, the Amsterdam Stock Exchange resumed trade relatively quickly after sudden closure on 29 July 1914 and allowed trade in all kinds of securities for the rest of the war (cf. Table 3), so that it is possible to have a vital part of the war covered. Moreover, secondly, following preliminary evidence[91], the Amsterdam Stock Exchange ranked fifth in Europe and in the world on the eve of World War One regarding its sovereign bond segment's market capitalization – that is, broadly speaking, the segment's aggregate value or size.[92] Figure 7 reports the corresponding aggregates for twelve major stock exchanges.[93] Finally, thirdly, if we take into account the number of sovereign bonds traded on the whole and the proportion of foreign bonds – both measures are given in Table 4 – Amsterdam even ranked second in Europe and in the world, only outperformed by London. Especially in Berlin and Vienna did the sovereign bond segment consist of many *domestic* bonds with a sizeable market capitalization.

Figure 7: Comparative sovereign bond market capitalization in 1914



Sources: Moore (n. d. a), Table III. Available at http://lyndonmoore.yolasite.com/research.php; accessed 16 August 2019.
Notes: Market capitalization as of January 1914.

[91] I speak of the evidence as preliminary here, as it is, to the best of my knowledge, not yet published but comes in the form of a working paper; cf. Figure 7.

[92] A firm's market capitalization at a particular point in time is the product of the price of its shares times the number of outstanding shares. Analogously, a bond's market capitalization can be thought of as its amount outstanding being weighted with current prices. Cf. Rajan/Zingales (2003) and Kuvshinov/Zimmermann (2018) on long-run stock market capitalization of various markets.

[93] If stocks were included, Amsterdam would still rank sixth in the world, as New York made a jump; cf. Moore (n. d.a).

Table 4: Comparative range and internationality of the sovereign bond segment in 1914

Stock exchange	# of sovereign bonds in total	Thereof # of foreign sovereign bonds	Proportion of foreign sovereign bonds
Amsterdam	171	168	98.2 %
Berlin	112	93	83.0 %
Johannesburg	0	0	0.0 %
London	239	232	97.1 %
Madrid	6	1	16.7 %
New York	18	14	77.8 %
Paris	36	34	94.4 %
Sydney	9	0	0.0 %
Tokyo	5	0	0.0 %
Toronto	0	0	0.0 %
Vienna	40	8	20.0 %
Zurich	41	31	75.6 %

Sources: Estimated from Moore (n. d.a), Tables I and XI. Available at http://lyndonmoore.yolasite.com/re-search.php, accessed 16 August 2019.
Notes: Figures as of January 1914.

According to Siegfried Quandt (1993), war may be seen as a *communication event*.[94] Players actively taking part in war may be prone, even more than neutral ones, to channel or, respectively, censor information. For example, think of administrated minimum prices, as in the case of the UK consols quoted at London, or of the extensive restrictions on publication of official but also unofficial price statements, as in the case of the Berlin market.[95]

Thus, taking the perspective of a neutral trading place arguably bears the advantage of information destined for the public, including financial data, having been less controlled or, respectively, doctored. Indeed, taking the perspective of marketplaces from inside the primary belligerents – London, Berlin, or Paris – may be preferred. Strictly speaking, we will be likely seeing through the lens of Dutch lenders in the first places, even if investors from Germany – or other countries – might have gained access to trade in sovereign bonds in the Amsterdam market, too (cf. the statement on this in Subchapter I.1.1).

The evidence assembled in Table 4 in combination with Figure 7 suggests that only a European trading place is worth looking at, and that Amsterdam is the best choice given the neutrality constraint.[96]

[94] Cf. Quandt (1993: 5).
[95] Cf. Michie (1999: 6) on London.
[96] To be fair, the evidence is not explicit on which sovereign bonds were exactly traded outside Europe, or in Madrid or Zurich. My own inquiries led to the assessment, however, that nowhere in Europe, or outside, have bonds on so many belligerents been traded *during* the war. If we do not want to turn to London, in combination with Paris, Amsterdam offers the broadest range; cf. Chapter II.

4.3. Structure of the study

The study's structure is guided by the three aims postulated at the beginning of this subchapter: answering the question as to how the capital market assessed the course of the war by answering two specific research questions on the perception of investors trading in Amsterdam; and by describing the database created for this purpose.

Chapter II is dedicated to the last point in this enumeration which is, of course, the basis of the actual empirical analysis. The chapter starts with a baseline overview of how the Netherlands fared during World War One. What follows is an in-depth description of my sources and of the bond price database gathered at daily frequency. Based on this introduction to the data, a broader description of the sovereign bond segment at the Amsterdam Stock Exchange during wartime follows. This is a description naturally lacking, as the data have not yet been gathered in the necessary detail. The descriptive analysis will focus on the market development – especially liquidity – and on a comparison with the three European markets of London, Paris, and Berlin. The chapter concludes with a brief source critique addressing the data's potential and limitations. Among other things, I will discuss the modalities of price formation to come up with an idea of how strongly prices might be biased, and I will touch on the issue of the investors' nature.

In Chapter III, I examine sovereign bonds issued by *ten* belligerents for structural breaks. These ten belligerents are: Germany, Austria, Bulgaria, and the Ottoman Empire, together forming the Central Powers; and England, France, Italy, Romania, Russia, and Serbia, together forming the largest part of the Allied Powers. Note in advance that the US is not part of the analysis, as the price account on US bonds is insufficient for the task. Although the structural break analysis has the form of an agnostic event analysis – that is, does not rely on an input of events deemed important by historians in retrospect –, I will engage in a little exercise to condense such events out of the vast historical literature on World War One. This enables me to formulate a simple *historical hypothesis* as to which events we should be expecting to have been perceived as major at the time. For reasons of data availability, the structural break exercise, as goes for the exercise in Chapter IV, too, is limited to the last 39 months of the war. Unfortunately, we necessarily miss the first year of the war since belligerents' bonds were back in trade in August 1915 at the earliest. The structural break analysis is augmented by a robustness check which takes into account that structural breaks may well be explained by economic fundamentals, like market liquidity, time preference, or inflation. As this analysis has to be taking place on the daily level, too, there is a clear limit on variables that are gatherable at this frequency. The analysis concludes with a broader discussion generalizing on the previous findings – among other things, by condensing them into simple country-specific and faction-specific perception indices.

Chapter IV answers the question as to how credible the alliances that formed since the outbreak of the war were in the eyes of Amsterdam investors. For this purpose, the number of analyzed countries is raised to thirteen; the ten from the previous analysis plus China, Japan, and Portugal. After the discussion of some definitional issues and data description, the empirical analysis based on two simple statistical *ad-hoc* tests – a "global" test and a "sub-periods" test on perceived alliance credibility – will follow. Both tests are based on a simple co-integration framework that is informed by state-of-the-art market integration studies but used in an entirely new fashion to get a hold of "alliance integration". The chapter concludes likewise with a broader discussion of the evidence. A simple way of measuring the degree of alliance integration through the lens of the capital market is implemented.

Chapter V concludes the study by summarizing its basic findings and discussing some of the evidence's broader implications for our understanding of World War One and the way it is studied. The analysis is complemented by an extensive online Appendix consisting of two sections – one on the data and one on technical matters.

4.4. Placing the study

This study principally links with three big literatures: (i) with the historiography of World War One, (ii) with the part of the political science research that overlaps with economics and the historical science when it comes to the study of alliance formation and alliance behavior (and, of course, public opinion research), and (iii) with economic and economic historical research on the effects of extraordinary (political, diplomatic, military, economic) events on securities markets. Block (i) can be deconstructed into general accounts of the course of World War One, on the one hand, and public opinion studies, on the other hand. Some relevant studies in both regards were cited in Subchapters I.1 and I.2, so that I will spare a discussion here. Basically, my study is a valuable addition to the historical study of World War One – methodologically as well as content-wise. Regarding block (ii), political science studies laboring on (historical) alliance formation and behavior, I was rather brief in the introductory chapter. I indeed mentioned a few general titles, but gave no greater picture. While I am sparing a discussion here, I will discuss the relevant "alliance literature" and its neglect of "alliance perception" by the public in Chapter IV. Finally, block (iii) should be deconstructed in a variety of sub-literatures and, most basically, into economic studies, on the one hand, and economic historical studies, on the other hand. Regarding the technical complexity of my study, which I tried to keep on a modest level, the pure economic literature certainly is not addressed in the first place. There are principally many empirical studies on the effect of (news on) wars and military conflicts on bond and stock markets. These may be based

on the *classical* event analysis or the *agnostic* type when it comes to determining structural breaks in securities prices or market indices. The literature has been paying special attention, for example, to the Israeli-Palestinian conflict, the Iraq Wars, or even World War Two.[97]

Within the economic historical literature, we should also distinguish between classical event analyses, based on examining abnormal return behavior of, predominantly, stock price series around pre-defined events, and the agnostic approach to breaks. Examples of the former include studies on the effect of cartelization on firm value, on market reactions to the extension of the franchise in late nineteenth-century Saxony, and on stock market reactions to the Russian Revolution in 1905 and the related Russo-Japanese War.[98] Finally, there is the highly relevant sub-literature on *agnostic* turning points. Kristen L. Willard et al. (1996) pioneered the procedure with a study on the American Civil War and the greenback market, and other studies followed on this first "war subject".[99] Besides the American Civil War, economic historians have dedicated at lot of attention to measuring the perception of World War Two.[100] World War One as a third major war topic has only recently gained some attention. The relevant studies will be discussed in Subchapter III.2.[101] The remaining relevant studies have generally focused on various periods of relative peace, but also unrest, and on events such as political unification and political regime turnover, to name only two topics.[102]

[97] Cf., for example, Niederhoffer (1971), Elmendorf/Hirschfeld (1996), Balduzzi et al. (2001), Green (2004), Barro (2006), Schneider/Troeger (2006), Corallo (2007), Zussman et al. (2008), Andersson et al. (2009), Wolfers/Zitzewitz (2009), Hudson/Urquart (2014), and Walker (2016).

[98] Cf. Bittner (2002, 2005), Lehmann-Hasemeyer et al. (2014), Günther (2015, 2017), Opitz (2018), and Lehmann-Hasemeyer/Opitz (2019).

[99] Cf. Williard et al. (1996), Brown/Burdekin (2000), and Weidenmier (2000, 2002).

[100] Cf. Kucher/Frey (1998, 1999a, 1999b), Frey/Kucher (1999a, 1999b, 2000a, 2000b, 2001), Lambelet (1999), Brown/Burdekin (2002), Waldenström/Frey (2002, 2003, 2006, 2008), Oosterlinck (2003), Frey/Waldenström (2004, 2007), Waldenström (2010), and Bialkowski/Ronn (2017).

[101] Cf. footnote 26 in this chapter.

[102] Cf. e. g. Sussman/Yafeh (2000), Brown et al. (2006), Burdekin (2006), Ferguson (2006), Calvo-Gonzalez (2007), Burdekin/Lahey (2008), Sicotte et al. (2010), Christodoulaki et al. (2012), Flandreau/Oosterlinck (2012), Oosterlinck/Ureche-Rangau (2012), Collet (2013), and Ho/Li (2014).

II. Historical background, sources, and data

This chapter provides background information on the Dutch economy around World War One (Subchapter II.1) followed by a detailed description of the database created for the purpose of assessing public opinion on the belligerents' war effort from the angle of investors in Amsterdam (Subchapters II.2 and II.3). The last part of this chapter discusses important data quality-related issues and may, thus, be understood as a source critique on the statistical data.

1. The Netherlands and World War One

Figure 8 depicts the long-term growth of the Dutch economy in terms of real GDP per capita from 1870 to 1950. The series is directly comparable to the series shown in Figure 2 on the big players – the UK, France, and Germany. In the long term, over the First Age of Globalization (1850–1914), the Dutch economy experienced a growth spurt at least as impressive as that of its big European neighbors. As of 1913, following Jan Luiten Van Zanden's assessment, the Dutch economy had grown into one of the most productive economies in the world. Its relative labor productivity amounted to 78 percent of the productivity leader's, the US'. In comparison, German and French labor productivity relative to US labor productivity was lower, amounting to 68 and 56 percent, respectively. The relative labor productivity of the UK was 86 percent.[1] Figure 9 illustrates that this growth spurt rooted especially in the Dutch export economy. The Dutch economy's share in world exports almost doubled from 3.4 percent in 1870 to 6.3 percent in 1913 letting it rank fifth in the world, and closely to much bigger France.[2]

The immediate as well as the long-term impact of World War One on the Dutch economy is well reflected in these two measures – real GDP per capita

[1] Cf. van Zanden (1998: 16). For an in-depth picture of productivity leadership and catch-up in the run-up to and on the eve of World War One, cf. the specialized productivity literature including Broadberry/Fremdling (1990), Broadberry (1997a, 1997b, 1998), de Jong (2003), Broadberry/Burhop (2007), Ritschl (2008), Allen (2012), Broadberry/Klein (2012), Veenstra (2014), and Timmer et al. (2016).

[2] Figures are computed on the basis of Jacks/Tang (2018); cf. Figure 9. Figures for 1913 are: France: 6.7 %; Germany: 12.1 %; UK: 12.9 %; and the US: 12.8 %.

and the share in world exports. The war years themselves are highlighted as a grey area in Figures 8 and 9. Real GDP per capita fell back to the level of 1900, but quickly recovered after the war and grew further towards 1930 before the Great Depression and World War Two threw the world, and the Dutch economy, once more into an economic crisis. The massive growth in the interwar period is all the more remarkable for two reasons. For one, north-western European countries, on average, witnessed a decrease in GDP as well as GDP per capita.[3] Beyond that, the Dutch economy's share in world exports did not recover to the same degree as GDP per capita after passing its low in 1918 (0.8 percent). This is likely due to the general protectionist attitude reigning as a consequence of the war and, of course, the stagnating growth of major trading partners such as Germany.[4]

The Dutch economy's growth prospects as of the outbreak of war decisively depended on how it would deal with its geographical location between the two major opponents Germany and the UK – or, perhaps more realistically put, on how these two would deal with the Netherlands.[5] What turned out to be a *precarious* geographical location in the summer of 1914 had, however, benefited the Dutch economy for a long time prior to 1914.[6] The Netherlands had well-established economic relations to both the UK and Germany, but economic interdependence with Germany was traditionally stronger, not the least due to the connection through the Rhine River as a major transport route.[7]

The Netherlands chose to remain neutral and kept their military forces on stand-by duty throughout the war as a principle threat to the belligerents that violation of neutrality by means of invasion would not be passively accepted. This was maybe not the most credible threat, as the military technology available to the Netherlands was not quite state-of-the-art compared to the Great Powers' military resources.[8] In fact, Dutch neutrality was respected by the leaders of the German Empire due to economic interdependence – Dutch ports principally offered essential access to overseas trade routes –, but also by the

[3] Cf. van Zanden (1998: 92).

[4] Note that in absolute figures, Dutch exports averaged over the interwar period (1919–1938) did not amount to even one-third of the 1913 level; figures computed again from Jacks/Tang (2018).

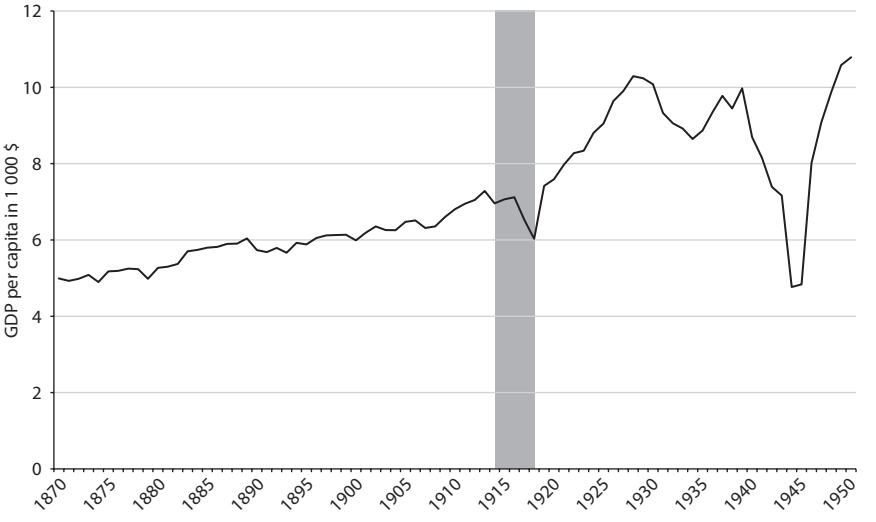
[5] Cf. de Jong (2005: 137).

[6] On the economic history of the Dutch economy in the nineteenth and twentieth centuries, cf. principally Kiliani (1923), Baasch (1927), Brandes de Roos (1928), Renooij (1951), de Vries (1978), Meere (1983), Van Zanden (1989, 1998), van Ark/de Jong (1996), t'Hart et al. (1997), Eichholtz et al. (2000), Wintle (2000), Fremdling et al. (2001), de Jong (2003, 2005), and Fremdling (2006).

[7] Cf. Euwe (2009, 2010: 219, 2012a: 205–211), and, more generally on Dutch-German economic relations in historical perspective, Klemann (2007a, 2009, 2013), Klemann/Wielinga (2009), and Euwe (2012b).

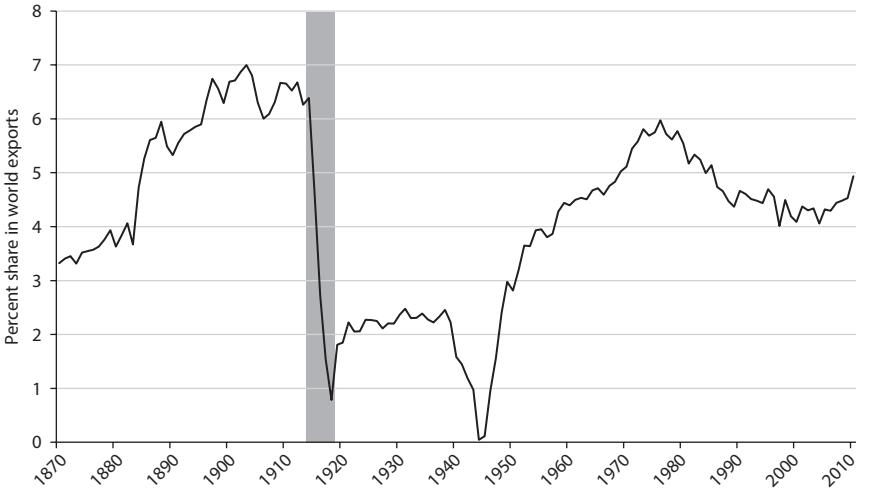
[8] Cf. de Jong (2005: 153) and Klinkert (2011).

Figure 8: Dutch GDP per capita in the long term



Sources: Maddison dataset at https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2018, as updated and described by Bolt et al. (2018); accessed: 3 May 2019.
Notes: Depicted is the GDP series labelled "rgdpnapc".

Figure 9: The Dutch economy's share in world exports over 1870–2010



Sources: Data are from Jacks and Tang (2018); available at http://www.sfu.ca/~djacks/data/publications/index.html; accessed: 8 May 2019.

British Empire.[9] However, the naval blockade established by the British early on hit the Dutch economy pretty hard. The blockade itself had two purposes: For one, it was intended to cut off Germany from precisely those trade routes that would allow access to the necessary supplies of foodstuffs and primary products; that is, it cut off Germany from its import markets. This certainly was a tactical motive. Beyond that, the blockade was supposed to help Britain penetrate new markets which would have otherwise, facing intact competition from German business, probably been impossible to penetrate; that is, the blockade was supposed to make it much more difficult for German firms to continue selling their produce on their traditional export markets once the war would be over. This was certainly a strategic motive, going beyond the actual necessities of war.[10]

Yet, from early 1917 onwards, after a phase in which the Netherlands had held up well against any economic or political pressure, both sides intensified attempts to draw upon Dutch resources. In short, Germany wanted to be supplied with foodstuffs, easy foreign bank credit by the internationally significant Dutch commercial banks[11], and access to the Dutch railway network. Otherwise, important hard coal supplies, on which the energy supply of the Dutch economy was predominantly resting, would be cut.[12] Britain, and also the United States, wanted to command over Dutch shipping capacity to support the naval blockade and transport military personnel and goods. If the Dutch did not voluntarily approve, ships would likely become subject to confiscation.[13]

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[9] On neutrality in World War One, in general, cf. Kruizinga (2016). On Dutch neutrality and the Dutch wartime economy, cf. especially Van der Heyden (1918), Vissering (1920), Van der Flier (1923), Vissering et al. (1928), Dunk (1980), Van der Bie (1995), Frey (1998, 2000), van Tuyll van Serooskerken (2001: 128–267), Sluyterman (2004), de Jong (2005), Abbenhuis (2006a, 2006b), Klemann (2007b, 2010), Tames (2012), Van Bergen/Abbenhuis (2012), Kroeze/Klein (2013), Moeyes (2014), and de Jong/Nikolic (2018).

[10] Cf. Fremdling (2007: 143). The more recent literature has especially highlighted the latter motive, namely, that British economic warfare was supposed to seize the moment and get rid of Britain's toughest European competitor on the world market. For a detailed account of the British naval blockade of Germany, cf. e. g. Offer (2000, 2017), Osborne (2004), Lambert (2012), and Kramer (2013).

[11] As for the factual extent of short-term lending to Germany, Euwe speaks of a total sum of 308 million Dutch florins having been lent over the war. This sum can be separated into 195 million florins that were officially reported by the Dutch central bank and another 113 million florins that, only after the war, turned out to have been secretly paid by Dutch commercial banks with no reporting to the central bank. Such short-term loans with repayment due immediately after the war's ending were also given to Britain (142 million florins), France (12), and Austria-Hungary (85). These sums may have also been higher due to non-reporting, but there is no hard evidence for this as of yet; cf. Euwe (2009: 158–159, 2010: 224).

[12] Cf. Böse/Ziegler (2015) and Roelevink (2015a, 2015b) on Dutch coal dependency on Germany and "coal relations" during the war; cf. Jopp (2016) on productivity in German coal mining.

[13] Cf. de Vries (1978: 80–81), Frey (2000: 237–239), Fremdling/de Jong (2001: 21), Fremdling (2007: 143), and Klemann (2009:20).

Table 5: Some stylized facts on the Dutch economy at war

	National Income (constant prices, million guilders)	Total tonnage of ocean carriers entering Dutch ports (million tons gross register)	Total tonnage of goods crossing the border by barge via the Rhine (sum of trade in both directions), 1913 = 100	Cost-of-living index	Coal imports from Germany (million tons)
1913	–	30.4	100	100	–
1914	2 278	22.6	69	100	–
1915	2 443	11.1	23	116	5.0
1916	2 697	–	28	128	4.2
1917	2 336	–	19	136	2.4
1918	2 006	2.8	14	164	1.3
1919	–	–	16	176	–

Sources: De Vries (1978: 44–49, 80).

Table 5 assembles some quantitative facts that underline the economic stress through which the Dutch economy went between 1914 and 1918. When the war had ended, the Dutch economy was not in the best financial state. Decreasing economic performance (Figure 8 and Table 5, columns two and six) due to labor and especially resource scarcity in the industrial sector[14], a drop in export activity especially regarding agricultural products (Table 5, columns three and four)[15], and inflation (Table 5, column five)[16], were taking their toll.

Another illustrative perspective on the Dutch economy's economic stress is offered by Figure 10 which depicts the price development of the Dutch 3 % government bond circulating before and during the war. This was one of three bonds that had been issued by the Dutch government prior to 1914 and that saw regular trade over the period 1914–1918 (cf. Subchapter II.3). The long-term decrease of the Dutch 3 %, observable since fall 1916, gives some indication of the severity of inflation, as this ought to be the main factor impacting on the price of Dutch government debt. As outlined in Subchapter I.3, whether a sovereign borrower does not pay interest to its lenders at all, or whether severe inflation reduces the real value of an interest payment orderly made, the effect is the same from the lender's viewpoint; an inflation discount rising with the level of inflation would be the consequence.

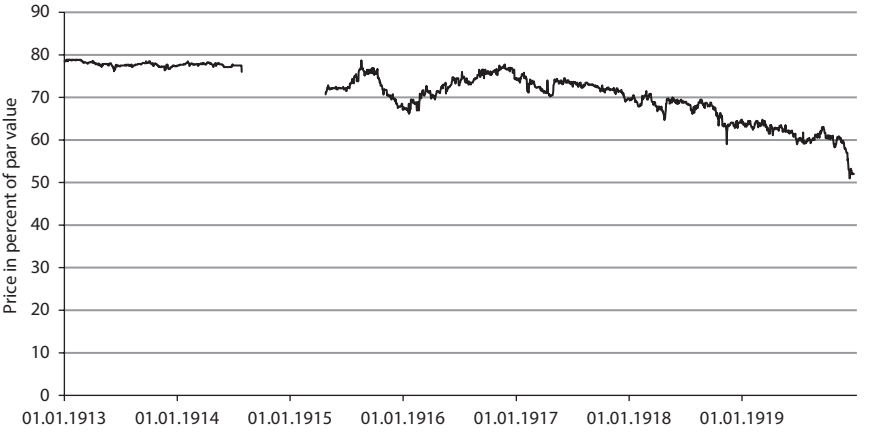
As noted earlier, international markets had already achieved a high degree of integration by mid-1914. In commodity market as well as financial market terms,

[14] Cf. on decreasing industrial production also the figures in de Jong (2005: 148).

[15] Cf. on decreasing agricultural exports and slightly rising agricultural production the figures in de Jong (2005: 140, 148).

[16] Cf. De Jong (2005) on inflation.

Figure 10: The pricing of Dutch debt – the 3 % *Nieuwe Werkelijke Schuld*



Sources: Cf. Subchapter II.2.

one can certainly speak of a *world market* having been established because larger price differentials between two geographically distinct market places would not have existed for a longer time period. Arbitrage transactions would have eroded them pretty quickly, thanks to low barriers to trade – or maybe none at all (depending on the marketplaces one compares).[17] However, it is commonly accepted that the outbreak of World War One marks a watershed in terms of market integration: it triggered the reversal of integration. It set into motion a long-term development towards more protectionism and less integration reaching well into the second half of the twentieth century.[18]

In the short term, capital markets were deliberately and in a controlled manner shut down almost everywhere between late July and the beginning of August 1914 as a preventive measure. Sheer panic among the market participants would otherwise have let them break down uncontrolled, so the reasoning of contemporary authorities. Immediate disintegration of formerly well-integrated markets was the consequence, rigidified in the belligerent countries by ad-hoc regulations that would subordinate the capital markets under the needs of the emerging war economies.[19] Typical restrictions imposed on stock exchanges, in

[17] Cf. e. g. on commodity markets O'Rourke/Williamson (1999), Findlay/O'Rourke (2003), Bordo et al. (1999), Uebele (2013), and Jacks/Novy (2018); and on financial markets e. g. Garbade/Silber (1978), Bordo/Rockoff (1996), Ferguson (2001), Goetzmann et al. (2001), Obstfeld/Taylor (2003), and Sylla et al. (2006).

[18] Cf. e. g. Silverman (1982), Berend (1998), Rajan/Zingales (2003), Feinstein/Toniolo (2008), Accominotti/Eichengreen (2016), Kershaw (2016), Jacks (2018), and Jacks/Tang (2018).

[19] Cf. Landsburgh (1916, 1917), James (2002: 160), Michie (2006b: 155), and Bernal et al. (2010).

particular, and the capital markets, in general, may have included (i) the setting of minimum prices for domestic debt such as happening in London, where a formal minimum price on UK consols was imposed and held up until the beginning of 1916;[20] (ii) the interdiction of trade in "enemy securities" by domestic residents; (iii) the interdiction of trade in securities of whatever origin – enemy or otherwise – by investors formally resident in enemy countries;[21] (iv) proof of loyalty by former residents of enemy countries working at the stock exchange;[22] (v) confiscations of enemy securities;[23] (vi) suspending the gold standard;[24] (vii) limiting the influence of foreign – and especially "enemy" – shareholders in firms;[25] (viii) defaulting on interest payments connected with one's own sovereign debt as far as "enemy country residents" were the beneficiaries;[26] or (ix) keeping the stock exchange closed completely.[27] Minimum prices in combination with all sorts of limits on stock exchange transactions executable by investors willing to trade surely introduced regulatory bias and inefficiency into price formation. This bias may have been strengthened by patriotic bias.

Neutral countries like the Netherlands followed, necessity-driven, suit in shutting down trade temporarily and resuming it under adjusted regulations that were, however, still less protectionist. Financial historians agree upon the fact that the severe cutback of the financial relations between the major European marketplaces London, Paris, Berlin, and Vienna due to the war's outbreak had two major structural effects. For one, it led to New York replacing London as *the* world's financial center.[28] Beyond that, it helped Amsterdam step up from the rank of a regional to the rank of a truly *international* financial center.[29] In the words of Michie (2006), Amsterdam could develop its position of an "[…] active international market for securities *during* [author's highlighting] war […]" further, benefiting strongly from capital searching for new investment outside the belligerent countries and in neutral, less restrained trading places.[30] It should

[20] Cf. Schwabe (1915) and Bernal et al. (2010: 1 195).

[21] In the UK, this was the essence of the "Trading with the Enemy Act". Similar acts were installed at other trading places, too; cf. e. g. Bernal et al. (2010: 1 195).

[22] Michie (1999: 149) describes the procedure for London, where a great many of all foreign-born members and clerks were of German or, respectively, Austrian descent; cf. also Michie (2004b, 2010).

[23] Cf. e. g. Kent (1989: 66–68), Michie (1999: 157), and also Michie (2004b, 2010).

[24] Cf. e. g. Kiehling (1998) on Germany.

[25] Cf. e. g. Michie (1999).

[26] There was a lively debate, for example, among politicians and practitioners in Germany as to whether the state should install a general moratorium on debt service. For all we know, however, Germany kept paying interest to its creditors unless they were residents of enemy countries; cf. Jopp (2014: 168).

[27] That happened, for example, with Berlin, where official trade in sovereign debt was forbidden throughout the war; cf. Table 3.

[28] Cf. e. g. Michie (1999), Cottrell (2005), Cochrane (2009), and Sylla (2011).

[29] Cf. Wouter (1938), Barendregt (2005), and Euwe (2010).

[30] Michie (2006: 161).

be pointed out that this judgment is not limited to the role of the Amsterdam Stock Exchange, which did certainly improve on its function as a hub for trading international securities, but that it refers to the whole financial sector. An international financial center, we may define, (i) offers the whole range of financial products with (ii) a considerable part of the attached payment streams being border-crossing, with (iii) a good part of those products being offered by foreign banks and other financial services providers alongside domestic suppliers, and with (iv) the local currency, in Amsterdam's case the guilder, gaining significance as a reserve currency, as it exhibited value stability.[31] So, we may conclude, it quite seems that World War One had a paradoxical effect on the Netherlands: The war affected economic growth negatively in the short term and the Netherlands' share in world trade negatively in both the short and the long term. But, at the same time, the war increased the financial sector's significance beyond borders. The financial sector's rise, in turn, provided a counterforce, providing the basis for a quick recovery of Dutch economic performance in the interwar period.[32]

In what follows, I concentrate on the Amsterdam Stock Exchange, which certainly formed the core of the emerging international financial center. Before the Dutch government subordinated the stock exchange under state supervision as a reaction to the war, it was a truly private institute carried and regulated by the *Vereeniging voor den Effectenhandel te Amsterdam* as the association of members of the stock exchange, which had been established in 1876 to replace the *Beurs-Comité voor Publieke Fondsen* and the *Effectensocieteit opgerigt door het Algemeen Beurs-Comité* as associations of members of the stock exchange. After its foundation, the *Vereeniging* accounted for the majority of members. It achieved monopolist status as a members' association in 1903 and acted as the sole carrier of the stock exchange from then on.[33]

After describing my sources and the database I was able to create thereupon, I will be looking into wartime regulations of the Amsterdam capital market and, in particular, into matters of price formation in more detail to assess the credibility of my data. This is not knowledge that is stringently required to be able to follow the argument in the subsequent two subchapters. The reader who is interested in these details at this point, though, is kindly referred to Subchapters II.4.2 and II.4.3, which can be read independently of the preceding data overview.

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[31] This definition is a short version of Barendregt's (2005: 97–98) definition which he offers in his account on Amsterdam's rise to an international financial center. On the history of the financial centers Paris, Berlin, Vienna, and Zurich, cf. Ronge (1959), Müller (1992), Gielen (1994), Eube (1998), Bonin (2005), Ullrich (2005), Weigt (2005), Resch (2006), Straumann (2006), and Baltzer (2007, 2013).

[32] Cf. e. g. Bochove (1990) for macroeconomic data on the interwar period.

[33] Cf. Brenninkmeyer (1920: 22–30).

2. Sources on sovereign bonds traded in Amsterdam

2.1. Amsterdam bond prices

For the purpose of this study, I created an extensive database consisting of the *daily* prices for the *entire* cross-section of domestic and foreign government bonds traded at the Amsterdam Stock Exchange in the period 1 January 1914 to 31 December 1919; that is, for a stretch of 2 191 days. Prices were hand-collected from a set of Dutch contemporary newspapers by going manually through every day. The official price list as originally prepared by the *Vereeniging voor den Effectenhandel* ("Amsterdam Corporation for Trade in Securities"), the Amsterdam Stock Exchange's private carrier, was frequently published in the locally relevant newspapers which are part of the digital collection of the *Koninklijke Bibliotheek van Nederland*.[34] The *Algemeen Handelsblad* (or *Nieuwe Amsterdamsche Courant*) became my most relevant source for the price list, the *(Uittreksel uit de) Officieele Prijscourant der Vereeniging voor den Effectenhandel te Amsterdam* ("[Extracts of the] official price list by the Amsterdam Corporation for Trade in Securities"). I consulted another seven newspapers to guarantee that my database of prices is complete (or, at least, as near to being complete as possible); these were *De Telegraaf*, *De Tijd: Godsdienstig-Staatkundig Dagblad*, *Het Centrum*, *Leeuwarder Courant*, *Nieuwsblad van het Noorden*, *Nieuwe Rotterdamsche Courant*, and *Rotterdamsch Nieuwsblad*. All newspapers were published daily, and the *Algemeen Handelsblad* was published in two issues – a morning and an evening issue. It was necessary to consult this extended set of newspapers for the reason that there are gaps in the stock of accessible issues of my main source. To fill gaps in coverage, I had to consult the others (which themselves may have also contained gaps).[35] Besides, on any randomly chosen day, the listings in two different newspapers did not necessarily show price quotations for exactly the same set of bonds. Occasionally, there was a price of bond *x* quoted in *Het Centrum*, which was not quoted in the *Algemeen Handelsblad*.[36] So, broadening the source base was imperative to obtain as many quotations as possible.[37]

[34] Cf. the *Koninklijke Bibliotheek* (*National Library of the Netherlands*) at www.kb.nl/en/home.

[35] For example, at the time of my data gathering, the *Algemeen Handelsblad* was not digitally available for the second half of 1915.

[36] In some way this is not surprising as the price list in the *Algemeen Handelsblad* is equipped with the addition "uittreksel" – "extracts". It took me a while to discover that there are no systematics on which one may count as to which price(s) is/are dropped. So looking into several price lists per day to fill gaps was crucial.

[37] There are several older as well as more recent publications that one may consult on some baseline information about the newspapers (their history in brief, and maybe some statistics). Publications exclusively focusing on Dutch newspaper are Schneider/Hemels (1979) and van de Plasse (2000). According to van de Plasse (2000: 137), the circulation of the *Algemeen Han-*

Beyond these newspapers, I drew on several volumes of the relevant handbooks on the Amsterdam Stock Exchange to gather additional information which does not come with the price lists; these are the *Gids bij de Prijscourant* edited by the *Vereeniging voor den Effectenhandel te Amsterdam* and the *Effectenboek* edited by S. F. van Oss. These are complementary sources that provide us with the bonds' financial characteristics. Both handbooks offer entries on every security officially admitted to trade by the *Vereeniging voor den Effectenhandel*.

Plates A.1 to A.3 in online Appendix 1.2 to this study give a well-enough impression of the scans' quality, which varies across the available issues for one and the same newspaper as, in particular, across newspapers. This is primarily due to the historical newspapers' particular design. As becomes obvious from plates A.1 and A.2, which show extracts of the *Algemeen Handelsblad* and *Het Centrum* for two randomly chosen dates, these were large-sized newspapers with a per se small font size.[38] So, having the possibility to cross-check with as many newspapers as possible was imperative to not only fill gaps in the price account, but also identify what the quoted price exactly is. While panel (a) in both plates shows the full page on which the price list is printed, panel (b) zooms into the first part of the price list, marked by a frame, which always began with government bonds.

Principally, the *Officieele Prijscourant* reported three different prices per security, sometimes even four, as in the case of the *Algemeen Handelsblad*. These price quotations were abbreviated with *L. K.*, *H. K.*, *V. K.*, and, depending on the newspaper one looks at, *S. K.*, so abbreviated in the newspapers without further explanation. According to Ludger Brenninkmeyer's (1920) institutional overview of the Amsterdam Stock Exchange for the time in question, these were the lowest (*laagste koers*) and highest (*hoogste koers*) quotations of the *actual* day – 16 May 1916 and 27 December 1917 in the examples –, the mid-price of the *previous* day (*vorige koers*) – that is, the average of the lowest and highest quotes of that day –, and the closing price of, again, the *actual* day (*sloetkoers*).[39] I collected all "middle prices" that I could find and, in addition, also the lowest and highest prices for five particular bonds for which those prices were regularly reported in conjunction. While going through all the price lists, it turned out that the lowest *and* highest prices were only rarely reported in conjunction for one and the same bond which is why having those prices for, at least, five bonds is quite a bonus.[40]

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delsblad (*De Telegraaf*, *Het Centrum*, *Leeuwarder Courant*, *De Tijd*) as of 1914/15 amounted to 17 191 (28 095, 20 000, 10 500, 5 000); the circulation for 1917/1918 is given only for the *Algemeen Handelsblad* and *De Telegraaf* and amounted to 36 000 and, respectively, 28 259. German-language publications focusing on a broader array of countries include, among others, *Handbuch der Auslands-presse* (1918) and *Handbuch der Weltpresse* as edited by Prakke et al. (1970).

[38] Note that my copying of the extracts into the online Appendix did not worsen the quality.

[39] Cf. Brenninkmeyer (1920: 136).

[40] As can be gathered from the price list in plates A.1 and A.2 in online Appendix 1.2, the

Four further notes on the price quotes are in order: Firstly, we are, formally, dealing with the *secondary market* for government bonds – that is, the market for securities already issued. This market has to be clearly distinguished from the *primary market* for securities; generally speaking, the "underwriting market(s)" (in case of firm stock, the market for initial public offerings).[41] Secondly, the sovereign bond prices reported in the *Officieele Prijscourant* are spot market prices – that is, the underlying transactions have to be fulfilled in due course where, ideally, (i) the buyer of the bond already has the money he would be owing when making the transaction, and (ii) the seller already owns the piece of the bond he would be wanting to sell at that point in time. Effectively, spot market transactions were not handled that strictly. What matters here is that we are not formally dealing with forward transactions which, at the time, were generally rarely done at the Amsterdam Stock Exchange.[42] Thirdly, prices are noted in percent of par value, which is 100 percent.[43] Finally, fourthly, as to my understanding, the quoted prices do not include accrued interest by default. So, principally, we would have to correct these "clean prices" for lacking accrued interest in order to receive the "dirty prices".[44] Below, when it comes to liquidity issues, I will explain why I do not consider this step of data manipulation in this study, though.

In addition to the prices of the sovereign bonds that were officially allowed to be traded at the stock exchange – in short: "official prices" –, I also collected a set of prices of bonds that were traded in the unofficial, or "grey", market; cf. Plate A.3 in online Appendix 1.2 for the general looks of that section in the *Algemeen Handelsblad*. These bonds were not admitted to be traded in the rooms of the stock exchange but turn out to have been traded quite lively on the streets. In

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lowest prices were usually reported along with the middle prices of the previous day; these lowest prices, if no highest price was reported alongside, are simply to be taken as the middle price of the actual day which would be reported the next day under "V. K."; cf. Subchapter II.4 on price formation.

[41] Cf. Flores (2010), Burhop/Lehmann-Hasemeyer (2016), and Lehmann-Hasemeyer/Streb (2016).

[42] Cf. Brandes de Roos (1928: 67).

[43] If the price in percent of par value was quoted as 80.0, a standardized piece of bond of 500 monetary units would be traded at 400 monetary units.

[44] Recall the simple bond price model outlined in Subchapter I.3: a bond pays interest in regular intervals. Imagine a bond of 500 monetary units with a single payment per year, paying five percent interest on 2 January. Assume further that a bondholder collects the interest payment and then wants to sell the bond on 9 January, a week later. Theory says that on that day the bondholder has already acquired a new *implicit* entitlement to 7/365 times the next interest payment which, however, the buyer would collect in full (one could discuss extensively which length the standard year should actually have; I spare that discussion here). This entitlement increases monotonically, day by day, towards 2 January of the next year. The buyer of the bond would have to compensate the seller for this foregone share in the next interest payment by paying the price of the bond as quoted plus the accrued interest (0.0192 * 25 = 0.479 monetary units); cf. e. g. Martellini et al. (2003: 42–54).

the diction of the newspapers, these are the *niet-officieel genoteerde fondsen* ("not officially quoted securities") reported at a different place in the newspaper issue – if reported at all.

There are three reasons for why these prices are a particularly valuable addition to the official prices: Firstly, we cannot take for granted that grey markets existing parallel to the official market during World War One are sufficiently well-documented in historical sources. For example, we know from Fritz Kronenberger's (1920) study of securities prices in Germany during the war that a quite lively grey market existed in Berlin. This grey market compensated for the fact that the Berlin Stock Exchange was completely closed for any trade in securities until late 1917 and, thereafter, continued to be closed for trade in fixed-interest securities up until 1919.[45] In his study, Kronenberger reports monthly price for a number of fixed-interest securities and stocks which he said he had taken from unofficial price lists published by commercial banks at the time. To the best of my knowledge, none of these unofficial price lists have survived in the archives, though.[46] Insofar, having documented grey-market prices at hand for Amsterdam seems to be a true windfall.

Secondly, we find a set of English and French war bonds on the price list for the unofficial Amsterdam market which were apparently traded during the war. This is an interesting fact, as it implies that the English and French markets were not as sealed off from other markets than one would be tempted to assume (cf. Subchapter II.1). Otherwise, how would those countries' war loans issued to nationals find their way into the Amsterdam market?

Finally, thirdly, the fact that we find a number of English and French war bonds traded, if only unofficially, is a true windfall for and upgrade to this investigation. This is because, in advance of the discussion in Subchapter II.3, no French or English bonds issued before the outbreak of war were traded in Amsterdam during the war or in 1919. So, if it was not for the unofficially traded war bonds, two of three major European Allied Powers (with Russia being the third) would be completely missing in this investigation.

Unfortunately, though, there is no source on this market segment beyond the pure price report in the newspapers. The stock exchange handbooks do not cover it, and the secondary literature is actually limited to the contemporary account of Ludger Brenninkmeyer (1920) who, however, does not go beyond stating the existence of a grey market. Insofar, there is a good deal of uncertainty about what the price quotes actually say in this segment, as it did not fall under

[45] Cf. Kronenberger (1920: 6), and also Obst (1915), Pohle (1915), and Klebba (1920: 2–11, 28–34).

[46] Firstly, if some had survived, we would expect them to be mentioned in relevant studies on the Berlin capital market during World War One. Kiehling (1998) provides such a relevant study where there is no mention of such lists having survived, though. Secondly, my own archival inquiries have yielded no success whatsoever on this matter.

Table 6: Summary of the created sovereign bond database

Fact	Entire observation period	By sub-period		
		Pre-war period	War period	Post-war period
Coverage	01/01/1919 – 31/12/1919	01/01/1914 – 28/07/1914	09/02/1915 – 11/11/1918	12/11/1918 – 31/12/1919
No. of raw price quotes				
(1) Officially reported middle prices	155 022	30 175	98 566	26 281
(2) Officially reported lowest/highest prices	3 282	258	2 236	788
(3) Unofficial prices on English and French war loans	2 936	–	1 764	1 172
(4) Unofficial prices on officially traded piece-time issues	26	–	20	6
Total	*161 266*	*30 433*	*102 591*	*28 247*
No. of bond (sub-)series	288	227	262	247
No. of sovereign issuers (i. e., countries)	38	36	38	37

Sources: Cf. the text.
Notes: Dates in this table, as in all tables in the remaining part of the study, are given in *dd/mm/yyyy*-format.

the regulations of the stock exchange. A look at Plate A.3 reveals that, for example, a price of 93 percent was quoted for the Anglo-French war loan issued in 1915. In the absence of better knowledge, I take this quote as being comparable to the middle price of the previous day reported for officially traded bonds.

Table 6 gives a summary of the price database I created for Amsterdam at *daily* frequency.[47] The number of raw price observations is given (i) for the entire observation period and for the three sub-periods as well as (ii) by the type of price quote reported, of which I distinguish four: middle prices on officially and unofficially traded bonds issued prior to 1914; middle prices of unofficially traded English and French war bonds issued since 1915; and full sets of lowest

[47] Note that, to the best of my knowledge, the hitherto most comprehensive (and yet unpublished) database on Amsterdam securities prices is that built by Lyndon Moore. That database is at monthly frequency (one price quote gathered every four weeks). As Moore created that database for the purpose of measuring long-term market integration among a set of twelve internationally important stock exchanges between 1900 and 1925, that is a high enough frequency, for sure. However, for the purpose of measuring bondholders' perception, we need the highest frequency possible. Insofar, my database is genuinely new.

and highest prices on officially traded bonds again issued prior to 1914.[48] The slightly more than 161 000 price quotes, of which 155 000 are officially quoted middle prices, refer to 214 different main bond series, or 288 different bond *sub*series, issued by a total of 38 different sovereign issuers or, respectively, countries.[49]

To give an example: One of the main bond series traded was the German 3 % Imperial bond issued between 1890 and 1901 with the clear intention to borrow in foreign markets. It was the only bond of the central government that was traded outside Germany at the time, and Amsterdam was one of its trading places (besides London and Brussels).[50] The bond was issued in two series that differed in the point in time when they paid interest – or, in short, they differed in the *coupon date*. The one series paid interest in January and July, and the other in April and October.[51]

The price account for the war period is quite rich, with almost 64 percent of all collected price quotes falling into this period. Note that the number of bond subseries traded during the war increased from 227 to 262 due to new issues admitted to the stock exchange. These were Dutch domestic issues in the first place. Likewise the number of countries that saw their bonds traded increased by two – namely the US and, due to the war loans, England.

Table 7 conveys an impression of how much of the Amsterdam securities market my database actually covers. Shown in the table is the composition of the traded securities for selected years between 1855 and 1943. The one part of the information is from Ludger Brenninkmeyer's (1920) seminal study. The other part is by me, as I went through a number of stock exchange handbooks to add data for some war years and for the period 1924 to 1943 to offer a long-term view. The second column reports the total number of securities officially listed. This number increased from 86 in 1855 over 1 471 in 1914 to not less than 2 998 in 1918 (and also in 1934), telling of the considerable expansion of the Amsterdam Stock Exchange in the long run, but especially during World

[48] With a "full set" I mean that both the lowest and highest price had to have been reported for a particular day, not simply one of them. However, it occurred regularly that only the lowest price was reported, which is essentially the middle price of the actual day then.

[49] The actual number of sovereign issuers is higher if we consider that also entities below the central government had issued bonds that were subsequently traded in Amsterdam, e. g., the state of Prussia (Germany) or the state of Bahia (Brazil). I do not count these cases separately here.

[50] According to the contemporary stock exchange handbooks like *Saling's Börsen-Jahrbuch* (1918/1919) on Berlin or Skinner's *Stock Exchange Year-Book for 1915* on London, the German 3 % formally constituted domestic debt (in contrast to foreign debt), as it was issued under German jurisdiction; for more information on the German 3 %, cf. the online Appendix and Jopp (2014: 167–168).

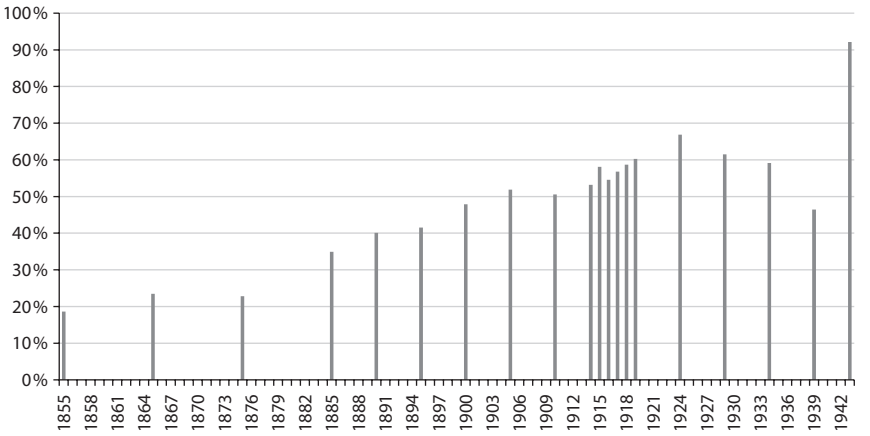
[51] I plan on making my price database digitally and, especially, sustainably available to the interested scholar in due course; cf. Jopp (2021).

Table 7: Composition of securities traded at Amsterdam in the long term

		Fixed-interest bearing securities (excluding corporate bonds) in %			Stocks (including corporate bonds) in %						
Year	Total #	Sovereign bonds (1)	Provincial/ Municipal bonds (2)	Other A (3)	Banks (4)	Railways/ Tramways (5)	Manufacturing (6)	Shipping (7)	Oil (8)	Tobacco/Tea/ Rubber/Sugar (9)	Other B (10)
1855	86	73.3	3.5	7.0	9.3	4.7	0.0	0.0	0.0	0.0	2.3
1865	115	57.4	2.6	8.7	7.0	20.9	0.0	0.0	0.0	0.0	3.5
1875	237	31.2	2.1	9.3	3.8	46.0	0.0	2.1	0.0	0.0	5.5
1885	432	25.2	3.0	11.6	4.9	44.4	0.9	3.5	0.2	0.0	6.3
1890	606	17.8	4.6	12.2	4.8	42.9	1.0	2.6	0.0	1.8	12.2
1895	787	17.3	4.1	13.5	4.6	40.2	1.9	2.2	0.0	2.8	13.6
1900	1 000	16.6	5.4	14.2	5.2	32.0	4.0	2.4	2.4	3.8	14.0
1905	1 238	16.6	5.7	14.7	5.5	29.2	5.3	3.2	2.5	3.2	14.3
1910	1 471	15.7	6.9	14.7	5.1	26.0	9.0	3.0	2.5	3.7	13.4
1914	1 797	14.5	8.0	15.9	5.0	22.0	11.2	2.3	2.6	4.8	13.7
1915	2 163	13.4	9.6	16.0	5.5	18.7	13.9	2.9	2.2	4.1	13.7
1916	2 549	13.2	11.3	15.7	4.9	15.9	16.8	3.0	1.8	5.8	11.7
1917	2 756	14.0	11.9	14.3	5.4	14.2	18.0	2.6	2.0	5.9	11.8
1918	2 998	13.8	14.3	14.7	5.1	12.8	18.9	2.1	1.8	5.5	10.9
1919	2 163	13.4	9.6	16.0	5.5	18.7	13.9	2.9	2.2	4.1	13.7
1924	2 549	13.2	11.3	15.7	4.9	15.9	16.8	3.0	1.8	5.8	11.7
1929	2 756	14.0	11.9	14.3	5.4	14.2	18.0	2.6	2.0	5.9	11.8
1934	2 998	13.8	14.3	14.7	5.1	12.8	18.9	2.1	1.8	5.5	10.9
1939	2 558	15.5	8.8	13.9	5.5	13.0	20.6	1.8	1.9	6.0	13.0
1943	1 172	4.3	11.7	13.1	7.0	4.4	23.3	2.6	1.8	11.6	20.4

Sources: 1855–1914, 1917, 1919: Brenninkmeyer (1920: 184–187). 1915, 1916, 1918, 1920–1943: My own counting based on the *Gids bij de Prijs-Courant*.
Notes: The classification scheme did not remain stable across the years. Categories are formed on the basis of Brenninkmeyer's account. "Preliminarily noted securities" are not counted. "Other A" includes lottery bonds, mortgage bonds, and bonds by church and polder institutions. "Other B" includes the sectors agriculture, mining, trade, and miscellaneous.

Figure 11: Share of domestic securities in all securities in the long term



Sources: Cf. Table 7.
Notes: 1943 is an obvious outlier. The relative weight of domestic issues of 92 percent is certainly due to the Nazis shutting down the Amsterdam market for trade in foreign issues except German securities.

War One.[52] In the remainder of the table, this total number is deconstructed into different categories of fixed-interest bearing securities and stocks. Shown is the relative frequency distribution of the different categories. Most relevant for this study is the weight of the sovereign bonds' segment: in the years under study, this segment accounted for between 13.2 and 14.5 of all listed securities. So, I have been observing roundabout one-seventh of the total market. The share of all fixed-interest bearing securities together fluctuated around two-fifths between 1914 and 1919.

Figure 11 and Table 8 extend the picture. For the same stretch of time, Figure 11 depicts the development of the share of domestic securities in all securities. Obviously, domestic issues gained importance in the long term because their share rose from roughly 20 percent to 60 percent in 1918 and 67 percent in 1924. Up until the war, this certainly tells of the Dutch economy's strong growth since the middle of the nineteenth century.

Table 8 sorts traded securities, broadly, by geographical origin. As becomes obvious, roughly three-quarters of all securities originated in Europe when, for example, focusing on 1914. Except for the middle of the nineteenth century,

[52] The severe drop in 1943 is due to the fact that over 1 000 securities were marked as "preliminarily noted securities". While there were such securities in the previous years, too, the sheer number in 1943 is unprecedented. I did not count this category of securities, as it was not separately reported by sector.

Table 8: Composition of traded securities by continent in the long term

Year	Europe	North America	Central/South America	Asia	Africa
1855	74.4	8.1	17.4	0.0	0.0
1865	74.8	12.2	13.0	0.0	0.0
1875	60.3	32.9	5.9	0.0	0.8
1885	70.6	25.5	3.2	0.0	0.7
1890	70.1	24.9	4.1	0.0	0.8
1895	72.2	23.3	3.7	0.0	0.9
1900	76.6	17.6	4.1	0.5	1.2
1905	78.1	16.3	4.3	0.6	0.7
1910	74.6	18.2	5.3	1.2	0.8
1914	75.3	17.5	5.7	0.8	0.7
1917	77.4	16.0	5.3	0.7	0.6
1919	79.5	14.3	4.9	0.6	0.6

Sources: Cf. Table 7.

European and North American securities together accounted for a roughly stable share of between 90 and 95 percent.[53]

2.2. Additional bond price and miscellaneous data

My core database is augmented by additional data used for descriptive and inferential purposes at different stages in the analysis. Like with the cross-section of government bond prices, I hand-collected these additional data from either my primary sources – the set of Dutch historical newspapers – or other printed or digitally available sources. To the best of my knowledge, none of these data have yet been made publicly available in any database, or have been collected (at the frequencies I have collected them), at all. Insofar, this additional dataset of slightly more than 32 000 observations, like my original price database, represents a genuine contribution to the literature.

Table 9 provides an overview of (i) the types of data; (ii) the trading place (i. e., stock exchange) or country to which the data refer; (iii) the period over which as well as the frequency at which the data are observed; (iv) the number of observations falling on the different types of data; and (v) the consulted sources. The first four types of data are observed at daily frequency, too, and augment the analysis in Chapter III. These are prices for six selected Dutch municipal bonds as traded in the provincial and municipal bonds' segment at the Amsterdam Stock Exchange; share prices for twelve selected joint stock companies, likewise

[53] This finding is, of course, not too surprising, as the economically most advanced countries – then, as now (with few exceptions) – are to be found on these two continents.

Table 9: Additional data and their sources

Type of data	Trading place referred to	Frequency of observation	# of observations	Source
Prices of six Dutch municipal bonds	Amsterdam	Daily, 1914–1919	2 931	Subchapter II.2
Prices of twelve Dutch corporate stocks	Amsterdam	Daily, 1914–1919	11 373	Subchapter II.2
Prolongatie koers (interest rate on loans intermediated via the stock exchange)	Amsterdam	Daily, 1914–1919	1 216	Subchapter II.2
Exchange rates of the Dutch guilder to nine foreign currencies	Amsterdam	Daily, 1914–1919	5 988	Subchapter II.2; van der Heyden (1918: 170–198)
Notes issued by six central banks/countries	Austria, England, France, Germany, Netherlands, Russia	Weekly, 1914–1919	1 576	Economisch-Statistische Berichten
Prices of 25 domestic and foreign sovereign bonds	London	Weekly, 1914–1919	6 757	The Times of London; and The Financial Times of London
Prices of 14 domestic and foreign sovereign bonds	Paris	Weekly, 1914–1919	2 492	Bulletin de la Côte
Prices of five domestic and foreign sovereign bonds	Berlin	Monthly, 1915–1918	229	Kronenberger (1920)

Sources: Author's own depiction.

as traded in Amsterdam; the so-called *prolongatie koers*, which was the one-month interest rate for loans intermediated via the stock exchange and which represented the single-most important interest rate in the Dutch capital market at the time; and nine exchange rates as quoted in Amsterdam – among others, the value of the Dutch guilder to British pounds sterling, French francs, Russian rubles, Austrian kroner, and German marks. I will discuss these data in more depth at the appropriate place in Chapter III.

On a weekly basis, I observed the money circulation for a set of six countries as reported by the respective central banks and printed in a contemporary Dutch specialized journal, the *Economisch-Statistische Berichten*. These data are used as the basis for assessing money inflation, and they will likewise be part of, and discussed in, the analysis in Chapter III. Beyond these data, I hand-collected additional prices for three sets of sovereign bonds as traded in London, Paris, and Berlin. For descriptive purposes, I collected London and Paris official prices at weekly frequency and Berlin unofficial prices, as reported by Fritz Kronenberger (1920) (recall the previous subsection), on a monthly basis.

3. Description of the created sovereign bond database

3.1. The Amsterdam cross-section of sovereign bonds

This subchapter offers a description of the cross-section of bonds or, respectively, bond subseries in more detail. Note upfront that the online Appendix offers background information on all bonds in the cross-section and, thus, is an indispensable complement to the analysis. Online Appendix 1.2 provides baseline information per bond *subseries* gatherable from the stock exchange handbooks like the interest rate, the year of issuance, the currency denomination, the redemption modalities, and so on. Online Appendix 1.3 contains plots of the raw middle price of all bonds for which a certain minimum number of observations is available. Online Appendix 1.4 briefly discusses the bonds for which I could gather additional lowest and highest prices. Online Appendix 1.5 provides monthly price series on selected bonds in tabular form. Finally, before continuing with the database's description, a note on diction is necessary: From now on I will refer to a particular bond just as, for example, "the German 3 %" instead of "the German 3 % imperial loan". If necessary, I will make an addition so as to clarify which particular subseries I am addressing, for example, "the German 3 % with coupon dates April and October" (instead of the one with coupon dates January and July). Using this "*x* %" notation might serve to confuse the reader as we will be dealing with several "percent concepts", in fact. Besides a bond's name and mathematical growth rates on which the preceding subchapter's argument (and also Subchapter I.1) partly rested, we will be meeting prices in *percent* of

par value and yields which are expressed in percent, too. Throughout the text (that is, except for tables), I use the percent sign, "%", exclusively to denote a bond. Otherwise, it reads "percent".

Turning to the database's description in more detail, Table 10 shows how both the number of bond subseries and the number of price observations distribute over the issuing countries. In line with how the official price list was arranged, I report the figures continent by continent. Note that the Dutch East Indies and Surinam are counted for Europe as they were Dutch colonies at the time. The bond subseries on European countries account for 75 percent of all bond subseries in my database, namely 207; and, beyond that, for 77 percent of all price observations, namely 122 000. This reflects pretty well the basic finding that most of the securities traded in Amsterdam were of European origin. Within the subset of European countries, Russia alone accounts for roughly 28 percent of all bonds – i. e., 77 – and about 37 percent of all observations – i. e., 59 000 price quotes. Note that many Russian issues were railway bonds issued to finance the expansion of the railway network spanning the Russian Empire's vast territory.

Noteworthy also is the weight of Dutch bonds in both the number of bonds and the number of observations falling on them, namely 25 and, respectively, slightly over 19 000. Russia and the Netherlands together thus roughly account for half of all price observations. Interestingly, Romania accounts for the third-largest number of bonds, but these bonds were traded extremely infrequently, as they make up for only 1.4 percent of all price observations on European countries' bonds.

However, contrasting the general message of Table 8, Central and South America are quite well represented in government bonds. A fifth of all bond series and also observations fall on Central and South American countries. Brazil accounts for the largest number of bonds within this group, namely 30. This lets Brazil rank second behind Russia. Correspondingly, Brazil also accounts for the largest number of price observations in that group thereby ranking third behind Russia and the Netherlands regarding the entire cross-section.

Table 11 complements Table 10 by showing the respective numbers on the unofficially traded bonds that I was able to collect prices for. Besides England and France, which are represented by eleven war loans, I was able to collect a tiny number of price quotes on German bonds which were actually officially traded – the German 3 % (14 observations), the Prussian 3 % and 3.5 % (one and eight observations, respectively), and a German 5 % bond (one observation) which very likely was a war bond. In the analysis below, I will not consider these unofficial quotes on German bonds, though.

Table 10: The cross-section of officially traded sovereign bond subseries by country

Country	# of series	Share in total	# of observations per country	Share in total
[1] Austria	10	3.6 %	8 109[b]	5.1 %
[2] Belgium	2	0.7 %	174	0.1 %
[3] Bosnia-Herzegovina	3	1.1 %	79	0.0 %
[4] Bulgaria	5	1.8 %	3 129	2.0 %
[5] Denmark	3	1.1 %	434	0.3 %
[6] Dutch East Indies[a]	13	4.7 %	8 889	5.6 %
[7] Finland	1	0.4 %	164	0.1 %
[8] France	1	0.4 %	63	0.0 %
[9] Germany	10	3.6 %	3 192	2.0 %
[10] Hungary	12	4.3 %	4 834[b]	3.0 %
[11] Italy	1	0.4 %	178	0.1 %
[12] Netherlands	25	9.0 %	19 268[b]	10.4 %
[13] Norway	1	0.4 %	7	0.0 %
[14] Portugal	5	1.8 %	4 831	3.0 %
[15] Romania	17	6.1 %	2 162	1.4 %
[16] Russia	77	27.8 %	59 074[b]	37.3 %
[17] Serbia	3	1.1 %	1 895	1.2 %
[18] Spain	2	0.7 %	192	0.1 %
[19] Surinam[a]	2	0.7 %	99	0.0 %
[20] Sweden	3	1.1 %	655	0.4 %
[21] Switzerland	1	0.4 %	388	0.2 %
[22] Turkey	10	3.6 %	4 124[b]	2.6 %
Europe	*207*	*74.7 %*	*121 940*	*77.0 %*
[23] China	4	1.4 %	2 137	1.3 %
[24] Japan	7	2.5 %	3 187	2.0 %
Asia	*11*	*4.0 %*	*5 324*	*3.4 %*
[25] Argentina	3	1.1 %	2 193	1.4 %
[26] Brazil	30	10.8 %	17 729	11.2 %
[27] Chile	4	1.4 %	1 748	1.1 %
[28] Colombia	1	0.4 %	744	0.5 %
[29] Cuba	2	0.7 %	1 267	0.8 %
[30] Dominican Republic	1	0.4 %	956	0.6 %
[31] Mexico	9	3.2 %	3 507	2.2 %
[32] Nicaragua	1	0.4 %	331	0.2 %
[33] United States of America	1	0.4 %	1	0.0 %
[34] Uruguay	2	0.7 %	1 167	1.0 %
[35] Venezuela	2	0.7 %	915	0.6 %
America	*56*	*20.2 %*	*30 578*	*19.3 %*
[36] Egypt	2	0.7 %	298	0.2 %
[37] Liberia	1	0.4 %	164	0.1 %
Africa	*3*	*1.1 %*	*462*	*0.0 %*
Total	*277*	*100.0 %*	*158 304*	*100.0 %*

Sources: Cf. Subchapter II.2 and Table A.2 in online Appendix 1.2.
Notes: "Share in total" is the share in total observations, not in the continent's sum total. Percentages might not sum up exactly due to rounding to the first decimal place. [a] As both territories were Dutch colonies at the time, they are subsumed under "Europe". [b] Observations also contain all available lowest and highest prices for one bond; cf. the discussion in the text.

Table 11: Unofficially traded sovereign bond series by country

Country	# of series	# of observations per country
[8] Germany	*4*	*24*
[9] France	*2*	*472*
[38] England	9[a]	2 466[a]
Total	*15*	*2 962*

Sources: Cf. the text and Table A.3 in online Appendix 1.2.
Notes: [a] The Anglo-French war loan is ascribed to England.

As already pointed out, having price quotes on the English and French war loans is highly welcomed. But, and that is a bit unsatisfactory, the bonds are not easy to identify. I will make this clear for the two issues that I will be analyzing in Chapters III and IV. These are the English 5 % endorsed with "1919" and the French 5 % endorsed with "1915". Following H. Köppe, who provides us with a rich contemporary account of the war loans issued by the belligerents, I strongly suppose that the English 5 % was one of the various exchequer bonds with short duration (up to five years) issued since 1915. The first price quote in my database is for 6 May 1916.[54] For the French 5 % bond, I recorded the first price for 27 November 1915. This bond very likely refers to the national defense loans ("obligations de la défense nationale") issued with fixed duration of ten years the first time in early 1915. However, the French government had also issued 5 % national defense bills ("bons de la défense nationale") at the time which matured after only 6 to 12 months, so had an extremely short duration. From the fact, though, that the French 5 % was traded during the rest of the war, I suppose it refers to the defense loans and not to the defense bills. Principally, we also have to take into account that there was a French 5 % "victory loan" issued between 25 November and 15 December 1915. However, as this bond would have had to find its way to the Amsterdam market within two days right after the first day of issuance, I doubt that we are dealing with this bond.[55]

In all, the composition of the cross-section gives an impression of how internationalized the Amsterdam marketplace for government bonds actually was: of the 34 foreign countries the bonds of which were officially traded during World War One, 19 were European, 11 Latin-American, 2 African, and 2 Asian countries. Domestic issues (including Surinam and the Dutch East Indies) accounted for about 14.6 percent of traded bonds. This broad range of countries reflected by the bonds in my database enable me to cover the Central Powers in full and the Allied Powers to a significant degree. Table 12 lists the countries I am covering by faction and, within faction, it sorts them by the first declaration of war they either received or submitted. I take this date as the official date for entering the war.

[54] Cf. Köppe (1916a: 328–331).
[55] Cf. Köppe (1916e: 740–746).

Table 12: Belligerent countries that saw their sovereign debt traded at Amsterdam

Among Central Powers (Entry into war according to first declaration of war of or on the respective power)		Among Allied Powers	
Austria-Hungary	28 July 1914[a]	Serbia	28 July 1914[a]
German Empire	1 August 1914[b]	Russia	1 August 1914[b]
Ottoman Empire	5 November 1914[e]	Belgium	4 August 1914[c]
Bulgaria	9 October 1915[g]	Japan	23 August 1914[d]
		Italy	23 May 1915[f]
		Romania	27 August 1916[h]
		Portugal	9 March 1916[i]
		USA	6 April 1917[j]
		Cuba	7 April 1917[k]
		Liberia	4 August 1917[l]
		China	14 August 1917[m]
		Brazil	26 October 1917[n]
		Nicaragua	7 August 1918[o]

Sources: Dates of declarations of war taken from Gleichen (2000).
Notes: [a] Austria-Hungary declares war on Serbia; [b] Germany declares war on Russia; [c] Germany declares war on Belgium; [d] Japan declares war on Germany; [e] Great Britain declares war on Turkey; [f] Italy declares war on Austria-Hungary; [g] Bulgaria declares war on Serbia; [h] Romania declares war on Austria-Hungary; [i] Germany declares war on Portugal; [j] United States of America declare war on Germany; [k] Cuba declares war on Germany; [l] Liberia declares war on Germany; [m] China declares war on Germany and Austria-Hungary; [n] Brazil declares war on Germany; [o] Nicaragua declares war on Germany and Austria-Hungary. We might also bring Bosnia-Herzegovina, which was under Austro-Hungarian rule, in on the Central Powers' side; and also Egypt on the Allied Powers' side, which was pronounced a British Protectorate on 17 December 1914 and certainly saw substantial fighting as part of the Middle-Eastern theater.

As further complements to Tables 10 and 11, Table 13 assembles some baseline descriptive statistics on the price observations, and Figure 12 gives a visual impression of the age distribution of the bonds in the cross-section. Firstly, the descriptive statistics refer to the raw prices (in percent of par value) and are given for the entire observation period as well as for the three sub-periods. The subsets of official and unofficial prices are treated separately here. At a later point, I will also introduce descriptive statistics on transformations of the price – i. e., yields and returns.

Secondly, Figure 12 displays the age distribution from the perspective of 1914, hence, for the subset of peacetime issues. A bond's age is simply computed as 1914 minus the year of issuance as reported in Table A.2 in online Appendix 1.2.[56] As can be gathered from the figure, the majority of bonds had an age of between 1 and 35 years in 1914. A few series even go back to the first third of the nineteenth century. Generally, one can observe that the duration of sovereign bonds issued

[56] If a bond was issued over a range of years like, for example, the German 3 %, which was issued over 1890–1901, I simply took the first year – 1890 – as the year of issuance (instead of taking the mid- or end-year).

Table 13: Descriptive statistics on raw middle prices for the universe of sovereign bonds

Statistic	Pre-war period	War period	Post-war period	*Total*
A. Official prices				
Mean	83.7	60.6	52.5	*63.7*
Median	83.9	58.8	51.0	*63.2*
Standard deviation	11.2	21.6	29.4	*24.0*
Minimum	28.0	10.0	3.0	*3.0*
Maximum	132.2	110.0	106.9	*132.2*
Skewness	–0.93	0.22	0.20	*–0.21*
Kurtosis	5.16	–0.45	–1.52	*–0.84*
N	*30 175*	*98 566*	*26 281*	*155 022*
B. Unofficial prices				
Mean	–	86.7	90.7	*88.3*
Median	–	92.2	94.5	*93.0*
Standard deviation	–	12.6	11.6	*12.4*
Minimum	–	2.5	15.0	*2.5*
Maximum	–	100.7	104.7	*104.7*
Skewness	–	–1.49	–2.77	*–1.90*
Kurtosis	–	2.72	9.87	*4.60*
N	–	*1 784*	*1 178*	*2 962*

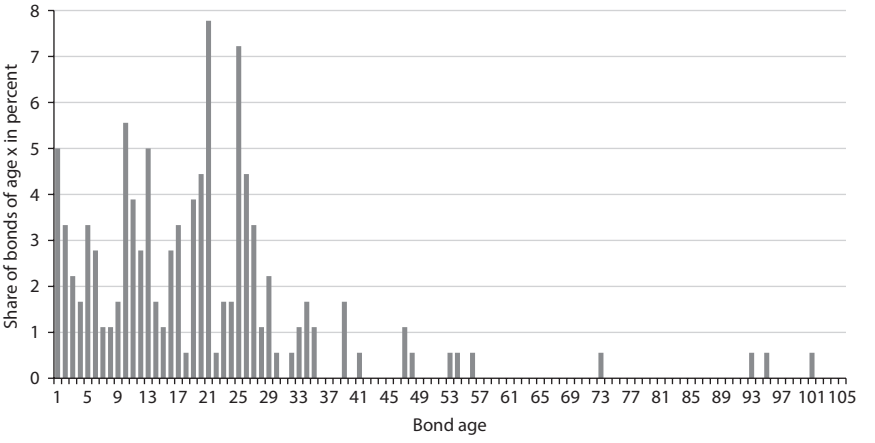
Sources: Author's own computations.

in the nineteenth and the first half of the twentieth century had much longer durations than is common for sovereign bonds issued nowadays. Insofar, an age of 35 years was still "young" for most of the bonds in my database. Put the other way around, the *remaining* duration of almost all bonds in the database was still extensive, meaning that they would mature from the perspective of 1914 – if a date of maturity was specified at all – well thirty or more years later.[57]

This has an important technical implication, as we principally have to take into account the term structure of interest rates when dealing with bonds – that is, the relationship of bond yields and the terms of maturity. The simplest form of a bond yield is the current yield (CY), which is simply the actual price in percent of par value divided by the interest rate that the bond is paying. This is a widely used easy-to-calculate measure of a bond's return, and it is said to much better reflect the risk inherent in the bond than does the price in per-

[57] Principally, it would be helpful for the argument to also plot the bonds' remaining duration as of 1914. However, as Table A.2 in online Appendix 1.2 shows, the modalities of redemption were quite diverse. In many cases there was no clear date of maturity specified. Rather, the sovereign issuer was allowed, or would have, to begin redeeming the bond in a certain year. Formally, this could well have been the first year after issuance. So, in such cases it is unclear which date we should be setting in order to be able to compute remaining durations. Therefore, I abstain from a graphical proof of the fact that the bonds had a sufficiently long remaining run-time, so that we do not have to worry about duration effects; cf. e. g. Birth (1958).

Figure 12: Age distribution of officially traded bonds as of 1914



Sources: Author's own depiction.

cent of par value. A more sophisticated yield concept is the yield-to-maturity (YTM), which is the return that the bondholder would realize if he held the bond until it matures. This return is expressed from the perspective of a day *t* before the day on which the bond actually matures. Hence, computationally, the yield-to-maturity is sensitive to the remaining time until the bond matures as it is based on a present value concept. The closer a bond is to its date of maturity, the more do the current yield and the yield-to-maturity measures diverge.[58] Note that calculating the current yield does not require making any assumption on the bond's date of maturity at all. As I will use the simpler current yield notation in my analysis below, it is imperative to be sure that such duration effects are not going to confuse my results. I will address this aspect for the specific bond series under analysis at the appropriate point.

Finally, Table 14 in conjunction with Figure 13 provides some detail on how trade was resumed after 9 February 1915, when the Amsterdam Stock Exchange began to work again. In Table 14, I assembled information on the order of trade resumption. Given in column one is the date of the initial war price quote of the subseries reported in column two. Column three states the initial price in percent of par value, and column four states the last peacetime price, which frequently fell on either 27 or 28 July 1914. The column on the far right shows the cumulated number of bonds in trade up to the particular point in time. As follows from the list, the first bonds to be traded again were Dutch domestic issues. Peacetime issues were clearly noted at a lower price than before the war. This is a piece of information naturally lacking for the newly issued voluntary

[58] Cf. e. g. Goyenko et al. (2011).

Table 14: Order of resumption of trade in sovereign bonds up until August 1915

Date [dd/mm/yyyy]	Bond series	Initial war-time price	Last peace-time price	# of bonds in trade
09/02/1915	Dutch 5.0 % obligation NWS (100/200)	99.7	–	
	Dutch 5.0 % obligation NWS (500/1 000)	99.8	–	2
26/03/1915	Dutch East Indian 5.0 % 1915 (100/500)	97.7	–	
	Dutch East Indian 5.0 % 1915 (1 000)	97.5	–	4
15/04/1915	Dutch 2.5 % certificates	62.0	65.4	5
16/04/1915	Dutch 2.5 % Groetbook obligation	62.1	66.5	6
26/04/1915	Dutch 3.5 % obligation NWS	82.1	89.2	
	Dutch 3.0 % obligation NWS	70.7	76.8	9
	Dutch 3.0 % certificates	70.7	76.7	
27/04/1915	Dutch 3.0 % Groetbook obligation	71.4	77.8	10
04/06/1915	Dominican 5.0 % customs	87.0	97.2	11
10/06/1915	Cuban 5.0 % 1904/05	98.0	101.7	12
15/06/1915	Cuban 4.5 % 1909	87.0	93.9	13
29/06/1915	Dutch 4.5 % obligation NWS (1 000)	101.1	–	14
02/07/1915	Dutch 4.5 % obligation NWS (100)	101.1	100.5	15
05/07/1915	Argentinian 5.0 % 1905	75.0	77.5	
	Brazilian 5.0 % 1914 (20/100)	66.2	–	18
	Brazilian 5.0 % 1914 (500/1 000)	66.2	–	
14/07/1915	Portuguese 4.5 % 1890 tobacco	82.0	93.0	19
03/08/1915	Colombian 3.0 % 1896	41.0	49.5	20
19/08/1915	Swedish 3.5 % 1890	74.0	84.0	21
24/08/1915	Among others:			
	Austrian 4.0 % kroner (Jan/Jul)	56.1	72.0	66
	Bulgarian 5.0 % 1902 tobacco	73.5	92.0	
	German 3.0 % imperial (Jan/Jul)	59.7	75.0	
	Ottoman 4.0 % Baghdad Rw.[a] 2nd ser. 1910	48.1	73.8	
	Romanian 4.0 % 1890 (500/1 000)	59.0	86.2	
	Russian 5.0 % 1906 (2 500/5 000)	81.1	95.0	
	…	…		

Sources: Author's own depiction; cf. online Appendix 1.2 for the bonds' details.
Notes: Prices are rounded to one decimal place. [a] "Rw." abbreviates "Railway".

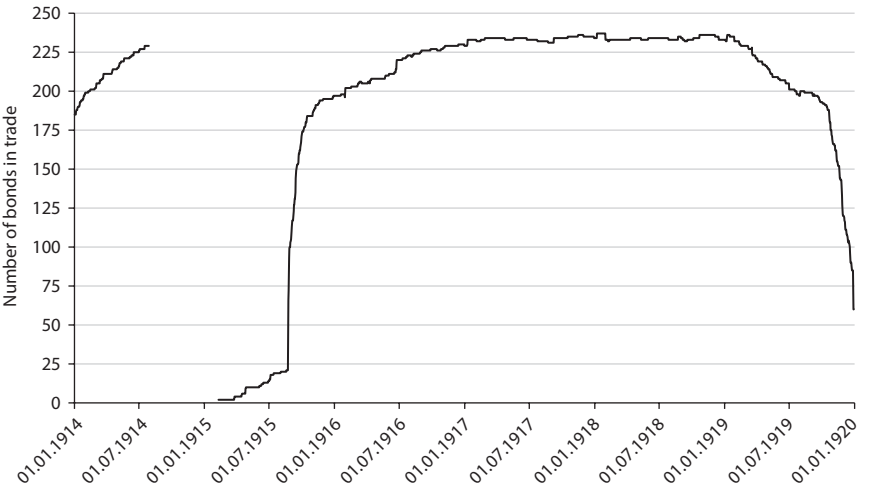
war loans – the Dutch 5 % and Dutch East Indian 5 %. The first foreign bond to see trade again was a bond of the Dominican Republic in which trade was resumed on 4 June 1915. The Dominican 5 % was followed by another Dutch issue and further bonds of Central American and South American countries, namely Cuban, Argentinian, and Brazilian bonds. The Portuguese 4.5 % and the Swedish 3.5 % bonds were the first European, non-Dutch bonds to be traded again since mid-July 1915. Both countries were neutrals at that time.[59] The first of three big waves of bonds coming into trade again is linked with 24 August when bonds of all four Central Powers and also, for example, of Russia and Romania resumed trade. 66 sovereign bonds were back in trade at that point in time.

Figure 13 helps to locate the other waves. The figure itself is a bit tricky to read. Depicted for each day is the cumulated number of bonds (i) that came into trade again up and including that day and (ii) that were *principally* tradable from that day on. This value corresponds to what is reported in Table 14 in the column on the far right. What we can gather from the figure is that the second wave followed right on 26 August 1915, when another 27 bonds started to be traded again, and the third wave followed between 27 August 1915 and 12 October 1915, when another 87 bonds re-entered trade. Thereafter, more bonds followed, obviously, but at a slower pace. The graph's pattern in the pre-war months as well as in 1919 has to be taken with caution. The values for 1914 just reflect how many bonds were in trade on each day compared to how many were traded on 2 January 1914, as this is my formal starting point for observing prices. Turning to the end of 1918 and 1919, the graph implies attrition. Some bonds actually left the database for good, as they stopped being traded (this goes for some Dutch voluntary war loans; cf. Table A.2 in online Appendix 1.2). Other bonds just temporarily stopped being traded sometime in 1919, or even earlier, while still being officially tradable. The fact that the curve declines in 1919 is explained by my price series interpolation strategy. In the following subsection on "market development" I will address how I treated missing values in a bond's price series in more detail. To understand the behavior of the graph towards the end of 1919, it suffices to know that I did not extrapolate the price series beyond the last available price quote for the purpose of creating that figure. Thus, if a bond temporarily ceased to be traded – meaning we have no price quote whatsoever on it – and, say, it did so on 1 August 1919, I did not extrapolate this last price from 2 August 1919 forward to 31 December 1919.[60] So, the part of the graph on 1919 is actually kind of measuring liquidity effects (cf. the subsequent subchapter for liquidity in detail).

[59] While Sweden remained neutral, Portugal entered the war in March 1916 and thereafter took part in some fighting; cf. Ribeiro de Meneses (2014).

[60] That is to say, Figure 13 is based on cumulating prices in each day's cross-section.

Figure 13: How trade was resumed – the number of sovereign bonds in trade



Sources: Author's own computations.
Notes: Cf. the text.

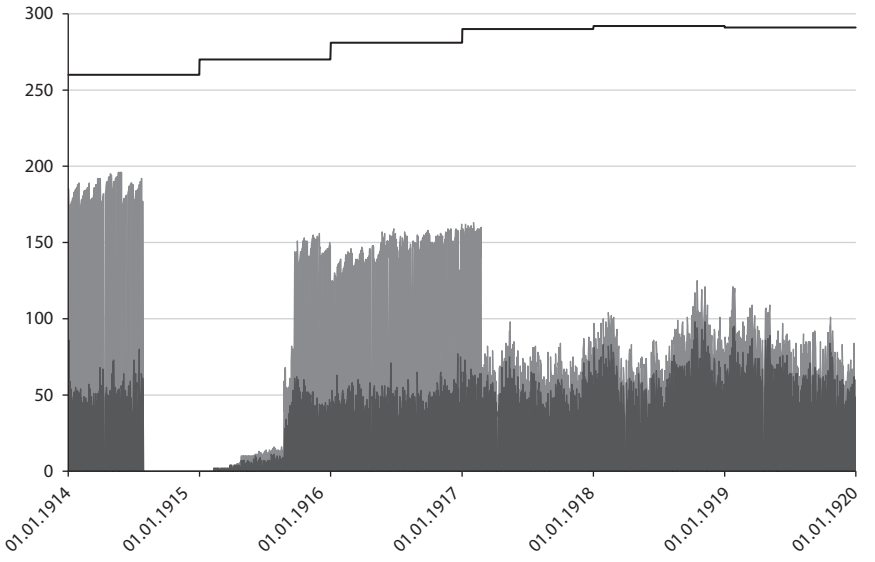
3.2. Market price indices and liquidity

In order to describe the Amsterdam market's development during the observation period in more detail, it would be preferable to have data on trading volume – the number of pieces of each bond traded – or, respectively, on turnover – the money value of the trading volume – at hand. Unfortunately, these data are not available, as there were no records of transactions held from which this information could be gathered.[61] This lack in the historical account of stock exchanges is a common phenomenon for the time under study. Such data are also lacking for the Berlin Stock Exchange, for example, which is the reason why attempts have been made in the literature to come up with some workable proxies based exclusively on the occurrence of price quotes.[62]

Figure 14 provides us with two proxies solely based on information about the number of bonds traded per day. The smooth black line indicates the number of tradable bond subseries – that is, subseries officially admitted for trade as they were mentioned in the stock exchange handbooks (the *Gids bij de Prijs-Courant*, for example).[63] As already known, that number increased in steps due to the Dutch government placing a series of voluntary war loans and colonial debt

[61] Cf., fundamentally, Brenninkmeyer (1920: 163).
[62] Cf. Gehrig/Fohlin (2006), Fohlin/Reinhold (2010), and Burhop/Gelman (2010, 2011).
[63] This is actually the line, give or take, that we would see in Figure 13 if I had extrapolated prices of bonds not yet fully redeemed forwards to the end of my observation period – that is, 31 December 1919.

Figure 14: Trading volume proxies



Sources: Author's own depiction.
Notes: Grey-shaded area: Number of price quotes reported per day. Dark-shaded area: Number of occurring price changes observable per day. Black line: Number of tradable bond subseries.

in the market after the outbreak of the war. This number serves as a benchmark for the extent of trading. The grey-shaded area gives the number of price quotes reported per day – a number which one may principally take to imply that a trade in the covered bonds must have occurred. As is obvious, this number quite varies over trading days.[64] It also becomes clear that, unsurprisingly, the price account is denser for the pre-war period than for the war- or the post-war period, and that the wartime price account, in turn, is much denser for the period before February 1917 than for the period thereafter. The spectacular drop in the incidence of reported prices dates 22 February 1917. The number of observable price quotes dropped from 160 to 54 on the next day and remained principally lower from then on. I have no convincing explanation for why this drop happened. What I can say is that before 22 February, a lot of bonds exhibit various longer stretches of time in which the price is reported *and* is constant.[65]

[64] Due to the high data frequency, it does not become clear in the figure that, of course, there are a lot of zeros due to Sundays and stock exchange holidays.

[65] I doubt that these longer stretches of constant prices indicate daily trade in the respective bonds. It might be that the *Vereeniging voor den Effectenhandel* as the authority which created the price list stuck to a practice of filling gaps by the last available price but stopped it for some reason on 22 February. Another possibility is that the implied "shortening of the price list" is

Due to this sudden fall in the number of reported prices, the second proxy of the trading volume depicted by the dark-shaded area is more telling. It is the number of price changes occurring on one day, measured as positive or negative (price) returns. In order to implement this measure, all gaps occurring in the bond subseries had to be interpolated. Beyond this particular exercise here, and the computation of a simple price-based market index following in a few lines, interpolation of gaps is a technical precondition that we have to meet in order for the statistical methods in Chapters III and IV to be applicable. So, it was an inevitable step.

Imagine a gap in a bond series m between the price $p_{t=i}$ and the price $p_{t=i+4}$, which is a three-day gap here. Principally, there are four ways to deal with this gap in the price series: Firstly, the three missing prices are assumed to be missing at random and the gap occurring is just kept as such in the calculation of the market index. Secondly, the gap is linearly interpolated. Thirdly, the gap is interpolated backwards by setting for the three missing prices the price of day $t = i + 4$. Or, fourthly, the gap is interpolated forwards by setting for the three missing prices the price of day $t = i$. The question is which interpolation approach we should choose. Approach one is possible when the analysis remains on a purely descriptive, graphical level. However, as noted in the preceding paragraph, the statistical tools used hereinafter require time series with no gaps whatsoever. So, given that we have to interpolate the bond series anyway, there is no point in doing it differently at this descriptive stage. Regarding approach two, we face a problem if $p_{t=i} \neq p_{t=i+4}$, because linear interpolation then introduces positive or negative returns at locations in the interpolated series where actually none are in the raw series. Since this has unwanted consequences for a returns-based liquidity measure as introduced in a few lines (and already touched on in the discussion of Figure 13), approach two is likewise no option. Of the two remaining approaches, I opted for forwards interpolation of prices as this is, in my opinion, compatible with how investors would cope with the missing price information. By interpolating forwards, I assume that investors, so to say, reckoned with an implicit price on the day, for which no actual price quote is available, and that this implicit price was the last known one. I applied this procedure to every bond series in my dataset and also to the other time series whenever there were gaps.[66]

Thanks to interpolating, we can conveniently measure the change in price from one day to the next in the form of the price return, which is the change in price from day $t-1$ to t divided by day $t-1$'s price (the growth rate, in fact). Based

due to the newspapers cutting space and kicking out most of the bonds for which no change in price occurred from the previous to the actual day. I am not quite comfortable with both explanations, but they are the best explanations I can offer for this strange phenomenon in the data.

[66] Cf. e. g. Warga (1992) on the principal problem.

on the incidence of zero or, respectively, non-zero returns (i) in the cross-section on one day or (ii) for one bond over a certain stretch of time, we can implement a standard measure of liquidity known in the economic literature as the LOT measure, named after the three scholars who proposed it.[67] The liquidity of a security can be thought of as the ease with which that security can be traded, that is, the ease with which a bondholder willing to sell that security finds a buyer, and *vice versa*. This ease of trading, in turn, depends on the number of pieces of that security ready to be thrown on the spot market and on the financial capacities of the buyer and the seller. By the latter, I mean how much money the buyer is willing, or able, to invest and, respectively, the seller can afford not to earn or, respectively, to lose. The more liquid a security is, the more sellers and buyers and the more pieces of that security are available on the market, by tendency.[68]

In a nutshell, for an observed security, the LOT measure is the number of non-zero returns occurring during time span T divided by the number of potential trading days, that is, all days for which the returns were at risk to be different from zero.[69] Theoretically, a non-zero return may be understood as measuring the combined influence of all transaction costs on the decision of the marginal trader as to trade in the particular security or not. Once enough information is accumulated such that the trader sees a surplus value in trading – that is, the expected return more than compensates for transaction costs –, he trades, and a non-zero return occurs.[70] In my view, this is the best available measure of liquidity that I can implement given data quality.[71] However, this

[67] Cf. Chordia et al. (2005: 85).

[68] Apart from these fundamental conditions, economic theory says that the more liquid a security, the smaller the observable price changes are. This is because the liquidity premium will be smaller. Viewed the other way around, the more illiquid a security, the larger the price changes are, as the buyer wants to be compensated dearly for buying a security which is difficult to resell again. On the theory and empirics of liquidity, cf. e. g. Butler/Malaikah (1992), Jokivuolle (1995), Chordia et al. (2001), Amihud (2002), Amihud et al. (2005), Bekaert et al. (2007), Goyenko/Ukhov (2009), Kim/Lee (2014), and Li/Sun (2014). Studies of liquidity in historical markets include Silber (2005), Alquist (2010), and Chavaz/Flandreau (2017).

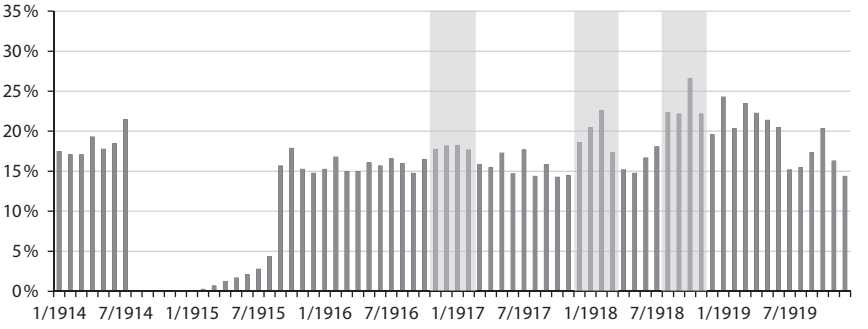
[69] Note that I do not use the "holding period return" here which consists of capital gain and accrued coupon payments. Due to the latter component, the use of holding period returns would likely boost a bond's liquidity in a given time interval, albeit prices remained constant (and thus the capital gain itself remained zero).

[70] According to Lesmond et al. (1999: 1 117), transaction costs include costs due to the spread, commissions, expected price impact, and foregone investment opportunity.

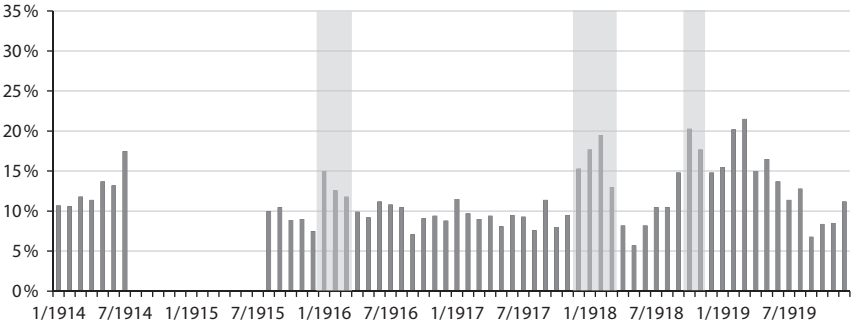
[71] Formally, we may distinguish two groups of empirical liquidity measures regarding stocks and fixed-interest securities: (i) proxies measuring trading costs directly (e. g., turnover or bid-ask-spreads); and (ii) proxies measuring trading costs indirectly (e. g., implied effective spread or non-zero returns). Since neither trade volume data nor bid-ask-spreads (or minimum and maximum prices in sufficient quantity to compute effective spreads) are available for Amsterdam for the time under consideration, I have to rely on a pure price behavior-based measure suitable in this context; cf. Amihud/Mendelson (1986), Lesmond (2005: 416–417), and Fong et al. (2017).

Figure 15: Monthly liquidity of the Amsterdam market for sovereign bonds

(a) Entire market segment



(b) "Central Powers segment"



Sources: Author's own computations.

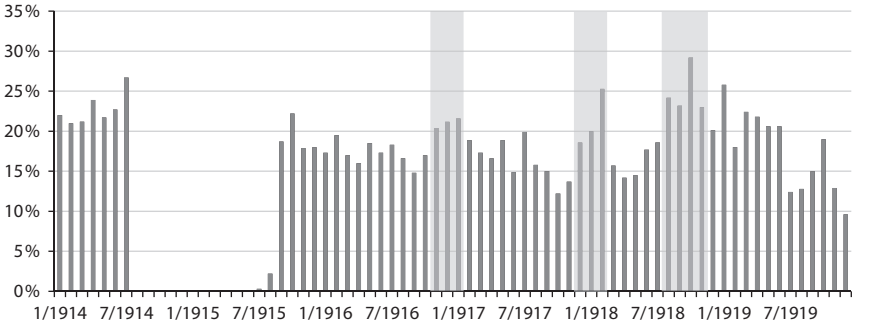
liquidity measure should be taken as a *lower bound* estimate of a bond's liquidity.[72]

Figure 15 plots the LOT measure for the government bond market as a whole, month by month over the entire observation period from January 1914 to December 1919. In this case, as we look at daily cross-sections, the number of non-zero returns per day is divided by the product of the number of tradable

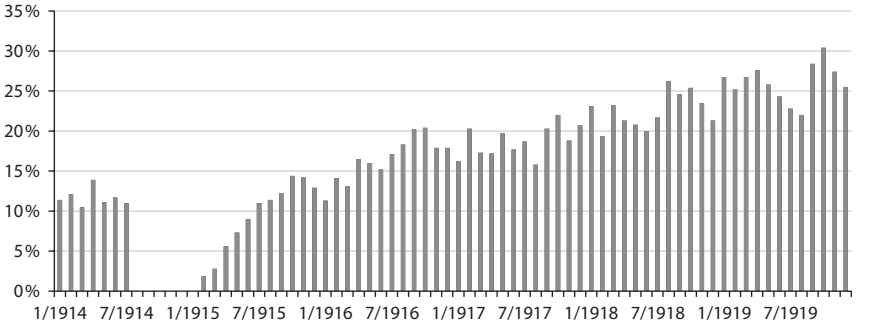
[72] Another alternative is to use the relative incidence of days with a price quote in all trading days assuming that a reported price is indicative of a trade, even if the price remained constant from one day to the next. This is, however, not feasible due to the sudden drop in the incidence occurring from 22 to 23 February 1917. This measure could principally be understood as an upper-bound measure of liquidity. Beyond that, it would be insightful to plot and analyze the daily difference between lowest and highest prices as a measure of perceived risk; the larger the span, the wider investors' opinions were set apart. However, regrettably, this measure cannot be constructed in this case, because highest quotes were seldom, if ever, reported for any bond; cf. Subchapter I.2.

Figure 15 (continued)

(c) "Allied Powers segment"



(d) "Neutrals segment"



Notes: Monthly liquidity is the proportion of non-zero returns in all potentially occurring returns. Sundays and holidays are taken into account.

bond subseries as depicted in Figure 14 and the number of trading days per month which varies across months. The denominator provides us with the maximal number of non-zero returns that could occur per month. Panel (a) of Figure 14 depicts the liquidity of the entire market segment. As can be gathered from the panel, pre-war market liquidity increased from around 17 to 21.5 percent between January and July 1914. Turning to the war period, trading activity fluctuated around a long-term trend of about 13 to 14 percent between September 1915 and November 1917, which is quite remarkable as this level is not so much below the average pre-war level of about 18 percent. From December 1917 onwards, the average liquidity level increased beyond the pre-war level, with February 1918, October 1918, January 1919, and March 1919 displaying the liquidity peaks in the observation period.

Clusters of comparatively high liquidity, which are grey shaded in the figure, can be observed for (i) the period November 1916 to February 1917 – the critical

period when Germany implemented its unrestricted submarine warfare doctrine the second time, threatening neutrals and thereby calling the US into war –, (ii) December 1917 to March 1918 – coinciding with the peace negotiations between the Central Powers and Russia –, and (iii) August 1918 to November 1918 – the final phase of the war, with the Allied Hundred Days Offensive commencing in August. Generally, the liquidity of the market rose towards the end of the war.

Panels (b) to (d) deconstruct market liquidity by faction. The Central and Allied Powers' segments include the bonds of all countries which sooner or later entered into war on one of the two sides, according to Table 12. The remaining segment includes all bonds of countries which were neutral throughout the war.[73] I want to highlight a few observations: Firstly, the liquidity level of the Central Powers' segment was generally lower in all three periods compared to the other two segments' liquidity. Secondly, in the Central Powers' segment, we do not find a liquidity cluster around December 1916/January 1917, but one around February 1916, principally coinciding with the beginning of the First Battle of Verdun. Thirdly, apart from occasional local liquidity peaks, the liquidity of the Allied Powers' segment shows a declining trend in the long term until October 1917. Finally, fourthly, the development of liquidity in the neutrals' segment followed a very different pattern as the level of liquidity rose more or less steadily until April 1919. This can be taken to say that trading in neutral countries' less risky debt was an attractive strategy for the less risk-prone investor and for the international investor who, generally, searched for a "safe haven" for his money.

That said on trading volume, how did the government bond segment in terms of prices develop over the course of war, on the whole? In order to answer this question, I construct a simple "market index". Principally, we would wish to compute the mean price at par value as the weighted mean at time t over all M bonds' prices, p. Formally, this is

$$MARKET_t = \sum_{m=1}^{M} P_{m,t} * \left(w_m / \sum_{m=1}^{M} w_m \right) \qquad \text{(Equation 2)}$$

where w denotes the bond-specific weights to weigh each price observation. This index should have two desirable properties in order to make it suitable for describing the market development: Firstly, a change in the weighted mean price over all bonds from t to $t+1$ should indicate – and only indicate – that the underlying prices changed. Secondly, a change in bond m's price from $t+1$ to $t+2$ should not be given considerably less or considerably more weight than is given to its change from t to $t+1$. In other words, we have to secure by design that a change in the index value was neither due to (i) bonds multiply entering and exiting the market index, which they would if missing values were allowed over the bond-specific run times, nor due to (ii) day-by-day variations in the

[73] This is to say that no country with its bonds is included in more than one segment.

underlying weights assigned to bond *m*, other things being equal. In order to implement a simple market index having these properties, I interpolate all bond price series to close any occurring gaps, and I apply "quasi-constant" weights.[74]

Regarding weights, weighting factors assigned to each bond *m*'s observations can be called "quasi-constant", as they are not really constant at all, albeit the extent to which they are subject to change is minimized. Used as weights are the bonds' shares in the nominal amount outstanding at the turn of 1917/1918, which I collected mainly from the *Gids bij de Prijs-Courant*, but in few instances also from *Saling's Börsenpapiere* (on the Berlin Stock Exchange) and the *Stock Exchange Year-Book* (on the London Stock Exchange).[75] The nominal value outstanding was converted into a common currency, namely pounds sterling, using the exchange rate parities from 1913/1914, when the gold standard was still intact.[76] Bearing in mind that all series are interpolated, weighting factors are still subject to change in a given daily cross-section if a bond enters the data set the first time after 9 February 1915 or leaves it before 31 December 1919 (therefore, "quasi-constant").

Figure 16 plots two versions of the market index: an equal-weighted (or, in fact, unweighted) index in panel (a), and the weighted index in panel (b) together with the equal-weights version to be able to visually assess the effect of weighting. Note that the equal-weighted versions in both panels are not identical due to the fact that I had to condense the bond price subseries into the main bonds to be able to apply weights. This is because the nominal amount outstanding was not always recoverable for the bond subseries, but only for the main bond – in the aggregate, so to say. Panel (a) shows the equal-weights version based on all officially traded bond sub-series, while in panel (b) condensed bonds are used.[77] Apart from the sub-period between February and early September 1915, during which the bonds came into trade one after another, both the unweighted and weighted series show quite stable bond prices up until the beginning of 1917, and a clear downturn thereafter.

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[74] On the calculation of historical stock and bond market indices, cf. e. g. Klovland (2004a, 2004b).

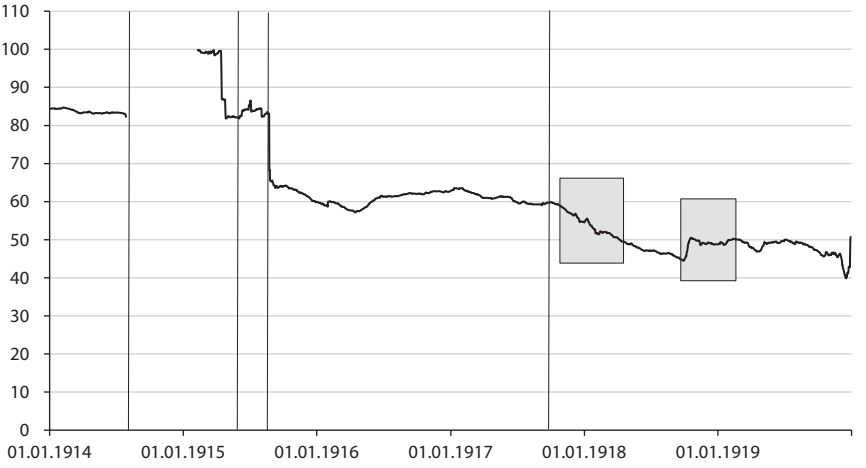
[75] It is necessary to take the nominal value outstanding at the end of some war year rather than at the turn of 1913/1914 since a number of bonds – mostly Dutch issues (cf. the previous subchapter) – had been newly issued after February 1915. Apart from this, the extent to which countries redeemed part of their bonds during the war was negligible, so that the nominal amount outstanding at the turn of 1917/1918 was not much lower than that of, for example, 1913/1914.

[76] The *Gids bij the Prijs-Courant* of 1913/1914, for example, reports the exchange rate parities right at the beginning of the overview of bonds. Converting nominal amounts outstanding reported during wartime with pre-war parities is no problem, as the reported amounts were not affected by inflation.

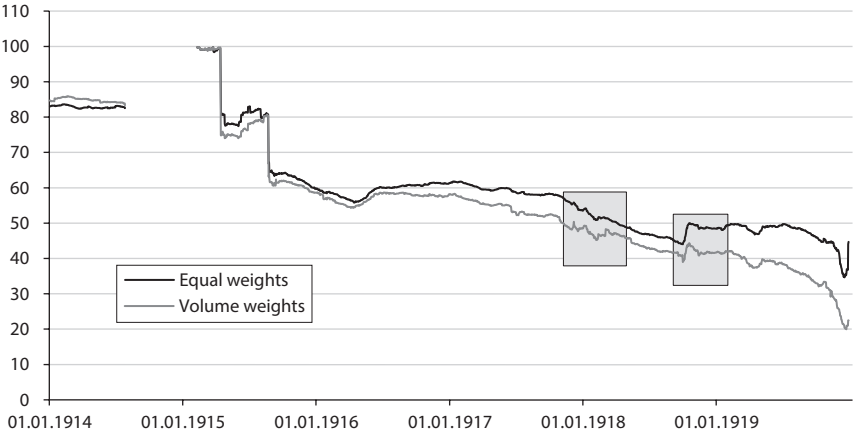
[77] For example, the German 3 % is the condensed bond based on its two subseries explicitly traded which differ in the point in time when they paid interest; cf. Table A.2 in online Appendix 1.2.

Figure 16: A simple market index

(a) Equal weights – based on subseries



(b) Equal weights vs. volume weights – based on condensed bonds



Sources: Author's own computations.
Notes: Computed as the equal-weighted or volume-weighted average over the whole set of interpolated official prices in percent of par value.

There are four phases into which we can separate the price development during the war; these phases are as follows:

– Phase 1: Trade occurred exclusively in domestic issues between 9 February and 3 June 1915 with the average price varying between 75 and 100 percent of par value depending on the market series addressed;

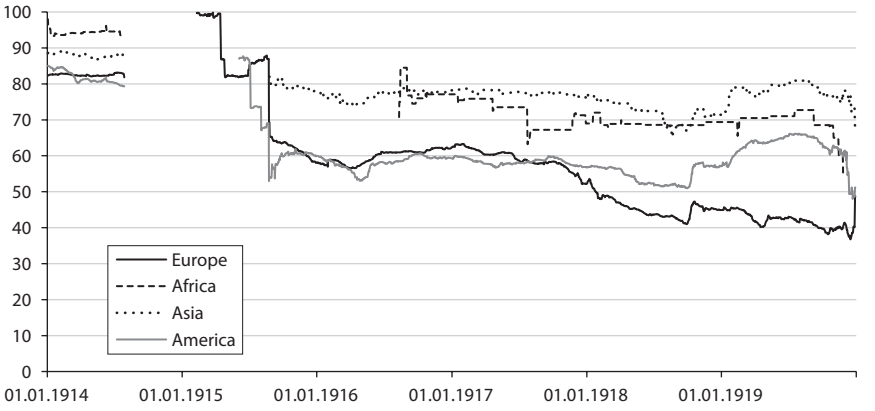
- Phase 2: Trade in foreign issues resumed on 4 June 1915 for some neutral countries first with the average price varying between 77 and 86 percent;
- Phase 3: From 24 August 1915 onwards, trade finally extended to bonds issued by belligerent countries, then actively participating in war, with the average price dropping to somewhere between 60 and 65 percent;
- Phase 4: From 24 September 1917 onwards, the average price declined straight for about a year (or even a bit more) if we take the weighted version as the basis.

Overall, there seem to be two periods of enhanced volatility (highlighted by boxes). Into the period around 1 January 1918 especially fall the defeat of Russia and of Romania, and also the associated German-Russian peace negotiations at Brest-Litovsk. Into the other around 11 November 1918 – the date of the Armistice of Compiègne – fall the final days of the war, and especially widespread political unrest after the war had ended.

For illustrative purposes, two further ways of manipulating the data seem to be insightful: Firstly, what do market sub-indices by continent and war party status look like? And, secondly, what does comparative sovereign risk of the Central Powers vis-à-vis the Allied Powers look like? To answer the first question, Figures 17 and 18 each plot four series. Figure 17 shows the market sub-indices for Europe, Asia, Africa, and America. I chose to display the unweighted version, as the basic downward trend in the weighted market index shown in Figure 16 is due to European bonds, and within this subset due to the price development for the many Russian bonds in the first place. As can be gathered from the figure, the average price for Asian bonds – that is, Chinese and Japanese bonds – fell from about 80 percent of par value in August 1915 to 65 percent in mid-August 1918 but recovered quickly to the initial 1915 level. The average price of (South) American bonds, broadly, shows the same pattern of fluctuation, yet on a lower price level (around a mean of 55 percent). Beyond that, it is the average price for European bonds beginning to fall secularly in September 1917.

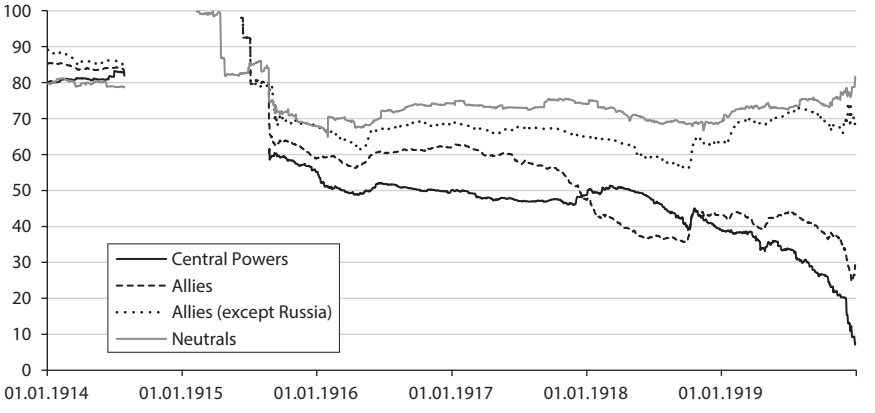
Figure 18 shows the average price rearranged by faction. The sub-indices for the Central and the Allied Powers are based on all bonds of countries that would sooner or later be part of the alliance. This means that, initially, neutral countries like, for example, Brazil are counted from the start as an Allied Power. The series on neutral countries contains such bonds of countries that remained neutral throughout the war. This procedure is necessary, as otherwise, we would face price effects stemming from bonds just entering and exiting the indices. As mentioned above, I wanted to avoid these effects in market indices. In a nutshell, the value of neutral countries' bonds, and of the "minor" Allied Powers when dropping Russia, was not exactly constant from about August 1915 onwards, but quite stable compared to the general downward trend we see for the primary belligerents.

Figure 17: Sub-indices by continent



Sources: Author's own computations.
Notes: Computed as unweighted averages over the respective set of interpolated prices in percent of par value.

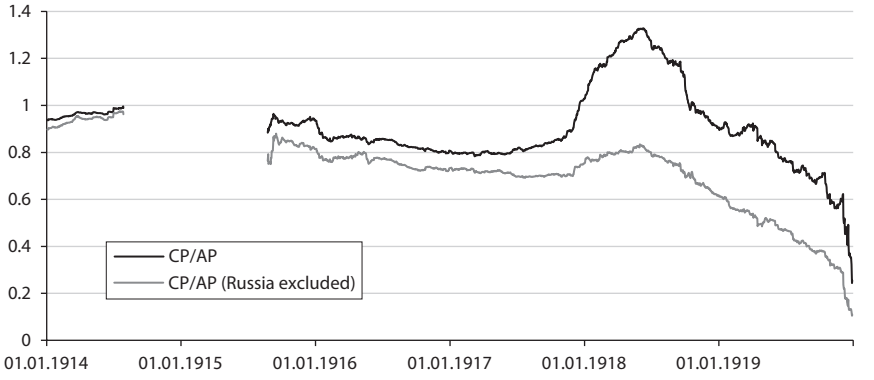
Figure 18: Sub-indices by faction



Sources: Author's own computations.
Notes: Computed as unweighted averages over the respective set of interpolated prices in percent of par value.

What has to be mentioned once again is the positive, temporary shock to the Central Powers' bonds that had come with the defeat of Russia and Romania and that lasted into May 1918. Another noteworthy feature is that, on the whole, post-war political unrest and restructuring, in combination with economic problems (e. g., open inflation) let the value of all Central Powers' bonds drop even faster than the fighting itself did.

Figure 19: Assessing war parties' comparative sovereign risk



Sources: Author's own computations.
Notes: "CP" and "AP" denote "Central Powers" and "Allied Powers". Indices depicted in Figure 18 used.

Finally, to measure the sovereign risk associated with the portfolio of all Central Powers' and Allied Powers' bonds, we can reference the indices on both factions displayed in Figure 18 against one another. Concretely, I put in the nominator the portfolio that serves as the risk-free or, at least, the relatively less risky alternative.[78] A rising ratio would indicate that the portfolio put in the nominator vis-à-vis the portfolio put in the denominator would have become less risky over time – either, *ceteris paribus*, due to rising prices for bonds in the nominator portfolio, or to simultaneously rising prices in the nominator and decreasing prices for bonds in the denominator portfolio. Figure 19 depicts the ratios measuring sovereign risk for the cases when Russian bonds are included and excluded, respectively.

Up until mid-1917, the ratio decreased implying that the portfolio of Central Powers' bonds became riskier in comparison, as these bonds' prices fell quicker. However, this pattern turned in the second half of 1917 when Allied Powers' bonds' prices began to fall quicker – with or without Russian bonds included – due to the closing of the Eastern Front by the defeat of Russia. This had substantially reduced the sovereign risk of the Central Powers' portfolio in the following, up until May 1918. The figure illustrates nicely that the relative risk inherent in the Central Powers' bonds increased secularly from mid-May 1918 onwards, when the German spring offensive had stalled.

[78] If I used yield data instead of prices in percent of par value, I would put the risk-free alternative, as is usual, in the denominator. However, in this case, it seems to be appropriate the other way around, since a *decrease* in price indicates an increase in risk. When yields are used, it is an *increase* in yields that signals an increase in risk.

3.3. Representative bonds versus country indices

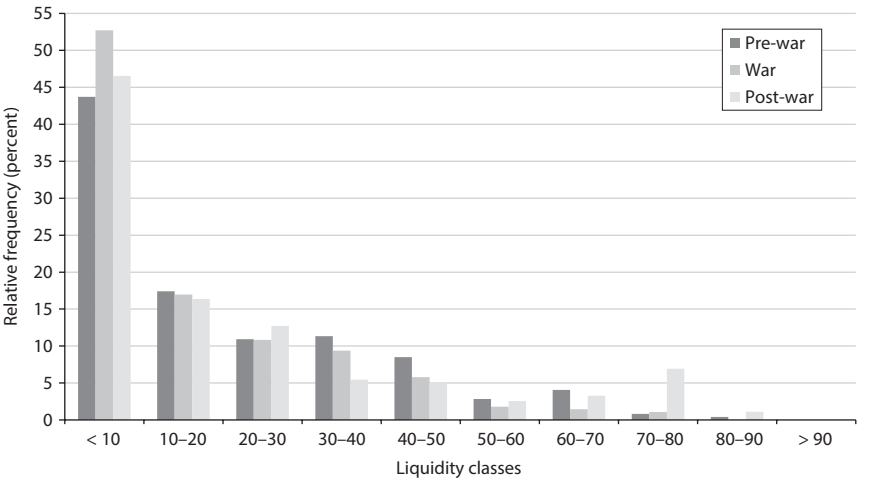
A basic question for the kind of investigation put forward in this study is how to cope with the bond subseries as the actual units of observation. Should the analysis of bondholders' perception of the war focus on single bonds or on country indices – that is, on aggregations of single bond (sub)series?

Regarding single bonds, there already are two alternative ways to go: Either we remain on the much disaggregated level of the subseries, so closest to the source, or we condense the subseries into a "main series". With the latter, I mean to merge the information inherent in the subseries on a bond into one time series. So, for example, we may wish to merge the two subseries on the German 3 % or the three subseries on the Austrian 4 % kroner perpetual, which all differ in coupon dates, into one series. This procedure might have the advantage that missing values in the one subseries can be compensated for, as price quotes for the days with missing observations potentially exist for the other series. However, the extent of this compensation effect obviously depends on the price observations being rather unequally distributed across subseries over the timeline. If, for the same day, price observations exist in all subseries, a reasonable operation would be to take the average of the price observations. However, by tendency, this leads to a flattening out of the condensed series at locations where the subseries exhibit unequal prices. This effect is likely much stronger if we consider condensing all bond subseries available for a country into an artificial "country bond" or, respectively, "country index".[79] So, in turn, if price observations were equally distributed across two or more subseries on a bond over the timeline or across all subseries available for a particular sovereign issuer, there would actually be no necessity to condense. The necessity, if any, stems from an unequal distribution of prices paired with a substantial number of missing observations. Yet, besides the unwanted flattening, there is another reason for why I do not consider condensing subseries into main series or into country indices: By condensing information in the described way, we delete original information on a subseries' liquidity level, that is, information on the ease with which this particular subseries was traded. Instead, creating "main series" or country indices would boost the perceived liquidity level, which is just ahistorical.

The concept I prefer is that of "representative bond subseries" or, as I will henceforth say in shorthand, "representative bonds". For the purpose of my analyses in Chapters III and IV, I define the representative bond of a country to be its most liquid subseries *during wartime* according to the previously introduced LOT measure. Basically, the more original price observations are available on a particular subseries, the better for the statistical analysis below. This is because any variation in the series – variation we need – is inherent in the raw price quot-

[79] To be fair, this flattening-out effect is well present in any market index as the highest form of aggregation, or condensing, of information.

Figure 20: The pre-war and wartime distributions of bond-specific liquidity



Sources: Author's own computations.
Notes: Bond-specific liquidity is the proportion of non-zero returns in all trading days. Exercise performed on the basis of bond subseries.

es, not in the interpolated observations. Thanks to having gathered prices on the entire cross-section of bonds traded in and around World War One, I am able to specify which subseries qualify for being the representative ones per country.

Figure 20 illustrates that bond (subseries)-specific liquidity as measured by the relative incidence of non-zero returns was very unequally distributed in all three sub-periods. Depicted in the figure is the relative frequency of liquidity by ten liquidity classes. As is evident, most bonds, regardless of the sub-period addressed, show a liquidity of below ten percent. Regarding the war period, only about ten percent of all subseries exhibited a liquidity level of 50 percent or more (most of them being Russian issues).

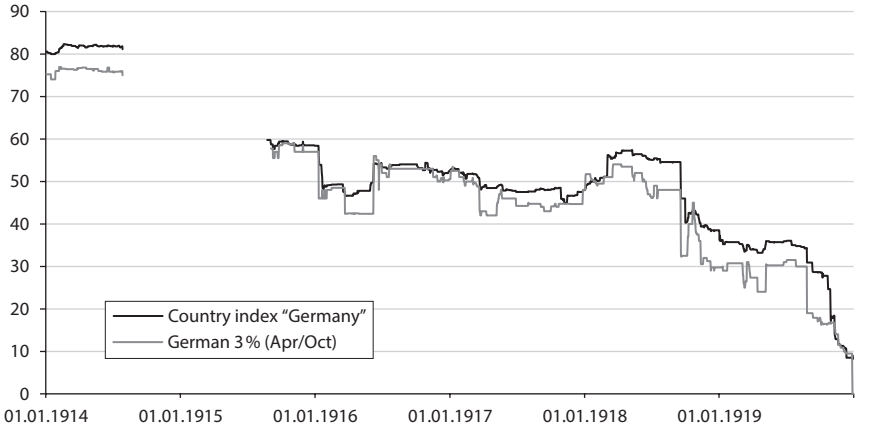
Table 15 displays a set of representative bonds for the Amsterdam market containing the most liquid bond subseries per country. Note that I could not specify a representative bond for France and the US due to insufficient observations on the officially admitted subseries. In the empirical analysis below, I will use the most liquid war loans for France and England to be taken from the subset of unofficially traded bonds. It is noteworthy that the very unequal distribution of liquidity shown in Figure 20 also reflects in the set of representative bonds. Have a look at column three which provides wartime liquidity levels. It might not be surprising at all that the most liquid bond during wartime was a Dutch bond, namely the 3 % bond issued between 1895 and 1905. In order to give an impression of the difference between an artificial country index and the representative bond, the correlation coefficient according to Pearson between the two series is

Table 15: A set of representative bonds for wartime

Country	Bond subseries	Wartime liquidity	Correlation with country index
Austria	4.0 % kroner perpetual of 1903 (Jan/Jul)	60.0 %	0.93
Argentina	5.0 % of 1905	17.8 %	0.88
Belgium	2.5 % of 1842	0.0 %	1.00
Bosnia-Herzegovina	5.0 % railway bebt of 1914	0.5 %	0.99
Brazil	5.0 % of 1914 (20/100)	42.5 %	0.55
Bulgaria	5.0 % tobacco of 1902	23.4 %	0.77
Chile	5.0 % of 1912	9.7 %	0.78
China	4.5 % gold of 1898	15.8 %	0.91
Colombia	3.0 % of 1896	13.7 %	–
Cuba	5.0 % of 1904/05	9.0 %	0.94
Denmark	4.0 % of 1912	4.1 %	0.24
Dominican Republic	5.0 % customs of 1908	25.5 %	–
Dutch East Indies	5.0 % of 1915 (1 000)	61.2 %	0.99
Egypt	4.0 % of 1876	1.3 %	1.00
Finland	3.5 % of 1889	3.4 %	–
Germany	3.0 % imperial of 1890–1903 (Apr/Oct)	12.5 %	0.88
Hungary	4.0 % kroner perpetual of 1892–1910 (2 000)	34.6 %	0.86
Italy	3.5 % of 1862–1881	1.7 %	–
Japan	5.0 % of 1908/09 (500/1 000)	18.3 %	0.85
Liberia	5.0 % of 1908/09	2.3 %	–
Mexico	5.0 % 1st–4th ser. of 1895 (100/1 000)	34.8 %	0.83
Netherlands	3.0 % NWS of 1895–1905	76.3 %	0.69
Nicaragua	5.0 % of 1909	9.2 %	–
Norway	5.0 % of 1888	0.2 %	–
Portugal	4.5 % tobacco of 1890	42.8 %	0.57
Romania	4.0 % of 1910 (2 500/5 000)	0.9 %	–0.52
Russia	4.0 % Hope & Co of 1889/90 (625)	65.0 %	0.98
Serbia	4.0 % of 1895 (500)	24.5 %	0.97
Spain	4.0 % of 1881 (1 000/6 000)	0.6 %	1.00
Surinam	4.5 % of 1915 (100/500)	1.8 %	1.00
Sweden	3.5 % of 1890	4.3 %	0.67
Switzerland	3.5 % of 1899–1902	1.2 %	–
Turkey	4.0 % Baghdad Railway of 1904 (1st series)	32.0 %	0.74
Uruguay	3.5 % of 1892	14.3 %	0.68
Venezuela	3.0 % of 1905 (20/100)	8.3 %	0.84

Sources: Author's own computations.
Notes: Liquidity is measured by the LOT measure. Correlation coefficient according to Pearson applied on the interpolated price series. Only officially traded bonds are incorporated. USA and France omitted due to insufficient observations.

Figure 21: Country index versus representative bond – the example of the German 3 %



Sources: Author's own computations.
Notes: Country index computed as the equal-weighted average of the set of interpolated German bond prices.

given in the column on the far right. By tendency, the more country subseries are available and thus are condensed into the country index, the lower the correlation. To also give a visual impression, Figure 21 compares the representative German bond – the 3 % having paid interest in April and October – with the country index we can compute for Germany. While the general time pattern is similar, there are differences in the severity of fluctuations, as the country index is subject to the aforementioned flattening-out effect.

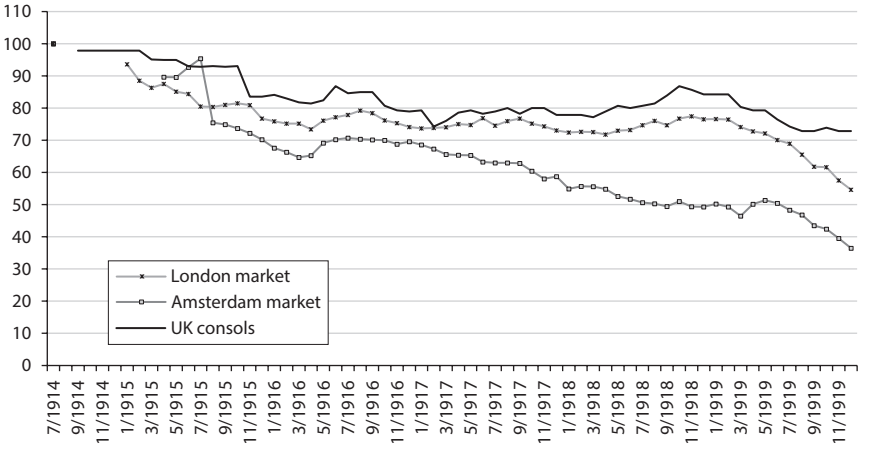
3.4. Comparative market development and cross-trading

How does the picture for the Amsterdam Stock Exchange compare with other markets? To give only a glimpse of an impression about comparative *market* development, I turn to London. A conveniently accessible source for the London prices of sovereign bonds is *The Investor's Monthly Manual*, a combined market and price review published monthly since the 1860s.[80] Among other things, the *Manual* reports the opening, lowest, highest, and closing prices in percent of par value per bond and month. I decided to build the comparison upon the "latest" – that is: end-of-month – prices and thus hand-collected these prices for the full cross-section of foreign government bonds plus the prices for the UK consols.[81]

[80] The Investor's Monthly Manual is digitally available at https://som.yale.edu/faculty-research/our-centers-initiatives/international-center-finance/data/historical-financial-research-data/london-stock-exchange.

[81] Thus, colonial bonds are excluded. In all, I obtained 10 458 end-of-month prices for 193 sovereign bond series.

Figure 22: Comparative market development – Amsterdam versus London



Sources: Cf. Subchapter II.2 on Amsterdam and The Investor's Monthly Manual (1914–1919) on London.
Notes: Cf. the text.

Furthermore, I extracted end-of-month prices for all sovereign bonds traded in Amsterdam from my dataset. Both price indices are weighted with the bonds' nominal amount outstanding at the end of 1918.[82]

These indices, running from July 1914 to December 1919, along with the price for the UK 2.5 % consols are plotted in Figure 22. Note that in contrast to Figures 16, 17, and 18, proper indices with base month July 1914 (1914 = 100) are depicted.[83] While all series essentially imply a kind of "price stalemate" between August 1915 and the end of 1916, they give a diverging picture after 1917, in that the London series remains stable around a horizontal trend well into 1919, while the Amsterdam series evidently signals more pessimistic – or, provocatively stated, more realistic – expectations based on assumingly more transparent price formation.[84] The development of the UK 2.5 % consols, which reached their absolute low point during war in February 1917, especially highlights the fact that their price was controlled up until the beginning of 1916. The plummets happening prior to 1916 were controlled reductions of the minimum price.

Notwithstanding distorted prices, one factor that may explain the indices' different pattern after 1917 is, of course, the different composition of the sovereign

[82] The Investor's Monthly Manual also reports the nominal amount outstanding per bond.
[83] It is worth noting that Moore has already offered market indices at monthly frequency on London, Amsterdam, and ten other market places between 1900 and 1925. However, to the best of my knowledge, the underlying data are not yet published; cf. Moore (n. d. a, n. d. b).
[84] Interestingly, the unweighted version of the London market index (not shown here) exhibits a *positive* trend between April 1916 and October 1918.

Table 16: Cross-trading of main belligerents' bonds during World War One

Bond subseries	Compared trading places		
	Amsterdam	London	Paris
A. Most liquid bonds during war in Amsterdam			
Austrian 4.0 % kroner perpetual of 1903	✓	✓	✓
Bulgarian 5.0 % tobacco of 1902	✓	×	×
German 3.0 % imperial of 1890–1903	✓	✓	×
Hungarian 4.0 % kroner perpetual of 1892–1910	✓	✓	✓
Italy 3.5 % of 1861–82	✓	✓	✓
Ottoman 4.0 % Baghdad Rw. 2nd series of 1910	✓	×	×
Prussian 3.0 % of 1890–1901	✓	✓	×
Romanian 4.0 % of 1910	✓	×	✓
Russian 4.0 % Hope & Co 1889/90	✓	×	×
Serbian 4.0 %	✓	✓	✓
B. Common bond available (if no complete match under A.)?			
Bulgarian 4.5 % of 1907	✓	✓	✓
Ottoman 4.0 % consolidated debt of 1903	✓	✓	✓
Russian 4.5 % of 1909	✓	✓	✓
Russian 5.0 % of 1906	✓	✓	✓

Sources: Amsterdam: Table A.2 in online Appendix 1.2. London: The Financial Times of London (available at: https:// www.gale.com/intl/c/financial-times-historical-archive) and Investor's Monthly Manual (available at: https://som.yale.edu/faculty-research/our-centers-initiatives/international-center-finance/data/historical-financial-research-data/london-stock-exchange). Paris: Bulletin de la côte (available at: https://gallica.bnf.fr/ark:/12148/cb32745962x/date.r=compagnie%20des%20agents%20de%20change).

bond segment. To give only two examples in this regard: The proportion of Central and South American bonds in the London cross-section is higher than in the Amsterdam cross-section, and the proportion of Russian bonds in the London cross-section is notably lower. So, it seems reasonable to also look at comparative time patterns for single bonds. However, this sort of comparison requires the bond series important for my study on Amsterdam to be cross-traded in London and/or Paris, which I consider for this step as well. I will also have a look a Berlin.[85] But, as stated above, we face the restriction here that there are only few monthly prices available (the "Kronenberger prices"), which relate to the unofficial market and should be taken with great caution.

Formally, a good deal of sovereign bonds was cross-traded in Amsterdam and London, Amsterdam and Paris, London and Paris, or in all three places. Starting from my list of the most liquid bonds in Amsterdam presented in Table 15, Table 16 reports on cross-trading among the main European belligerents' bonds. As no English or French bonds were officially traded in Amsterdam, we have

[85] Baltzer (2006, 2007) provides two studies on the Berlin capital market in 1870s investigating cross-trading (with Vienna) more formally.

to focus all the more on the other belligerents. As the upper part of the table shows, four of the bonds were traded in all three places, two in Amsterdam and London, three in Amsterdam and Paris, and three exclusively in Amsterdam. Because there is no match for the representative Bulgarian, Ottoman, and Russian "Amsterdam" bonds, I looked for alternative series that were traded in all places and came up with the ones presented in the lower part of the table. For eight sovereign issuers, price series on a weekly basis are depicted in Figure 23. Here, I abstained from plotting the Hungarian and Romanian bonds as they were extremely illiquid on the weekly level. My database on London and Paris prices has already been introduced in Subchapter II.2 under "additional data". Note that I gathered prices on London and Paris for every Friday, so I adjusted Amsterdam weekly prices accordingly.

The bottom line when comparing the bonds is the following: Firstly, when looking at the short stretch of time between January and July 1914, we find that prices in most cases moved quite closely together or, at least, closer than prices for after 1914. This certainly tells of the high degree to which these markets were integrated and, thus, of the rich arbitrage opportunities that prevailed up until wartime regulations cut them.[86] Secondly, if we turn to the war period and, even more so, if we turn to the post-war period, there were mostly substantial and persistent gaps between the price series. At least in part, these gaps can be explained by the fact that stock exchange regulations everywhere made arbitrage much more difficult. Thirdly, Amsterdam prices mostly lay notably below London and Paris prices. The German, Prussian, and Austrian bonds were those for which the differences were least severe while the time patterns nonetheless differed enough in detail. Fourthly, for all bonds it holds that differences in 1919 were persistently large and, what is more, larger than during the war. To summarize with the words of Bernal et al. (2010) on the London-Paris link: "As a consequence [i. e., of the impossibility to conduct arbitrage trade during war; the author], prices of internationally traded bonds stopped reflecting an international consensus. In segmented markets, prices became mainly affected by national expectations."[87]

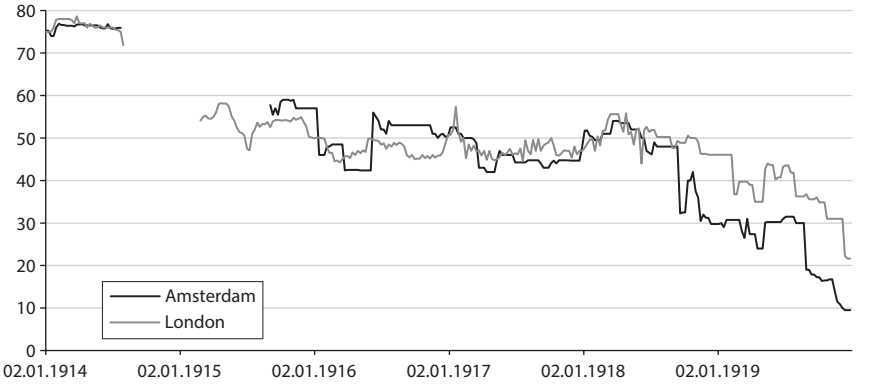
It seems to be instructive to have a look at simple pairwise correlations between the series *regarding wartime*: (1) German 3 %: 0.46 (Amsterdam-London), – (Amsterdam-Paris), – (London-Paris); (2) Prussian 3 %: 0.51 (Amsterdam-London), – (Amsterdam-Paris), – (London-Paris); (3) Austrian 4 %: 0.27 (Amsterdam-London), – (Amsterdam-Paris), – (London-Paris); (4) Ottoman 4 %:

[86] Bekaert/Harvey (1995: 403) define financial market integration in the following way: "Markets are fully integrated if assets with the same risk have identical expected returns irrespective of the market. Risk refers to exposure to some common world factor. If a market is segmented from the rest of the world, its covariance with a common world factor may have little or no ability to explain its expected return"; cf. also Flood/Rose (2004).

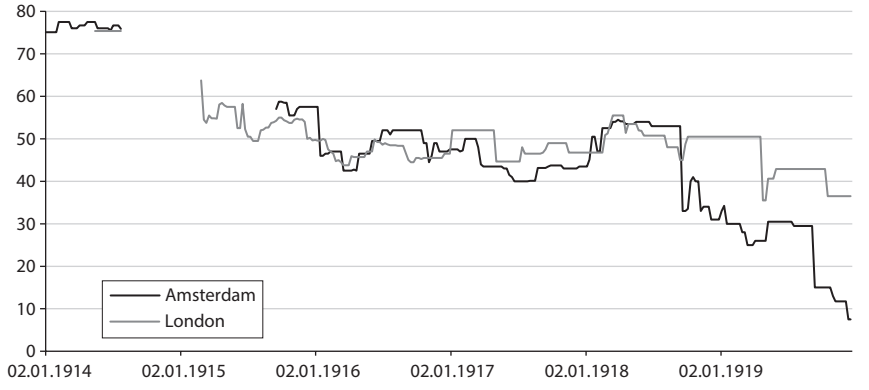
[87] Bernal et al. (2010: 1 195).

Figure 23: Comparison of selected cross-traded bonds' weekly price development

(a) German 3 %



(b) Prussian 3 %



(c) Austrian 4 % kroner

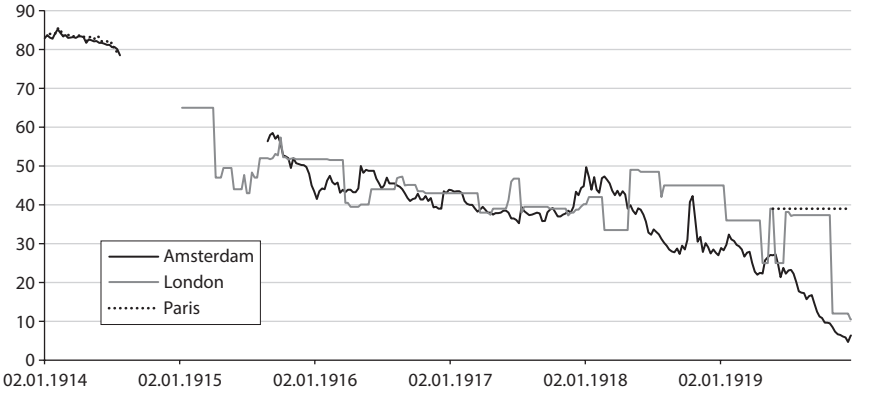
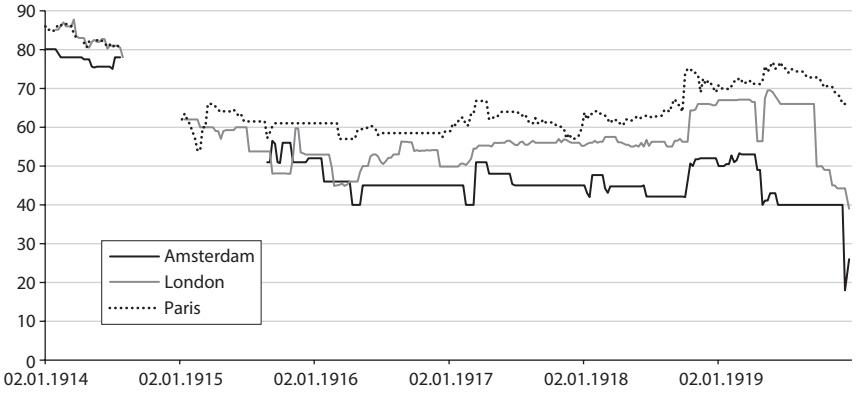
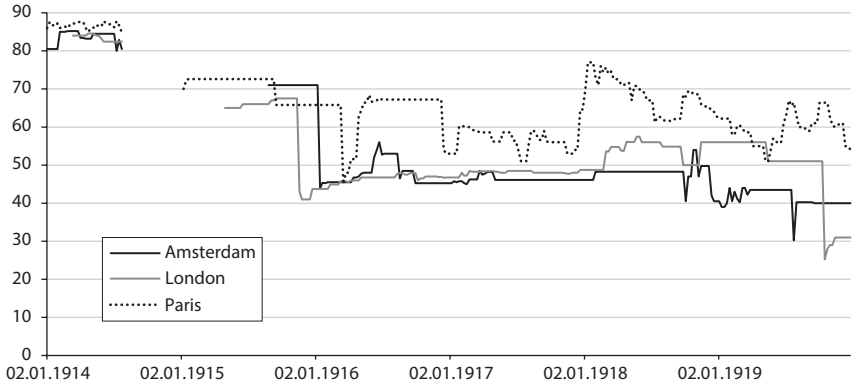


Figure 23 (continued)

(d) Ottoman 4 % unified



(e) Bulgarian 4.5 %



(f) Russian 5 %

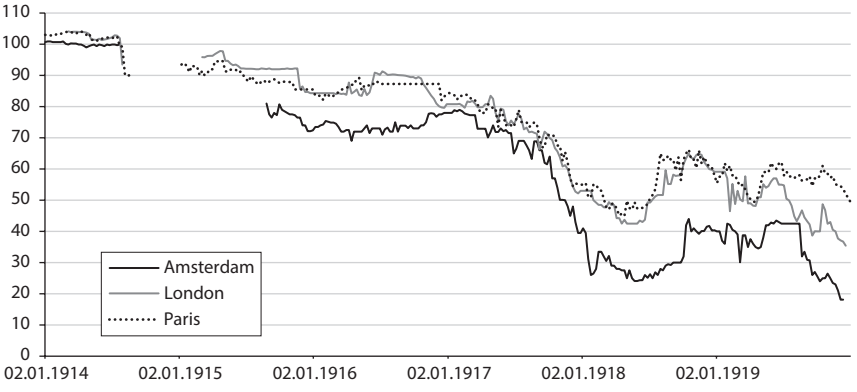
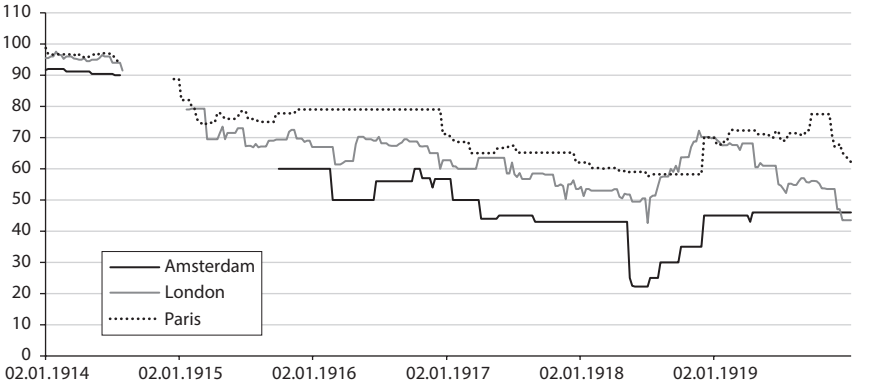
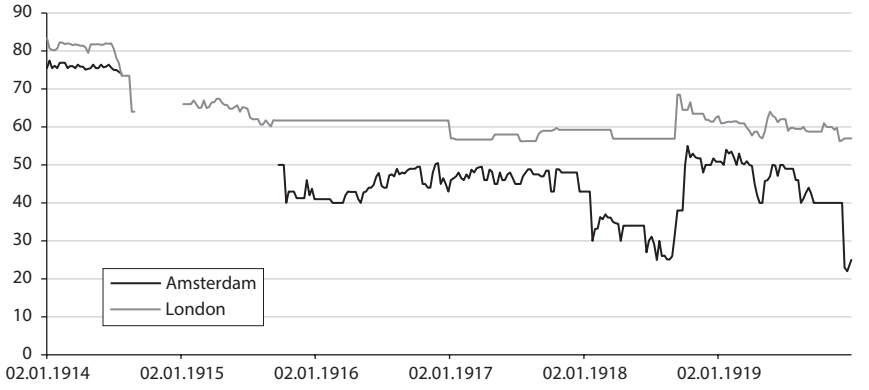


Figure 23 (continued)

(g) Italian 3.5 %



(h) Serbian 4 %



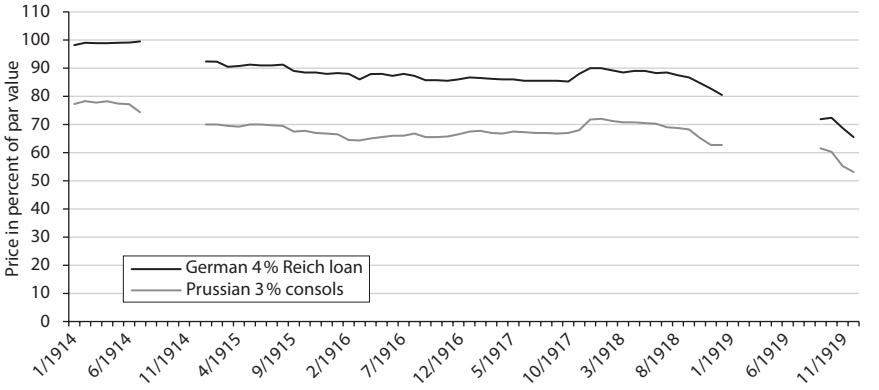
Sources: Cf. author's database for Amsterdam prices, The Financial Times of London for London prices, and Bulletin de la Côte for Paris prices.
Notes: Gaps in the weekly series are interpolated for the sake of lucidity. No Paris prices are available between July and December 1916.

–0.03 (Amsterdam-London), 0.15 (Amsterdam-Paris), 0.46 (London-Paris); (5) Bulgarian 4.5 %: 0.44 (Amsterdam-London), 0.27 (Amsterdam-Paris), 0.44 (London-Paris); (6) Russian 5 %: 0.95 (Amsterdam-London), 0.94 (Amsterdam-Paris), 0.98 (London-Paris); (7) Italian 3.5 %: 0.75 (Amsterdam-London), 0.86 (Amsterdam-Paris), 0.80 (London-Paris); and (8) Serbian 4 %: – (Amsterdam-London), 0.29 (Amsterdam-Paris), – (London-Paris).[88] We find the highest correlation for the Russian 5 % of 1906. Note, however, that the coefficient of

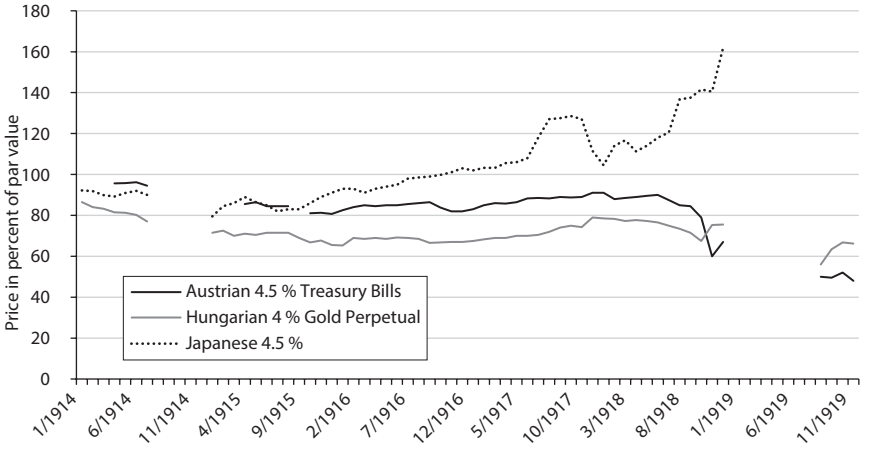
[88] Given is the correlation coefficient according to Pearson.

Figure 24: Kronenberger's monthly prices for the war period

(a) German sovereign bonds



(b) Selected foreign sovereign bonds



Sources: 1/1914–6/1914, 1919: Neumann's Cours-Tabellen der Berliner Fonds-Börse. 7/1914–12/1918: Kronenberger (1920), fold-out table between pages 28 and 29.
Notes: Prices between January 1915 and December 1918 reflect conditions in the unofficial market. Plotted are end-of-month prices.

correlation tells about the similarity in the time pattern of fluctuations. The prevailing level differences are not accurately accounted for.

Finally, we should take a look at Fritz Kronenberger's monthly prices for Berlin. In fact, the only relevant bonds of war parties that he reports on are the ones depicted in Figure 24. Besides the German *4 %* (not the German 3 %) and the Prussian 3 % loans, these were Austrian 4.5 % Treasury bills, the Hungarian

4 % gold perpetual, and the Japanese 4.5 %. The German and Prussian price series run parallel and, beyond that, do not exhibit much variation. Recall that even the market indices for London and Amsterdam at monthly frequency as depicted in Figure 22 show obvious variation. Of the bonds plotted in panel (b), only the Japanese issue shows a considerable fluctuation. The Hungarian 4 % even exhibits a slight positive trend up until June 1918. The most reliable part of all depicted series on the Central Powers is probably the decline since July 1918. In all, these prices should be taken with considerable caution.

4. Potential and limitations of the database

In this subchapter, I assess my dataset's quality – its potential as well as its limitations vis-à-vis the aim to infer public perception from it – by looking at the following aspects: analysis time or, respectively, coverage; the specifics of price formation; the extent of wartime regulations potentially affecting the prices' meaning; and investors' nature.

4.1. Time frame

Due to the pattern of trade resumption after 9 February 1915, we completely miss out the first year of the war (cf. Subchapter II.3, Table 14). If we were interested in how World War One affected Dutch neutrality in Dutch people's own eyes, we would "lose" only slightly more than half a year, because Dutch sovereign debt was traded first, right after the stock exchange's re-opening.[89]

Bond price data on Amsterdam do not allow us to get an impression of how the capital market perceived the sequence of mobilizations and declarations of war in late July and August 1914 or the major campaigns and potentially significant events that had taken place before end of August 1915; e. g. the Battle of Tannenberg (late August 1914), the First Battle of the Marne (September 1914), the removal of Helmut von Moltke as chief of the general staff by Erich von Falkenhayn (mid-September 1914), the Central Powers' conquest of Belgium (mid-October 1914), the start of submarine warfare (late February 1915), or Italy entering into the war on the Allied Powers' side (April 1915).[90] What we can essentially infer from the data is how the Amsterdam capital market answered the sequence of events having taken place up until 24 August 1915 *in net terms* by

[89] There is a recent study by Schaltegger/Schmid (2019) who – as the first – use sovereign bond prices to infer how a neutral country's residents assessed their own country to fare in World War One. More specifically, they look into the case of Switzerland – a country that, as the Netherlands, remained entirely neutral. Both Switzerland and the Netherlands, however, were put under constant pressure by both war factions to join sides, certainly due to their geographical position and, in particular in the case of the Netherlands, their economic significance.

[90] Events are taken from vom Bruch/Hofmeister (2002: 494).

comparing the last 1914 prices with the first wartime quotes on the belligerents. This is certainly not ideal; cf. Subchapters III.1 and IV.1 for two such exercises.

Keeping the Amsterdam perspective, a way to solve for this lack of data would principally be to turn to the analysis of exchange rates instead of sovereign bond prices. Some of the most important exchange rates with foreign currencies can indeed be observed over the whole war at a daily frequency; the guilder to British pound sterling, guilder to French franc, guilder to German mark, and guilder to Austrian kroner rate (cf. especially Subchapter III.6.1). For illustrative purposes, Figure 25 depicts the guilder-mark and guilder-franc exchange rates as part of my database. The stretch of time that we principally lose when analyzing sovereign bonds is shaded in grey color.

On the upside, looking at the time pattern of these and other exchanges rates would help to compensate for data insufficiencies in the early phase of war.[91] It should be kept in mind that this approach is technically feasible because the international gold standard broke down when the belligerents as well as neutrals like the Netherlands suspended convertibility of paper currency into gold and softened the rules on gold cover to enable central banks to print money without restrictions. Formerly fixed exchange rates were now to float freely, just as the demand and supply on the currency markets required.[92]

A look at Figure 25 shows that with regard to France we might actually not miss too much. The Dutch-French exchange rate began to fall around mid-1915 to a lower level that was more or less maintained until February 1918. Before that level drop and the initial reaction to the outbreak of war at the beginning of August, the series is also essentially flat. In contrast, the Dutch-German exchange rate generally shows more variation around a long-term declining trend.

This is, of course, only a crude assessment of the series' pattern. The actual challenge that one faces when analyzing exchange rates for the perception of currency market players is that, in my opinion, we require a whole different analytical frame to get a hold of all economic factors affecting exchange rates and for filtering out perception.[93] However, that is properly placed in a separate study.

If we wanted to look beyond Amsterdam, the possibilities for building a representative set of sovereign bonds on the major belligerents from another marketplace would be very limited. There are London and Paris, certainly. But, as I added for consideration, these prices might be biased due to wartime stock exchange regulations (cf. Subchapter II.1 and the following subsection). At least,

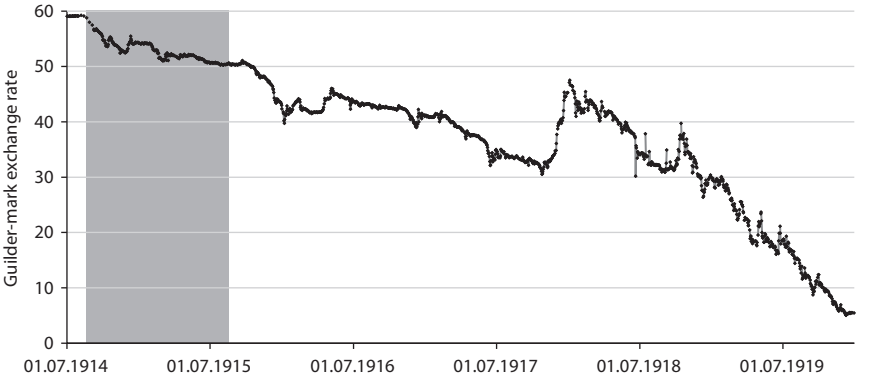
[91] Hall (2006) is the first to analyze the course of exchange rates over World War One by focusing on the Zurich currency market. Other studies have followed; cf. Subchapter III.2 for a brief discussion of these approaches.

[92] Cf. e. g. Obstfeld/Taylor (2003b) and Morys (2013, 2016) on the classical gold standard and its widespread abolition with the outbreak of war.

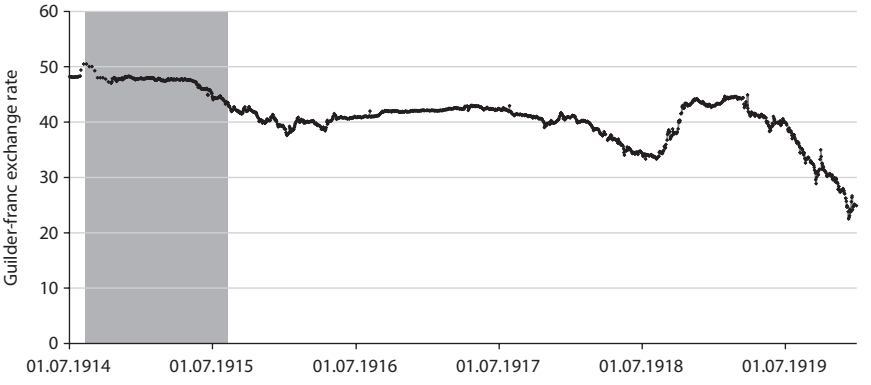
[93] Cf. again Hall (2006) and also Duarte et al. (2018).

Figure 25: Exchange rates at Amsterdam

(a) Dutch-German exchange rate



(b) Dutch-French exchange rate



Sources: Exchange rate 1915–1917: Brenninkmeyer (1920: 179–198). Exchange rate 1914, 1918–1919: Author's database.
Notes: The raw series is depicted.

given the range of foreign sovereign bonds traded, there is no alternative for Amsterdam beyond these two marketplaces.[94]

[94] As part of the project, I had to determine dead ends. As the sources on London and Paris prices are comparatively well documented in the literature – cf. e. g. Ehrensperger (1918), Dahl (1923), Brown/Easton (1989), Hautcœur (2006), Braggion/Moore (2011, 2013), Campbell et al. (2018), and this study's Subchapter II.1 – and digitally easy to assess, I especially looked into neutral trading places for the purpose of my study to be in line with the breakpoints studies on World War Two. Regarding the possibility of building a broad dataset on many countries' sovereign bonds, I spot-checked and ruled out the Swiss bourses and the bourse of Stockholm, which have proven especially helpful in investigating World War Two; cf. Frey/Waldenström (2004). Sources consulted but not used include *Manuel des valeurs cotées a la bourse*

Taken these points together, on the upside, my dataset principally offers the opportunity to assess investor perception of all major belligerents except for the US and of many minor European and non-European powers involved in the war for a substantial part of it. My dataset's major benefit is broadness in terms of which countries' sovereign debt was traded in Amsterdam. Principally, a similar broadness that was based on one and the same marketplace – and, thus, on in themselves consistent (yet maybe biased) data – would only be achievable by looking at London. I therefore opt for seeing the benefit rather than the limitation of my database: We "win" observations on the last three years of war.

4.2. Price formation

The new stock exchange regulations introduced by the *Vereeniging* in 1903, when it became the sole carrier of the stock exchange's business (cf. also Subchapter II.1), prescribed that access to the stock exchange was no longer free for everyone willing to make transactions or to just observe the daily happenings in its rooms,[95] but that affiliation with the *Vereeniging* was mandatory for being able to act as a securities trader or to be allowed to intermediate between such and investors. Everyone could become a member who was banker, trader, or broker – being self-employed or employed by a company.[96] As of 1914, the *Vereeniging* had 695 members of who 499, as clerks of the stock exchange, were allowed to execute transactions.[97] The council of the stock exchange acted as a governing body and consisted of 15 members of the *Vereeniging*. Five members were replaced every year by lottery.[98]

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de Genève et des changes, Belfrage (1917), *Neue Zürcher Zeitung*, *Neunter Geschäftsbericht der Schweizerischen Nationalbank 1. Januar bis 31. Dezember 1916, Siebenter Geschäftsbericht der Schweizerischen Bankgesellschaft umfassend das Jahr 1918*, Stucki (1924), Bauer (1976), and Schmidt/Meier (1977). An important source on the New York Stock Exchange which I certainly had to spot-check, too, is the *Commercial and Financial Chronicle*, a contemporary business newspaper (available at: https://fraser.stlouis-fed.org/title/1339#558102); cf. also Brown et al. (2008). I also went through the contemporary German finance press to make sure that there really are no unofficial Berlin prices (or, for example, Frankfurt prices) reported somewhere; specifically, I went through *Bank-Archiv*, *Deutscher Oekonomist*, *Berliner Börsen-Courier*, *Berliner Börsen-Zeitung*, *Kurs-Tabellen der Frankfurter Börse*, and *Neumann's Kurs-Tabellen*, Wormser (1919), *Geldmarkt, Wechsel- und Effektenkurse im Weltkriege,* and *International-vergleichende Statistik des Geldmarktes, der Börsen und der Warenmärkte.* As for the Brussels Stock Exchange, I spot-checked *Le Recueil Financier: valeurs cotées à la Bourse de Bruxelles* for 1916.

[95] Before 1845, entrance was entirely free for everyone. After 1845, a small entrance fee – labelled by Brenninkmeyer "bourse tax" (*Börsensteuer*) – had to be paid which still gave everyone who could afford it the right to enter the stock exchange's rooms. A possible reason for restricting access to members of the *Vereeniging* was that, for a long time, it had been raising concerns that virtually everyone – that is, in particular, the layman and the trickster – could enter the stock exchange and make transactions; cf. Brenninkmeyer (1920: 19).

[96] Cf. Brenninkmeyer (1920: 36, 42).

[97] Cf. Brenninkmeyer (1920: 47).

[98] Cf. Brenninkmeyer (1920: 41).

Official opening hours were weekdays between 13:30 and 14:45 o'clock and Saturdays between 10:30 and 12:00 o'clock. However, it had become standard to execute the first transactions starting at 13:00 o'clock, if not even earlier. It had also become practice to execute transactions to the so-called "middle price" of the day as all parties involved saw advantages in it.[99] This price has already been established in Subchapter II.2 as the mid-price between the lowest and the highest prices occurring on a day. This way of quoting prices was specific to Amsterdam at the time and a highly debated topic, as this way of quoting was not unproblematic. However, it was maintained beyond World War One and thus we need to explore its nature in more depth. For this purpose, I distinguish between the seller of a security, the buyer of that security, and the broker who executed the transaction. In order for the seller and the buyer to occur as what I have been calling "investors", they had to make contact to a member of the *Vereeniging*. If the member was allowed, he could execute the transaction himself or, if not allowed, mediate it to a broker who was. Principally, the Amsterdam Stock Exchange knew three kinds of brokers, two of them known as *hoekmannen*, with "hoek" and "mannen" being Dutch for "corner" and, respectively, "men". Thus, the *hoekmannen* were the specialist traders who were to be found in the various corners in the stock exchange's rooms where the different securities were traded according to geographical characteristics or sectoral affiliation (there was no single corner for sovereign bonds). The *hoekmannen*, who specialized in a particular corner and would stay there, were the most common type of broker. The *hoekmannen*, who switched between corners, were the second type. The so-called day traders (*daghandelaren*) were the third type. They did not regularly appear, but if they did, they usually traded in a particular security.[100] While the *hoekmannen* did not work for own account, the *daghandelaren* did.[101]

It was the brokers' job to compensate received buy and sell orders for a particular security – to match supply and demand. Say that the broker received a buy order – buy so and so many pieces, either unlimited or with a limit[102] – and found a seller who was willing to sell the amount of security for price p_e. While the seller would principally receive that price p_e, which is the *effective transaction price* negotiated (therefore the subscript "e"), the buyer would be charged, as was common practice at the time, with the middle-price of the day in that security, p_m, with the middle-price being the computational mid-price

[99] Cf. Brenninkmeyer (1920: 68).

[100] Cf. Brenninkmeyer (1920: 58, 64–65).

[101] To engage in a comparison to London, the *hoekmannen* resemble the stock brokers, while the *daghandelaren* more resemble the stock jobbers/dealers; cf. Brenninkmeyer (1920: 66–67) for this assessment.

[102] "Unlimited" means that the broker faced no limit on the price, but just had to buy the amount of security that he was charged with buying; "limited" would mean that the buyer provided a price range within which he was willing to agree on a trade; cf. Brenninkmeyer (1920: 58–63) for a discussion.

between the lowest and highest effective transaction prices having occurred for that particular security on the day. The strange nature of this way of quoting becomes evident when taking into account the following: Firstly, the middle price is an artificial price. Only by chance would it be equal to an effective transaction price achieved on the day, and only by chance would it be equal to the computational mean of the daily effective transaction prices (namely if there were exactly two transactions providing for the lowest and highest prices). Secondly, the buyer was not supposed to get to know the effective transaction price. He only got to know what he was effectively charged with, namely the middle price plus the usual commission. Thirdly, by definition, the final middle price of the day was established at the end of the opening hours – that is, after 14:45 o'clock on weekdays or, respectively, 12:00 o'clock on Saturdays.[103] The price was then applied retroactively to the trading day.[104]

One can argue that the third point principally set incentives for brokers to try to influence prices for their own benefit. In order to understand this point, we have to understand how a broker's (if he was not self-employed: his employer's) profit, or loss, was generated. A broker could have executed a transaction by compensating buy and sell orders among his own portfolio of orders when the price notions of buyers and sellers matched. In this case, he charged both parties with a commission. If the buyer did not want to pay price p_e, to link with the example in the previous paragraph, but a price $p_e^{buyer} < p_e^{seller}$, he stepped in and bought on behalf of the buyer for the seller's price, but charged the buyer the middle price. In case the day's middle price was higher than the effective transaction price, he would incur a price gain. If it was lower, he would have had to compensate the difference out of his own pocket.[105] This principle is said to have incentivized the broker to try to influence the day's lowest and highest prices by (small) bogus transactions. A broker was certainly able to observe the middle price's evolution over the day and, based on his expertise, could reckon pretty well at which level it would likely end up.[106] That is the theory. However, to the best of my knowledge, there is no evidence that this was a widespread problem in practice.

It should be noted that transactions at the Amsterdam Stock Exchange were spot market transactions. Fulfilment was due, principally, after four days. This means that after four days the buyer had to deliver the money and the seller had to deliver the security. As Ludger Brenninkmeyer (1920) has us know, this

[103] Cf. Brenninkmeyer (1920: 61–63).

[104] In other words, the Amsterdam Stock Exchange did not yet know continuous price quotation over the day.

[105] Formally, the lowest and highest prices were the range within which all transaction had to be concluded.

[106] Cf. Brenninkmeyer (1920: 61–63); cf. also Barendregt (2005: 107) on the problem of potential misuse.

did not necessarily work out like prescribed in practice, as the *Vereeniging* was oftentimes lenient regarding the time schedule. Besides, the seller might not always have owned the security at the point in time when he sold it. But trading securities in this way does not seem to have been a routine practice.[107]

What we learn from the discussion of the price formation at Amsterdam is that middle prices are not optimal prices because they were artificial. If we could observe all the transactions done day by day we would very probably not find any single transaction exactly equaling the middle price.[108] There is no mention in Brenninkmeyer (1920) as to how important the incentive problem for brokers practically was, that is, how many bogus transactions were conducted and what fraction of the recorded middles prices reflected the brokers' self-interest and not really market players' views on the fundamentals of the securities; in case of sovereign bonds, the effect of war on debt service. So, we necessarily have to go with the assertion that Amsterdam prices, practically, are not biased due to this theoretically relevant incentive problem.

4.3. Capital market regulation

A basic question regarding data quality is whether state intervention introduced systematic bias into price formation at the Amsterdam Stock Exchange like, we may suppose, state intervention did in the belligerent countries. The decision to close the stock exchange on 29 July 1914 was, following Jeroen Euwe (2010), a decision made by the *Vereeniging voor den Effectenhandel* as its private carrier. Though, it seems, the decision was well in line with the government's notion. The reason for why temporary suspension of trade in securities was regarded a necessary step is discussed in the subsequent section.[109] However, during the temporary closure of the stock exchange, the Dutch government enacted the Stock Exchange Act (*Beurswet*) on 4 September 1914 and thereby imposed hitherto unknown state supervision over the Amsterdam Stock Exchange (exercised according to Article 2 by the Secretary of Finance). On 15 January, new stock exchange regulations followed.[110]

Price formation itself, it seems, remained untouched. The middle price system continued to be the basis of securities trade at the Amsterdam Stock Exchange during wartime and in 1919.[111] In my view, the deepest cut into stock exchange business concerned the issuance of new securities – that is, the primary market

[107] Cf. Brenninkmeyer (1920: 87).

[108] In some sense, this is a general problem of price documentation. Historically, stock exchanges went different ways to document prices. Undoubtedly, there was and always will be the need or the desire to condense price information coming from a large number of transactions into a single, more or less, representative price statement.

[109] Cf. Euwe (2010: 222).

[110] Cf. Brenninkmeyer (1920: 173), Van Houten (1914), and *Beurswet 1914* (1914: 7).

[111] Brandes de Roos (1928: 66) mentions a change in the way prices were quoted in 1924.

for securities. By law of 30 December 1914, new foreign issues were prohibited from being placed on the market to prevent Dutch capital put into these new issues from flowing out of the country.[112] Interestingly, regarding my dataset, I can say that at least two foreign sovereign issues must have been newly admitted to trade at Amsterdam during the war anyway, namely two Brazilian bonds initially issued in 1915 – one each by the states of Bahia and Para.[113]

4.4. Who were the investors?

A question naturally suggesting itself to be asked is who the investors were that traded sovereign bonds in Amsterdam. It would certainly be nice to know more about the proportions of domestic investors and foreigners. It would also be nice to know about the proportions of individual persons – we may alternatively say: individual households – and of institutional investors; banks, insurance companies, other financial services providers, miscellaneous firms, and state bodies. I will address the points as good as possible in the following. However, I want to emphasize that this is not need-to-know knowledge for the approach put forward in this study to work.[114]

As mentioned above, we cannot approach the issue from the angle of the stock exchange as transaction information was not recorded appropriately at the time.[115] Approaching the issue from the other side, from potential domestic as well as foreign institutional and individual investors of which or, respectively, of whom one might be tempted to assume that they were involved in sovereign bond trading, is a possibility. But this endeavor would be laden with uncertainty as to the outcome, such that I have not attempted to do that. We might also consider approaching the issue by asking for what we principally know about the ownership of the involved countries' public debt like, for example, Michael Pammer (2017) did when analyzing the pricing of Hungarian sovereign debt pre-1913, or Thomas Winkelbauer (2004) did when analyzing Austrian World War One war bonds. But even if we knew the proportions of domestic and foreign ownership at a particular point in time, the composition of investors at a particular trading place might not reflect that composition, let alone that trade in a security constantly changes the structure of debt holders.[116]

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[112] Cf. Brenninkmeyer (1920: 173).

[113] There are further two Brazilian issues which had possibly been newly admitted to trade in the second half of 1914, namely the two series of 1914 denominated in British pound (cf. Table A.2 in online Appendix 1.2).

[114] Here, I refer to the principal economic historical literature that my study links to (cf. Subchapter I.3) where the question is usually not addressed. For a large part, this owes to data insufficiencies.

[115] A point that is emphasized by Brenninkmeyer (1920: 130).

[116] Cf. Rutterford et al. (2011) for a study on the nature of shareholders in Britain between the 1870s and 1930s; and Lehmann-Hasemeyer/Neumayer (2018) on the ownership structure

So, which general statements can we make? For one, the literature emphasizes that the Dutch were a rich people – one of the richest people in the world by 1914. A considerable part of Dutch national wealth was bound in securities. What made the Dutch unique in international comparison was the comparatively larger proportion of securities – stocks as well as fixed interest-bearing papers – in the mix of assets they owned. In his early study of 1928, Reinhard Brandes de Roos cites several estimations circulating in the literature about this proportion. These estimations were based on analyses of bequeathed assets. While the proportion is said to have been roughly 30 percent in 1855, it secularly increased to almost 46 percent in 1910/1914 with ownership in domestic and foreign securities being equally high.[117] By tendency, we may thus assume that holdings of shares and bonds were more widely distributed across the population than elsewhere; and we may assume by tendency that the greater role they had been playing for long-term investment of private savings drove more individuals to the stock exchange than we may observe for other European trading places.

The fact that holdings of securities played a special role in the Netherlands is also evidenced by the existence of a credit system unique to the Netherlands. This system principally rested on three types of short-term credit available on the money market: on call loans, which were day-to-day loans; on the *prolongatiekrediet* as a one-month renewable credit; and on *beleeningen* as a three-month non-renewable credit. Among these types, the *prolongatiekrediet* played a special role. It was intermediated via the Amsterdam Stock Exchange and, if the lender did not make explicit use of the right to demand cancellation and the borrower did not explicitly make use of the option to settle the credit, it was automatically prolonged for another month. The *prolongatiecrediet* was a collateralized credit in that the borrower had to provide securities as collateral.[118] According to Brenninkmeyer (1920), the credit sum was allowed to amount to a maximum of 90 percent of the collateral's value at the point in time when the credit was contracted. The ten percent discount was supposed to be a kind of buffer in case the collateral's actual market value fell during the one-month period of the credit.[119] In the case that the collateral's value would fall below the credit sum, the borrower had to provide additional securities as collateral. If he did not provide that additional collateral, the lender could demand cancellation of the credit and liquidation of the collateral.

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of a great many German firms of which the stock was traded at the Berlin Stock Exchange between 1869 and 1945.

[117] Brandes de Roos (1928: 63, 69–70). Cf. also Verstegen (1996) for recent estimates which do not change the general picture, though. De Meere (1983) provides an interesting study on long-term income and wealth inequality in the Netherlands between 1908 and 1940.

[118] Cf. Barendregt (2005: 101) and Euwe (2010: 222).

[119] Cf. Brenninkmeyer (1920: 71).

It was the volume of short-term liquidity bound in this form of credit by July 1914 that prompted the *Vereeniging voor den Effectenhandel*, in line with government interests, to close the stock exchange because it was assumed that a panic on the market would lead to overly many sells. These sells would have depressed securities prices which, in turn, would have depressed the aggregate value of the collateralized securities. This would have led to many sudden cancellations of credit arrangements with the consequence that securities supply would have grown, depressing prices further. It was assumed that borrowers would try to buy more securities to raise the aggregate value of their collateral. This increased demand might have offset part of the price-depressing effect of increased supply. But the literature agrees that, in net terms, a downward spiral would have been the consequence, as borrowers were required to draw on additional liquidity which they would likely not have had (otherwise, why take a credit in the first place?).[120]

The stock exchange's closure cut off the markets from liquidity. As everyone could have become a lender of a *prolongatiecrediet*, businesses also were affected, facing a sudden liquidity bottleneck. The main reason for why the Netherlands went off the gold standard was to enable the Dutch central bank to inject additional money into the market until the liquidity blocked in the stock exchange would be unblocked again.[121] The literature has us know that, after resumption of stock exchange business, almost all credits were settled by the beginning of 1916. However, the *prolongatiecrediet* was not banished but could still be offered.[122]

This feature of the Dutch money market around the outbreak of World War One is unique in international comparison and explains, to a large part, the relative backwardness of the Dutch banking system, as Dutch commercial banks have been seeing themselves in competition with the stock exchange and the *prolongatiecrediet* for private savings. The outbreak of war and the liquidity problems thereupon led to bank deposits gaining more significance as investment alternatives and led to commercial banks being able to expand their business.[123] Regarding the original question, it should have become clear that holdings of securities were an important investment alternative for the mass of Dutch people and that the *prolongatiecrediet* drove many people to the stock exchange, potentially reflecting a broader mix of what I have been calling investors than we would find when looking at other trading places.

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[120] Cf. again Barendregt (2005: 99–101), Euwe (2010: 222), and t'Hart et al. (1997: 124–125).

[121] Cf. again Barendregt (2005: 99–101) and Euwe (2010: 222).

[122] Cf. again Barendregt (2005: 99–101) and Euwe (2010: 222).

[123] Cf. the assessments by t'Hart et al. (1997: 124, 128–129), Wintle (2000: 99–100), Barendregt (2005: 99–100), and Euwe (2010). Kiliani (1923) provides an early in-depth study of the development of Dutch banking. Wijtvliet (1993) provides are more recent study.

How about the proportion of domestic and foreign investors? The literature stresses that Amsterdam could strengthen its position as an international financial center due to the banking sector's sudden boost and due to rising attractiveness as a safe haven for foreign capital.[124] For example, the Amsterdam money market benefited strongly from an increase in the acceptance business to the detriment of London, which was the leading center for such transactions until 1914. This notably increased the money market's liquidity in the longer term.[125] We also see a considerable inflow of gold which, due to the suspension of the gold standard, did not happen for mechanical reasons. A fair part of that inflow can assumingly be ascribed to foreign investors searching for a safe haven for their wealth.[126] Moreover, the number of foreign financial services providers increased towards 1918, and beyond. This probably made it easier for foreign capital to flow into the Netherlands.[127] While it is reasonable to assume that relatively more foreigners were active in trading securities at the stock exchange, as there was just more foreign capital that searched for investment, I cannot come up with a specific proportion, though.

What I can do based on my set of bonds is a little descriptive exercise. The idea is that we may get, at least, a glimpse of an impression as to which sovereign bonds may have been traded rather by foreign investors and which rather by domestic investors before the war. Thus, we may be able to at least make an educated guess as to which bonds were generally more attractive as trade objects to foreigners or, respectively, to domestic investors during wartime. I propose that a look at how individual bonds' liquidity changed from peace- to wartime can give us a clue in that respect. To keep the analysis manageable, I only look at the representative bonds defined above. They are listed in Table 17 in columns one and two. Given in columns three and four is bond-specific liquidity over the last three peace months (May to July 1914) and the first three months in which the respective bond was traded again after 9 February 1915. As indicated in Subchapter II.3, the individual dates of the resumption of trade in the bonds varied considerably. Recall that the European belligerents' bonds were in trade

[124] Euwe (2010: 223) stresses that foreign capital especially flowed in from the Central Powers. According to the President of the Dutch central bank, G. Vissering, the flight capital from Germany alone is said to have amounted to between 500 and 800 million guilders over the war and until 1923 – an amount equaling between 9.6 and 15.3 percent of Dutch GDP in 1923 and said to have equaled roughly 50 percent of total German flight capital.

[125] Acceptances were used to finance cross-border trade. The importer's or exporter's bank concluded on behalf of one party a credit contract with the other party in the form of a bill of exchange. This mechanism could mitigate short-term liquidity bottlenecks as in particular uncertainties about the reliability of trade partners. It, so to say, substituted for reputation; cf. the discussion in Jongman (1959: 191), Barendregt (2005: 102–104), and Euwe (2010: 223–224, 230–238).

[126] Cf. Vries (1989: 76) and Euwe (2010: 223).

[127] Cf. Euwe (2010: 226). Among those financial services providers were especially German banks or, respectively, Dutch banks with a clear link to Germany.

Table 17: The impact of the war's outbreak on bond-specific liquidity

Country	Bond subseries	Liquidity May 1914 – 28 Jul 1914
Austria	4.0 % kroner perpetual of 1903 (Jan/Jul)	0.692
Argentina	5.0 % of 1905	0.246
Belgium	2.5 % of 1842	0.046
Bosnia-Herzegovina	5.0 % railway debt of 1914	0.108
Brazil	5.0 % of 1914 (20/100)	0.000
Bulgaria	5.0 % tobacco of 1902	0.385
Chile	5.0 % of 1912	0.061
China	4.5 % gold of 1898	0.354
Colombia	3.0 % of 1896	0.354
Cuba	5.0 % of 1904/05	0.523
Denmark	4.0 % of 1912	0.000
Dominican Republic	5.0 % customs	0.508
Dutch East Indies	5.0 % of 1915 (1 000)	0.000
Egypt	4.0 % of 1876	0.261
Finland	3.5 % of 1889	0.000
Germany	3.0 % imperial of 1890–1903 (Apr/Oct)	0.246
Hungary	4.0 % kroner perpetual of 1892–1910 (2 000)	0.185
Italy	3.5 % of 1862–81	0.077
Japan	5.0 % of 1908/09 (500/1 000)	0.000
Liberia	5.0 % of 1908/09	0.061
Mexico	5.0 % 1st–4th ser. of 1895 (100/1 000)	0.492
Netherlands	3.0 % *Nieuwe Werkelijke Schuld*	0.600
Nicaragua	5.0 % of 1909	0.246
Norway	5.0 % of 1888	0.000
Portugal	4.5 % tobacco of 1890	0.431
Romania	4.0 % of 1910 (2 500/5 000)	0.077
Russia	4.0 % Hope & Co of 1889/90 (625)	0.708
Serbia	4.0 % of 1895 (500)	0.354
Spain	4.0 % of 1881 (1 000/6 000)	0.031
Surinam	4.5 % of 1915 (100/500)	0.000
Sweden	3.5 % of 1890	0.046
Switzerland	3.5 % of 1899–1902	0.138
Turkey	4.0 % Baghdad Railway of 1904 (1st series)	0.569
Uruguay	3.5 % of 1892	0.061
Venezuela	3.0 % of 1905 (20/100)	0.277

Sources: Author's own computations.
Notes: Liquidity is measured by the LOT measure. USA and France omitted due to insufficient observations.

Liquidity in first three months of bond's wartime trade	Liquidity change	Assessment
0.579	↓	Mostly traded by domestic investors
0.028	↓↓	Mostly traded by foreign investors
0.000	↓	Mostly traded by foreign investors
0.029	↓↓	Mostly traded by foreign investors
0.400	↑↑	No assessment possible as no trade pre-war
0.131	↓↓	Mostly traded by foreign investors
0.184	↑↑	Mostly traded by foreign investors
0.290	↓	Mostly traded by domestic investors
0.192	↓	Mostly traded by domestic investors
0.055	↓↓	Mostly traded by foreign investors
0.000	–	Extremely low liquidity throughout
0.294	↓	Mostly traded by domestic investors
0.548	↑↑	Mostly traded by foreign investors
0.130	↓↓	Mostly traded by foreign investors
0.263	↑↑	Mostly traded by foreign investors
0.156	↓	Mostly traded by domestic investors
0.237	↑	Mostly traded by domestic investors
0.000	↓↓	Mostly traded by foreign investors
0.131	↑↑	Mostly traded by foreign investors
0.054	↓	Mostly traded by domestic investors
0.631	↑	Mostly traded by domestic investors
0.720	↑	Traded by domestic investors
0.286	↑	Mostly traded by domestic investors
0.000	–	Extremely low liquidity throughout
0.571	↑	Mostly traded by domestic investors
0.053	↓	Mostly traded by domestic investors
0.684	↓	Mostly traded by domestic investors
0.130	↓↓	Mostly traded by foreign investors
0.026	↓	Mostly traded by domestic investors
0.000	–	Extremely low liquidity throughout
0.000	↓↓	Mostly traded by foreign investors
0.026	↓↓	Mostly traded by foreign investors
0.395	↓	Mostly traded by domestic investors
0.182	↑↑	Mostly traded by foreign investors
0.306	↑	Mostly traded by domestic investors

again, at the latest, at the turn of August/September 1915. Column five indicates in a simple way whether liquidity had fallen (risen) by less than (more than) 50 percent, indicated by one arrow, ↓(↑), or two arrows ↓↓ (↑↑). Column six, finally, contains a statement as to whether that particular bond may have been subject to trade rather by foreign or rather by domestic investors as of 1914.

It is clear that the change in liquidity, whether it is a drop or a rise, somehow is a *net* effect of several factors at work. On the one hand, there were international capital, trade, and mobility controls on arbitrage in securities, which assumingly cut off foreigners from trade in Amsterdam in the short term. However, as the literature has argued, in the middle and long term, the Dutch capital market saw a net inflow of foreign capital searching for investment. Part of that inflow assumingly found its way specifically to the sovereign bond market. As this exercise somehow builds on the first factor having had a strong impact, a credible assessment is possible, I think, for bonds that were traded again relatively soon after 9 February 1915. As mentioned above, the principal representative belligerents' bonds came into trade again at the end of August/beginning of September 1915. So, there were roughly seven months between the re-opening of the stock exchange and the resumption in these bonds' trade. The more it took for a bond to be re-traded again, the less credible my assessment, as displayed in Table 17, certainly is (cf. the date in parentheses given in column four).

There certainly is another factor at work that might explain shifts in liquidity across the bonds. Investors might have generally been less inclined to trade in bonds of the belligerent countries after war had broken out, as these, obviously, exhibited a greater risk. Whether they did or did not depended on investors' attitude towards risk in the first place. Risk-averse investors would have preferred less risky bonds of neutral countries and might therefore have wished to go out of belligerents' bonds.[128] In all, we cannot really disentangle these effects in this kind of exercise.

There are two bonds in the subset that may serve as some kind of benchmark for assessing the proportion of domestic and foreign investors per bond. At least, we should pay special attention to them. The one is the Dutch 3% which saw an increase in liquidity from 60 to 72 percent. I think it is reasonable to assume that this bond was most attractive for, and was thus held first and foremost by, domestic investors. The second is the Russian 4% Hope & Co, which only saw a modest reduction in liquidity as it fell from 70.8 to 68.4 percent. As Hope & Co was a Dutch commercial bank having underwritten that bond, it is reasonable to assume that domestic investors held pieces in the first place.[129] The modest absolute reduction in the bond's liquidity of 2.4 percent may be taken, with all due caution, as some clue that domestic investors reacted with

[128] Surely, if the aim was to maintain a diversified portfolio, they would have kept holdings of belligerents' bonds to some extent.

[129] Cf. De Vries et al. (1999: 54).

only a slight reduction in their trading activity to the fact that Russia became a war party. It is highly speculative, but one may be inclined to generalize this reaction to the other belligerents' bonds. One may be inclined to say that every reduction in liquidity larger than 2.4 percent is already indicative of a reduction due to foreigners being kept from trading. I leave it to the reader to decide on the plausibility of this reasoning.

In assessing the proportion of domestic and foreign investors per bond in Table 17, I just assume that a reduction in liquidity by less than 50 percent is, by tendency, indicative of a high proportion of domestic investors as long as liquidity was not generally very low and fell to (almost) zero. As stressed above, the later trade in a bond was resumed, the more uncertainty comes with this assessment. I further assume that a reduction by more than 50 percent meant that a high proportion of foreigners was active in trading the particular bond and therefore was, by tendency, more interested in trading it again during wartime. This reasoning holds analogously for the case of a jump in liquidity.

I just want to point out that on the basis of this very crude reasoning, three of four bonds of the Central Powers – i. e., Austria, Germany, and the Ottoman Empire – may be assumed to have been traded by domestic investors in the first place. As these bonds will also be at the center of my empirical analysis in the following chapters, we may thus get the targeted "neutral view".

Regarding the Allied Powers, this also holds for Russia and Romania. Regarding the Bulgarian, the Italian, and the Serbian bonds, we observe a general rise in liquidity over the remaining war period. According to my reasoning, this would be due to foreigners resuming trade in these bonds. In contrast, to conclude this chapter, the German 3 % and the Ottoman 4 % did not see liquidity increase in the long term beyond the mean of the initial three months after resumption of their trade. Again, in my reasoning, this supports the assessment that these bonds indeed continued to be traded by domestic investors in the first place.

III. Turning points in the perception of the Great Powers' war effort[1]

1. The problem

To promote our understanding of World War One, historians have introduced a battery of questions concerning war mentality and public opinion (cf. Chapter I). For example, one may wish to ask how the course of World War One was perceived at the time and whether contemporaries saw distinct phases emerging; which events they deemed more important, or unimportant, than others; or which of the belligerents' war efforts made the greatest impression on public opinion, as they possibly came as a true surprise in a war presenting itself to a large part as a stalemate.[2] The analysis performed in this chapter wants to address these questions by looking at the course of the war through investors' eyes. Examined is a non-random sample of bonds constructed from the universe of bonds traded in Amsterdam. Bond prices, or transformations of them like the yield (i. e., current yield or yield-to-maturity) expressing more directly the risk attached to a bond, have been established as being quite reactive to extraordinary events like wars or deep political crises.[3] Investors' assessments of war through bond prices may well serve to draw a level-headed picture of contemporary opinion, and especially of a larger mass of people, the opinion of which would otherwise be hard to assess with qualitative data, or not assessable at all.

A look at the literature reveals that we still know little about how the capital markets assessed the outbreak of World War One. This holds true even more so regarding its course. Regarding the securities markets as a part of *the* capital market, this is not surprising since all but a few minor trading places were shut down immediately when the war broke out – with the notable exception of the Paris Stock Exchange which finally closed in late August 1914. What is more, not every major market reversed to full functioning at all. The Paris and London Stock Exchanges took up trade relatively soon again, in December 1914 and

[1] Parts of an earlier version of this chapter are published in Jopp (2014, 2016).

[2] Cf. e. g., Van der Linden/Mergner (1991), Van der Linden (1991), Verhey (1991), Fries (1995), Ferguson (1998), Neiberg (2005), Silbey (2005), Stevenson (2005), Sondhaus (2011), and Clark (2013).

[3] Cf., fundamentally, Mauro et al. (2006) on this assessment as well as the discussion in Subchapter I.3.

January 1915, respectively, but trade was heavily regulated in the following and possibly suffering from patriotic bias. Both points together raise doubts about whether bond prices formed in the belligerents' markets provide that "level-headed picture" we wish to have. The Amsterdam Stock Exchange, as the most important trading place in a neutral country, formally followed in February 1915, but it took until August 1915 that belligerents' sovereign debt was finally traded again. Finally, the Berlin Stock Exchange stayed closed throughout the war regarding trade in sovereign bonds.

However, there seems to be no reason to believe that we cannot trust the pattern of bond prices formed in the belligerents' markets before they actually became belligerents and before war made the imposition of restrictions necessary or, respectively, attractive in governments' eyes. In this spirit, analyzing bond prices in the run-up to the war, Niall Ferguson (2006) argues that its outbreak came as a true surprise for the London capital market, meaning that expectations had initially not been so pessimistic. The possibility of a great war was assessed as rather low.[4] This conclusion on investor opinion seems to back the recent path taken towards explaining the war's outbreak that we can conveniently put under the label "sleepwalker hypothesis" – the unwanted, more or less unconscious slithering into the war that was born out of negligence.[5] However, there is also a study that looks at bond prices that somewhat backs the more traditional view of seeing the war as being the natural end point of a path of stringently rising political and military tensions among the European powers fueled especially by the general tendency for arms build-up (i. e., the "arms race").[6] This is the study of Avni Ö. Hanedar et al. (2015) who analyze two Ottoman government bonds (a Rumelia Railway bond and a treasury bond) as traded at the Istanbul Stock Exchange between 1910 and 1914. They argued that investors' trades implicated rising country risk due, especially, to the conflicts in the Balkan in 1911 and 1912 in which the Ottoman Empire was involved. This led, so the argument goes, to a higher sensitivity in the Istanbul market and among Turkish politicians for the actual likelihood of a great war being rather high.

What goes implicit here is the view that the outbreak of World War One *did not* come as a surprise for the Turkish capital market, contrasting what

[4] Cf. Ferguson (2006: 73–74).

[5] Cf. Clark (2013).

[6] Cf. the argumentation in the introductory chapter of Ferguson (1998) and, additionally, Ferguson (2006: 73–74) on this point. In the latter study, Ferguson basically groups relevant studies into two groups: Firstly, into those studies which trace the beginning of the direct path towards war back to the foundation of the German Empire, thus, at least, three or four decades back. Secondly, those which trace the lock-in on that path back "only" some ten or twenty years, to the late nineteenth century or the series of crises beginning with the Moroccan Crisis in 1905. As examples of the former group, cf. Taylor (1954), Geiss (1990), Strachan (2001), and Fromkin (2004); as examples of the latter, cf. Herrmann (1996), Stevenson (1996, 2004), and Williamson (1998). On the "arms race", specifically, cf. Brose (2004) and Eloranta (2005, 2007, 2018).

happened in the London market. However, Hanedar et al.'s (2015) data show that observed prices did fall quite considerably just before the outbreak of World War One nevertheless. This, indeed, implies that the outbreak of a world war did come unanticipated The perceived higher country risk as a consequence of the conflicts in 1911 and 1912 may, thus, be alternatively interpreted as indicating that indeed the perceived likelihood for a greater *local* conflict in the Balkan, instead of a greater war (including not just Austria-Hungary as a great power), had increased.[7]

Table 18 is an attempt at verifying Ferguson's capital market-related "surprise hypothesis" for the other three important European trading places, too; that is, for Paris, Berlin, and Amsterdam. Shown in the table is the price development of selected bonds in the weeks preceding the closure of these stock exchanges. Shown for illustrative purposes is the price for the first week after the respective stock exchange had re-opened, too. Due to the fact that the cross-sections of bonds traded at the four trading places differ, I just attempted to construct a representative-enough sample for the major powers' bonds to make the general point.

If markets expected the war's outbreak, a gradual and pronounced decline in the price of a major power's bond would have occurred between January 1914 (or starting earlier, of course) and the last trading days before trade was stopped. This would be a sign that the market gradually factored increasing war risk into prices. If the outbreak of war came as a surprise, there would either be no such gradual decrease, or the decrease would happen suddenly, right when war broke out. Table 18 shows, firstly, that capital market data, when broken down to single securities, do not give a unanimous picture. Investors at the different trading places might have judged the sovereign risk of one and the same country differently (e. g., regarding Austria). However, secondly, the evidence generally supports the "surprise hypothesis" for all trading places. When it reads in the table that the outbreak of the war did apparently not come as a surprise for traders in Austrian, Hungarian, and Serbian bonds, this rather should be taken as reflecting that a *local* conflict was thought to be due. This conflict may have involved Russia as well, as the protective power in the Balkan. The behavior of the Paris and Berlin prices supports that conclusion.

For investors even beyond London (and possibly except for Istanbul), a great conflict seemed to be an unlikely event – regardless of the formal interconnections via bilateral or multilateral alliances. We may say, therefore, that investors did not generally believe in the credibility of the threats inherent in the alliance

[7] Cf. Hanedar et al. (2015). In addition, Hanedar et al. (2017) focus on the development of Turkish stocks as traded at the Istanbul Stock Exchange. Their findings based on an analysis of stocks do not generally support Hanedar et al.'s (2015) conclusion based on an analysis of bonds. This probably owes to the very difference between the properties of stocks and sovereign bonds (cf. the discussion in Subchapter I.3).

Table 18: World War One – a surprise to investors?

Trading place/Bond	3 January 1914 (1)	18 April 1914 (2)	25 July 1914 (3)
London			
German 3.0 % imperial loan	75.0*	77.0*	75.0*
Hungarian 4.0 % kroner perpetual	83.0	83.0	77.0
Russian 5.0 % of 1906	102.7*	104.0*	102.0*
Turkish 4.0 % of 1903	77.8[a]	83.0	80.5
UK 3.0 % consols	71.7*	75.7*	74.9*
Paris			
Austrian 4.0 % of 1876–1892 (8 fl.)	89.0	86.7	84.3
French 3.0 % perpetual	85.2	86.7	80.0
Hungarian 4.0 % (4 fl.)	90.4	85.7	79.0
Russian 5.0 % of 1906	103.0	103.7	91.3
Serbian 4.0 % (20 fr.)	83.4	81.0	73.5
Turkish 4.0 % of 1903 (20 fr.)	86.0	81.7	79.8
Berlin			
Austrian 4.0 % kroner perpetual	84.2	82.6	74.0
German 3.5 % imperial loan	85.3	87.1	85.9
Hungarian 4.0 % kroner perpetual	82.4	82.0	75.5
Russian 4.0 % consols of 1880	87.9	86.6	81.0
Serbian 4.0 % of 1895	79.3	78.7	72.1
Amsterdam			
Austrian 4.0 % kroner perpetual (Jan/Jul)	82.3	82.8	78.5[e]
German 3.0 % imperial loan (Apr/Oct)	75.2	76.8	75.9[e]
Hungarian 4.0 % kroner perpetual (100/1 000)	83.1	82.0	78.5[e]
Russian 5.0 % of 1906 (500)	100.7	99.5	99.9[e]
Turkish 3.0 % of 1903 (500)	80.1	77.5	78.0[e]

Sources: Cf. Chapter II on Amsterdam, London, and Paris; cf., in addition, *Berliner Börsenzeitung* on Berlin (Issues No. 4, 180, 344, 348, 350, and 352 of 1914) available at http://zefys.staatsbibliothek-berlin.de/list/title/zdb/2436020X/-/1914; accessed: 5 August 2019.
Notes: All prices are rounded to one decimal place. London and Paris prices are from a weekly sample I gathered, with prices recorded for Saturdays. The London price marked with "*" is the average of the daily minimum and maximum prices reported in the respective source. Paris and London prices are reported on Saturdays but refer to the previous Friday. Given in parentheses at the end of the bond's name is an addition necessary to identify the subseries (either denomination or months of interest payments). Not in all cases do sources identify the subseries for which the price is reported. [a] Price is for 30 January. [b] Price is for 22 August. [c] Price is for 29 July. [d] Price is for 30 July. [e] Price is for 24 July. [f] Price is for 27 July.

28 July 1914 (4)	1 August 1914 (5)	29 August 1914 (6)	Did the outbreak of the war come as a surprise? (7)	Price in first week after resumption of trade in the particular bond (8)
–	72.0*	–	✓	54.0 (27 February 1915)
–	74.0	–	×	53.0 (30 January 1915)
–	93.0*	–	✓	93.2 (2 January 1915)
–	78.0	–	✓	62.0 (16 January 1915)
–	69.2*	–	✓	68.5 (2 January 1915)
–	–	–	×	59.0 (14 May 1915)
–	–	75.0[b]	✓	70.5 (19 December 1914)
–	–	–	×	65.0 (19 December 1914)
–	–	89.7	× (?)	93.5 (9 January 1915)
–	–	64.0	×	66.0 (9 January 1915)
	–	–	✓ (?)	62.0 (9 January 1915)
				–
73.0[d]	–	–	×	–
84.0[c]	–	–	✓	–
71.2	–	–	×	–
76.0[d]	–	–	×	–
64.7[d]	–	–	×	–
72.0	–	–	✓	56.1 (24 August 1915)
75.0	–	–	✓	57.7 (3 September 1915)
78.0	–	–	× (?)	54.5 (24 August 1915)
94.5	–	–	✓	81.1 (24 August 1915)
73.9[f]	–	–	✓	51.0 (26 August 1915)

system; I will take up this particular point in Chapter IV. What is more, after resumption of trade in late 1914 or sometime in 1915, prices for all countries show a severe adjustment compared with the last pre-war prices. It is certainly speculative, but if war had been seen coming, these adjustments would have had to be smaller since much of the increased country risk had been factored into prices beforehand.

Was investors' attitude actually ignorant of basic political facts? If we follow Niall Ferguson's argumentation once more, it certainly was not. Economic historians have shown that capital markets were generally well integrated on the eve of World War One – that is, the major and minor powers that would eventually fight the war were as much interwoven financially, and economically per se, as they were interwoven in the international system of alliances.[8] Against this background, a great conflict seemed to be highly unlikely, as it constituted an economic risk too high to take.[9] Looking at the long-term development of major powers' sovereign bond spreads in London in the decades before the war, Ferguson's (2008) observation fits quite nicely with this view:

> The yields on the bonds of the other great powers, which accounted for about half the foreign sovereign debt quoted in London, declined steadily after 1880, suggesting that political risk premiums were also falling. Before 1880, Austrian, French, German, and Russian bonds had tended to fluctuate quite violently in response to political news; but the various crises of the decade before 1914 – such as those over Morocco and the Balkans – caused scarcely a tremor in the London bond market. Although the major stock markets did not perform spectacularly – Britain's essentially flat-lined after the 1895–1900 "Kaffir" (gold mine) bubble burst, and the Dow Jones failed to recover its January 1906 high in the aftermath of the 1907 panic – the volatility of returns trended downward.[10]

Ferguson goes on to show that first news in the London market as to the potentially harmful effects of the late political crisis on the international financial system, rooted in Archduke Ferdinand's assassination (28 June 1914), dates 22 July 1914.[11] So, investors along with the financial press in London had good reason to believe that financial interrelations would prevent the European Powers from going to war eventually.[12]

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[8] On financial market integration in the so-called "First Age of Globalization" (c. 1850–1914), cf. e. g. Neal (1987), Findlay/O'Rourke (2003), Obstfeld/Taylor (2003a, 2003b), and the brief discussion in Subchapter I.1.

[9] Angell (1911) is a famous early proponent of the idea that the (unknown) economic costs of war to the belligerents were to too high to let them engage seriously in it.

[10] Ferguson (2008: 443).

[11] Cf. Ferguson (2008: 445). He refers to an article in the *Times of London*, hence to "English-language news".

[12] Thus, we may call the decision to go to war irrational from the perspective of the capital market. As, for example, Jopp (2018b), based on Baten (2005) and Plumpe (2015), has argued for Germany, business leaders generally saw nothing to gain economically by lobbying for war. Rather, they tried to make the best out the fact that they suddenly saw themselves being right in

I could locate similar German-language news dating from 20 July and tied to the marketplace of Zurich. This news I found in Walter Stucki's 1924 dissertation thesis on the Swiss bourses during the war, where he cites a news article from the *Neue Zürcher Zeitung*:

> Yesterday's panicky decline at all continental bourses has not spared our place; one is tempted to believe that a European war is imminent. One thing is certain: the longer Austria is going to postpone the step expected by Belgrade, the tenser do bourses get; and the stronger prices will fall.[13]

Note that 20 July was a Monday. Provided that the news was correctly dated in Stucki's thesis, the news article's author must actually refer to the Saturday (or Friday?) before as the bourse of Zurich, to the best of my knowledge, was, like every other bourse, not open on Sundays. There are two interesting points to note here: Firstly, the article's author speaks of "*a* European war". This reads like he addresses the possibility of a localized conflict, rather than a really great conflict. Insofar, this news is well in line with Ferguson's assessment on London and also, in my view, with Avni Ö. Hanedar et al.'s (2015) evidence on Istanbul. Secondly, and that is the even more thrilling point, whatever news the article's author had received from "all continental bourses", these news could not have referred to the sovereign bond segments in Amsterdam, Berlin, London, or Paris, as in all these places there was no such "panicky decline" in prices on that date. That becomes pretty evident when looking at the stock exchange price lists around that date. But even if the time stamp of the article was wrong, there were no such declines several days before or after.[14] If anything, the panicky declines appeared at the end of July at the earliest.[15] It is needless to say that these four bourses were covering *the* substantial part of the trade in securities in Europe. In my view, this is a nice example of how misleading it could be for a researcher to derive market sentiment from qualitative stock exchange news instead of inferring it from what really matters, namely the material effects embodied in the prices themselves.

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a war. So, if political leaders thought they would have to go to war, they were not informed by business's interest, as this interest was, in fact, lacking.

[13] Cf. Stucki (1924: 16). This is my own translation of the German original: *"Der gestern eingetretene panikartige Rückgang an allen kontinentalen Börsen verschonte auch unseren Platz nicht; man könnte beinahe glauben, ein europäischer Krieg stehe unmittelbar vor der Tür. Eines ist gewiss; je länger der in Belgrad zu erwartende Schritt Österreichs hinausgeschoben wird, desto nervöser werden die Börsen, und desto mehr kommen die Preise ins Fallen."*

[14] The article has been cited by Stucki as part of a whole sequence of such articles. The next in line that he refers to dates 24 July 1914.

[15] Regarding Amsterdam, this follows from my database. For Berlin, this can be gathered from the price list in the *Berliner Börsenzeitung*; and for London and Paris one may just consult *The Times* or, respectively, *Financial Times of London*, and the *Bulletin de la Côte* for the respective stock exchange price lists.

This discussion leaves room for extending the picture on the war period itself using bond prices as a useful, and probably the only valid, measure of contemporary investor thinking on the major players' performance. I therefore trace contemporary investor opinion in the daily prices of government bonds traded at the Amsterdam Stock Exchange, a formally neutral trading place – and one of the major international trading places for sovereign bonds – at the time. Specifically, to be able to compare opinions on both war factions, I analyze the evolution of bond yields for ten major players over the war – namely the German Empire, Austria, the Ottoman Empire, and Bulgaria (together forming the Central Powers) as well as France, England, Russia, Italy, Romania, and Serbia (together forming a substantial part of the Allied Powers). Bond yield series will be screened for structural breaks in the constant. These breaks are taken as revealing fundamental adjustments in investors' long-term expectations on default probabilities due to unanticipated news (recall the discussion in Subchapter II.3). Identified breaks are then checked for robustness in an empirical model explaining variation in daily yields by changes in returns on alternative investments, exchange rates, market liquidity, short-term interest rates, and inflation. A discussion of the results completes this chapter's investigation.

2. Which breaks have been detected so far?

Methodically, this chapter's investigation directly links up with the strand of literature in economic history in which financial time series are used to explore deep-cutting historical phenomena, such as wars, political unrest, regime change, and economic crises, by determining and interpreting turning points in the series; a cursory overview has been given in Subchapter I.4. As shown, the American Civil War and World War Two initially enjoyed most of economic historians' attention since Kristen Willard et al.'s (1996) study had kick-started this kind of research. World War One has become another focus of attention only since the mid-2000s. In the following, I briefly review the relevant studies on World War One which include Oosterlinck and Landon-Lane (2006), Christodoulaki et al. (2012), Jopp (2014, 2016), Adams (2015), Hanedar et al. (2016), Oosterlinck (2016), Hanedar et al. (2018a), and Schaltegger and Schmid (2020). Table 19 summarizes the breaks found in these studies.

Kim Oosterlinck and John S. Landon-Lane (2006) and Kim Oosterlinck (2016) especially focus on the question of how French holders of Russian government bonds assessed the Russian Revolution in 1917 and the Bolshevik repudiation of all Tsarist bonds in early 1918. They search for structural breaks in the price evolution of a representative Tsarist bond traded at Paris to filter out which events caused fundamental adjustments in expectations. Before early 1918, when the Russian Empire quit the war, Oosterlinck and Landon-Lane de-

Table 19: A summary of relevant breakpoints studies

Study	Screened Series	Detected breakpoints	Suggested event(s)
Oosterlinck/ Landon-Lane (2006)/Oosterlinck (2016)	Russian 5 % of 1906 as traded in Paris	16 May/23 May 1917	Russian Provisional Government acknowledges debt repayment (–)
		29 August/5 September 1917	No explanation given (+)
		16 January/23 January 1918	Peace negotiations at Brest-Litovsk; Repudiation of Tsarist debt (+)
Christodoulaki et al. (2012)	Three Greek government bond series as traded in London	28 March/10 April 1916	Greek troops disembarked in Smyrna (+)
Adams (2015)	French 5 % war loan as traded in London	20 March 1916	French successes at Verdun (–)
		7 June 1916	Battle of Jutland (–)
		7 July 1916	Related to war loan issue (+)
		2 October 1916	Related to war loan issue (+)
		30 October 1917	Battle of Caporetto (+)
		18 February 1918	Peace negotiations at Brest-Litovsk (+)
		27 August 1918	Allied counter-offensive in late summer (–)
		30 September 1918	Hindenburg Line breached; Bulgaria surrenders (–)
Hanedar et al. (2016)	Two Ottoman government bonds as traded in Istanbul (railway and treasury bond)[a]	17 July 1918	Central Powers' defeat (+)
		20 July 1918	Central Powers' defeat (+)
		12 September 1918	Central Powers' retreat (–)
Hanedar et al. (2018a)	Ottoman war bond as traded in Istanbul	26 September 1918	Bulgaria's defeat; Austria-Hungary's peace offer (+)
Schaltegger/Schmid (2019)	13 Swiss government bonds as traded in Basel	4 December 1917	Armistice at the Eastern Front (+)
		15 March 1918	Treaty of Brest-Litovsk (+)

Sources: Oosterlinck and Landon-Lane (2006: 528), Christodoulaki et al. (2012: 562), Adams (2015: 8), Hanedar et al. (2016: 152), Hanedar et al. (2018a: 13), and Schaltegger/Schmid (2020), Table 4.
Notes: (+) and (–) indicate an increase and, respectively, a decrease in perceived country risk. [a] Given are the breaks in the treasury bond.

tect three breaks in the 5 % bond of 1906, which can be linked to interior developments and the peace negotiations with the Central Powers at Brest-Litovsk.[16]

Olga Christodoulaki et al. (2012) analyze the volatility of three Greek government bonds traded in London between 1914 and 1929 and find only one turning point in the war period – namely an increase in Greek country risk due to "Greek troops [having] disembarked in Smyrna" in spring 1916.[17]

Using the method by Anindya Banerjee et al. (1992), Tobias A. Jopp (2014) detected nine structural breaks in the German 3 % Imperial loan as traded in Amsterdam.[18] The breaks were detected in a series that was the result of merging both subseries for the German 3 % into one price series (cf. the discussion on representative bonds in Subchapter II.3.3), and the breaks were detected in the prices themselves and not in the yield. The two major turning points standing out in the analysis are the conscription controversy in Britain in January 1916 and the Allied Powers' ultimate counterstrike at the Western Front since summer 1918. The remaining seven breakpoints are rather small in effect compared to these two events.[19] These turning points, as well as those detected in Jopp (2016), are not shown in Table 19, as they will pop up in the empirical analysis below and be discussed in detail there.

David S. Adams (2015) searches the prices of the French 5 % National Defense Loan, as quoted in London between December 1915 and March 1919, for structural breaks also using the method developed by Banerjee et al. (1992). He finds eight turning points of which six are explained by war news. Among others, the Verdun theater, the Battle of Jutland, and the Allied counter-offensive in late summer/early fall 1918 turn out to be major events related to France's war performance in the eyes of investors in a friendly market. Compared to preliminary findings put forward in Jopp (2014, 2016) and the empirical analysis below, it should strike the reader's eye that three themes apparently were not of relevance for bondholders' in London, namely the US entering the war upon Germany's unrestricted submarine warfare policy 1916/1917, the Russian Revolution in 1917, and the German spring offensive beginning in late March 1918.

Furthermore, Avni Ö. Hanedar et al. (2016) and Avni Ö. Hanedar et al. (2018a) analyze Ottoman government bonds to get a hold of how investors in Istanbul perceived the final phase of the war, its end, and the subsequent interior turmoil leading to the dissolution of the Ottoman Empire. While Hanedar et al. (2016) screen a railway and a treasury bond for breaks in price, Hanedar et al. (2018a) screen the Ottoman war bond for such. Overall, they find three breaks in the railway bond (not displayed in Table 19), four in the Treasury bond, and one in the war bond.

[16] Cf. Oosterlinck/Landon-Lane (2006) and also Oosterlinck (2016: 158–173).
[17] Cf. Christodoulaki et al (2012: 561).
[18] Cf. Banerjee et al. (1992) for the method, and Jopp (2014) for the breaks.
[19] The results put forward in Jopp (2016) are discussed in detail in the empirical part below.

Finally, Christoph A. Schaltegger and Lukas A. Schmid (2020) ask for how investors in Basel perceived neutral Switzerland to fare during the war. For that purpose, the authors analyze a set of daily price quotes on thirteen Swiss government bonds – four pre-1914 issues and nine voluntary war loans. Most of the nineteen breaks found in the various bonds can be attributed to interior Swiss matters. However, a few breakpoints coincide with the armistice negotiations between the Central Powers and Russia in late 1917 and the signing of the Treaty of Brest-Litovsk in March 1918.[20]

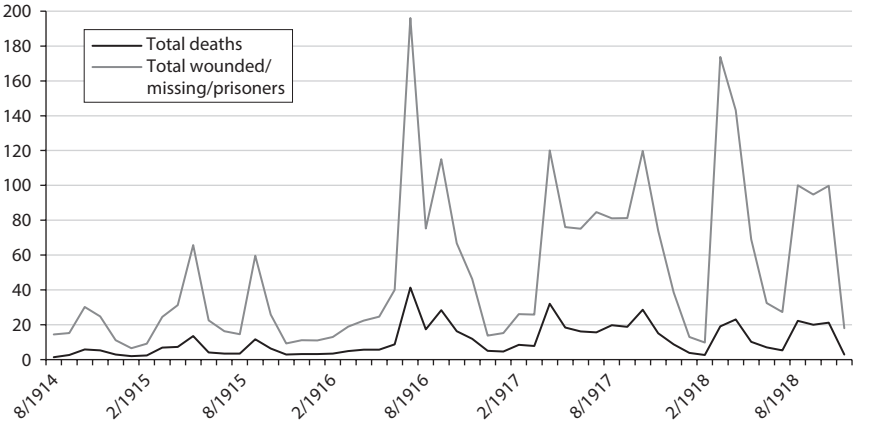
There are three studies that should be mentioned, in addition, namely George J. Hall (2004), Pablo Duarte et al. (2018), and Avni Ö. Hanedar et al. (2018b). These studies have in common that they analyze exchange rate movements in the war period instead of sovereign bond prices which, methodologically and regarding the implicit economic reasoning, puts them into another category. George J. Hall (2004) analyzes exchange rates of the Swiss franc with the currencies of Germany, Austria-Hungary, England, France, and Italy formed in the neutral Swiss currency market between early 1916 and late 1918. Hall uses factor models to deconstruct exchange rates into several components, one of which he labels the "common factor". That factor is interpreted as embodying contemporary market players' expectations of the course of war once it is controlled for economic hard factors determining exchange rates. Interestingly, adjustments in expectations turn out to coincide, at least to some extent, with the comparative *body count* on the Western front – i. e., war casualties inflicted, as well as prisoners of war taken on both sides.[21] Figure 26 shows the series on German and British casualties *in the British sector* of the Western Front that Hall uses in his study. It can certainly be revealing to bring exchange rate movements or bond prices, for that matter, in line with casualty figures (and the related war news – if available). However, since such casualty series do not come in daily frequency, but monthly at best, they are not easy to incorporate into any high-frequency structural breaks analysis.

Pablo Duarte et al. (2018) replicate Hall's approach for the "forgotten" Eastern Front. They likewise use exchange rates as noted in the Swiss currency market and deconstruct exchange rates by applying a factor model. The common factor is then correlated with war casualties on both fronts using a new dataset on casualties on the Eastern Front. They find that combined news on casualties measured by the *net body count* as well as the *net prisoner-of-war (POW) count* on both fronts can explain a good deal (87 percent) of the variation in the common factor which is supposed to entail market players expectations; the contribution of the Eastern Front to this variation is, however, only roughly 13 percent (caused almost entirely by the net POW count).

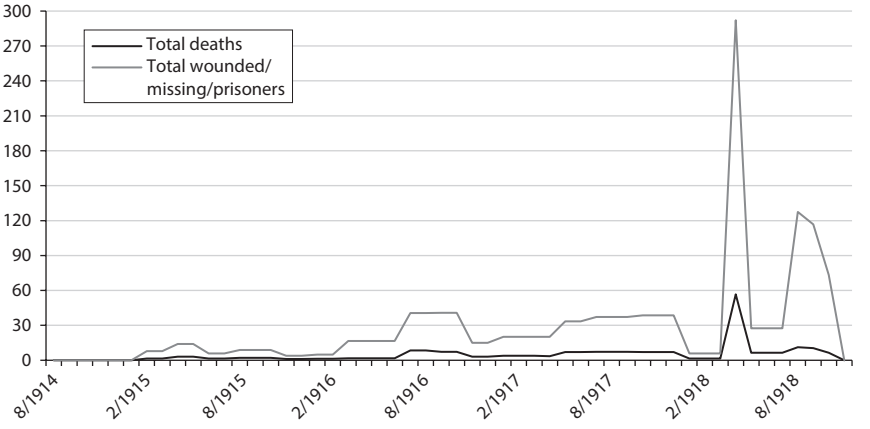
[20] On Switzerland's economic relations to the belligerents, cf. e. g., Fehr (2015).
[21] The body count concept follows Ferguson (1998: 369–371).

Figure 26: The body count in the British sector of the Western Front by month

(a) British troops (in 1 000)



(b) German troops (in 1 000)



Sources: Statistics of the Military Effort of the British Empire During the Great War – 1914–1920 (1922: 253–271, 359–362).
Notes: Both categories summed across officers and other ranks. Soldiers wounded and gone missing also includes soldiers taken prisoner of war.

Finally, Avni Ö. Hanedar et al. (2018b) analyze daily exchange rates of the Turkish lira with the Dutch guilder, the Swiss franc, and the Swedish kroner in the final phase of war and in its aftermath (1918–1919). They detect structural breaks in the exchange rates using the method proposed by Jushan Bai and Pierre Perron (1998, 2003a, 2003b) that will be hitherto applied in this chapter's

analysis, too. Bulgaria's surrender and the Ottoman Empire's peace offer turn out to be structural breaks in the final phase of war.[22]

3. How timetable analysis can help

The list of turning points detected in the literature so far certainly is a helpful anchor. It gives us an idea as to the events we might expect to pop up when analyzing Amsterdam prices in detail. These turning points are derived under the basic assumption that securities prices serve as an agnostic opinion poll; they were derived letting the series speak for themselves, without being informed by historians' hindsight judgment. However, given the vast amount of literature on World War One, is there a convenient way to filter out to which events historians generally attach much significance, as they seem to have had *decisive* effects on the course of World War One? This would provide us with a second such anchor, yet derived under a different assumption.

To keep the effort manageable, I propose to use timetables to be found as part of a monograph for this purpose instead of going manually through every potentially relevant title on World War One; the literature is far too vast for this to be a feasible approach.[23] By analyzing timetables, we are able to formulate a simple hypothesis stating which events historians deem comparatively more or most important. This certainly gives not more than a clue on historians' position towards the significance of individual events. However, as outlined earlier, it is exactly the appeal of the agnostic structural break approach that it does not require specifying potential break dates beforehand. It seems helpful nonetheless to formulate ad-hoc expectations as to which events should turn out as significant break dates. This is because any turning points analysis certainly establishes a kind of "black box" in that we cannot be entirely sure, after all, whether the events matched to the endogenously determined breaks really were the events to which investors reacted. Analyzing timetables is a way to filter out which events historians *most regularly* – and thus quite *unanimously* – think had been really important for determining the course of the war as it presents to us in retrospect.

The logic behind this reasoning, making the timetable analysis work, is economic and straightforward in nature: pages are a scarce good. In constructing a timetable, a historian faces space constraints and therefore has to make a choice as to which dates are going to be displayed in the timetable. This choice will

[22] Cf. Hanedar et al. (2018b: 11).

[23] I am not sure whether an approach based on automated text processing and searching would do the job properly, either. This is because any historian's argument in favor of an event's huge or, for that matter, little importance will be semantically complex and could not just be broken down to certain search terms; at least, not without investing tremendous effort.

Table 20: Selected studies providing timetables on World War One

Study	Comment	Total pages	Entries in timetable in total (thereof since August 1915 onwards)
[1] Hirschfeld et al. 2009	German-language encyclopedia	1 058	239 (155)
[2] Michalka 1997	Collective volume on various aspects	1 074	245 (175)
[3] Mommsen 2002	Textbook on Germany and WWI	189	150 (94)
[4] Neiberg 2005	Monograph on the war's global history	415	59 (39)
[5] Sondhaus 2011	Textbook on the war's global history	544	140 (95)
[6] Tucker 2005	English-language encyclopedia	1 661	521 (402)
[7] vom Bruch/ Hofmeister 2002[a]	Source compilation	138	82 (58)

Sources: Michalka (1997: 1 049–1 058), Mommsen (2002: 162–172), vom Bruch/Hofmeister (2002: 495–497), Tucker (2005: 1 307–1 317), Neiberg (2006: xiii–xv), Hirschfeld et al. (2009: 1 013–1 018), and Sondhaus (2011: 205, 273, 307, 405).
Notes: The number of entries is measured by the number of dates. [a] Refers to the German Empire, 1871–1918. Only pages and entries are counted which fall into the period between 28 July 1914 and 11 November 1918.

follow the special angle, or approach, of the specific work, and not all potentially relevant dates may be displayed in the timetable. The very point is that dates will not have been selected at random. Thus, the observable selection says something about the implicit relative importance the historian attaches to the dates that we find in the timetable vis-à-vis those omitted.

I selected seven timetables – the first seven timetables I found – and searched them for common dates after August 1915, when trade in the bonds under focus here began at the earliest. The seven works are pretty different regarding their approach or, respectively, the level of intended broadness vis-à-vis the level of intended profoundness. They range from encyclopedic works (e. g., the *World War One Encyclopedia* edited by Spencer C. Tucker) over in-depth monographs with a global history focus (e. g., Michael S. Neiberg's *Fighting the Great War – A Global History*) and textbooks with such global focus (e. g., Lawrence Sondhaus's *World War One – The Global Revolution*) to country studies in form of a textbook (e. g., Wolfgang J. Mommsen's *Die Urkatastrophe Deutschlands. Der Erste Weltkrieg 1914–1918*). Table 20 shows the total page count of the works and the number of entries in the timetables, which are counted by the reported calendar date. The number of such entries varies across the works but, it seems, not monotonically with the total page count. From these figures it follows that the work by Michael S. Neiberg (2005) certainly is the bottleneck in this analysis limiting the number

Table 21: Timetable analysis – the most significant events of World War One!?

		H0	
Event date	What happened?	CP	AP
1916			
21 February	German Verdun offensive begins on the Western Front (till July)	+	–
31 May–1 June	Battle of Jutland – clash of British and German fleets in the Skagerrak	+/–	+/–
4 June	Russian Brusilov offensive begins on the Eastern Front	–	+
27 August	Romania enters the war on the Allied Powers' side	–	+
1917			
6 April	United States enter the war on the Allied Powers' side	–	+
1918			
8 January	US president Wilson's Fourteen Points Peace Program	+/–	+/–
3 March	German-Russian Peace Treaty of Brest-Litovsk	+	–
21 March	German spring offensive begins on the Western Front	+	–
8 August	Allied forces break through on the Western Front at Amiens, and German lines collapsing in the following	–	+
11 November	Armistice of Compiègne officially ends the war	+	+

Sources: Cf. Table 20.
Notes: Mentioned are those dates that one can find reported in *all* the chronologies. "CP" and "AP" are abbreviations for "Central Powers" and "Allied Powers", respectively.

of potential event matches to a mere 38. Dropping this work together with Rüdiger vom Bruch and Björn Hofmeister's (2002) would likely increase the number of matches found in the remaining five works. However, my aim is to reduce the number of events that are *uni sono* viewed as significant to a robust number.

Collapsing these timetables into the very dates that they have in common yields the collection shown in Table 21. There are only ten dates that I find consistently reported in all timetables for the period after August 1915 – regardless of the studies' particular focus or design. Table 21 reports these dates along with statements about how investors might have reacted on them vis-à-vis both alliances (i. e., positively or negatively).

This timetable analysis enables us to formulate a simple, yet useful enough (historical) null hypothesis (i. e., H0) to be checked by the structural break approach: the break dates identified in either bond price (or yield) series are consistent with the dates displayed in Table 21. Correspondingly, the alternative hypothesis (i. e., H1) is: break dates differ from those exact calendar dates and suggest different events as having been important in investors' eyes. The hypothesis implicit in Table 21 is quite strong in two ways. For one, only those events are listed that are to be found in *all* timetables which, however, keeps the amount of candidate events manageable. And beyond that, the list directs

attention towards the exact calendar dates which certainly poses a challenge regarding the handling of sequences of events.

4. Data selection

To give a comparative account of how investors assessed both the Central and Allied Powers' efforts, I am going to analyze the bonds of the ten most important players the bonds of which were factually traded in Amsterdam; that restriction rules out the United States as an object of study.[24] Each player is represented by one single bond instead of a country index that would condense all available bond information on a country into one measure. I did not opt for focusing on country indices here for two reasons: Firstly, as shown earlier, there are marked differences in liquidity levels in the countries' respective cross-sections of bonds. And, secondly, the correlation among bonds of the same country is generally quite high which also shows up in my dataset.[25]

Table 22 informs on the players under observation and the selected bonds' financial characteristics such as the year when the bond had been initially issued, the coupon frequency, the currency in which the bond was specified, the possible date of redemption, the nominal value outstanding at the turn of 1913/1914, and the default status regarding the war period. On the side of the Central Powers, these are the German Empire represented by the 3 % imperial loan, Austria by the 4 % kroner perpetual, the Ottoman Empire by the 4 % first Baghdad Railway bond, and Bulgaria by the 5 % tobacco loan. On the side of the Allied powers, these are France represented by a 5 % war bond, England similarly represented by a 5 % war bond, the Russian Empire by the 4 % Hope & Co bond, Italy by the 3.5 % of 1862–1881, Romania by the 4 % bond of 1910, and Serbia by the 4 % bond of 1895.[26] Below I will first discuss evidence for the major powers – Germany, Austria, the Ottoman Empire, France, England, and Russia; and then evidence for the minor powers – Bulgaria, Italy, Romania, and Serbia.[27]

[24] Regarding the US, the only bond at the time admitted for official trading was a bond of the state of Louisiana. However, I only recorded a single price quote during the observation period. Thus, the US drops out due to a lack of sufficient observations. One might be tempted to proxy the US by either the Liberian bond or one of the Cuban bonds, as both Liberia and Cuba had a close political relationship with the US at the time. I am not going to explore this line of reasoning here, though.

[25] For the second reason, I excluded Hungary because the correlation between the most liquid Hungarian issue, the 4 % kroner perpetual (pieces à 2 000), and the Austrian issue is +0.98. There is not much additional information to be expected by including Hungary, as well.

[26] Note that, for example, the German 3 % and the Russian 4 % Hope & Co consisted of two series; the former distinct by coupon date (Jan/Jul and Apr/Oct), the latter by denomination (pieces à 125 and 625 gold ruble). The Austrian 4 % consisted of three series; as with the German bond, they differed in coupon dates (Jan/Jul, Mar/Sep, and Apr/Oct).

[27] For a baseline overview of Austria-Hungary during the war, cf. Haslinger (2014); for

The French and English bonds stand out because they were issued during the war and were exclusively traded in the unofficial market. As shown in Subchapter II.2, the *Algemeen Handelsblad* reported these unofficial prices ("niet-officieel genoteerde fondsen") quite regularly.[28] The two bonds themselves are hard to identify as no comments on these were made in the stock exchange handbooks.[29] In the following, I am simply referring to them as *the* French or, respectively, *the* English 5 % war bonds.[30]

As the representative bond, I selected the most liquid issue per country. Bond-specific liquidity, a highly elusive and empirically hard-to-grasp concept, was approximated by the relative incidence of non-zero returns – that is, the sum of all days with non-zero returns relative to all potential trading days. Formally, I selected the bonds based on their liquidity score with respect to the war period, in my definition the period between 9 February 1915 and 11 November 1918. These scores are given at the bottom of Table 22 along with those for the immediate pre- and post-war phases and the respective cross-section averages.[31] It might not be surprising at all that the peacetime issues were generally less liquid during war than before or after. In Subchapter II.4, I made use of this observation to determine loosely if a bond may have been traded by foreigners rather than by domestic investors.

Since trade in all selected bonds was resumed, at the earliest, on 24 August 1915 (cf. Table 22), I am forced to neglect the important first year of the war – a fundamental restriction of the analysis that has already been discussed. So, the analysis period with regard to the Central Powers' issues, and the Russian one, is late August 1915 to end of 1919. Regarding the other Allied Powers' bonds,

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France, cf. Fogarty (2014); for the German Empire, cf. Jones (2014); for Great Britain, cf. Garton (2014) and Nasson (2014); for Italy, cf. Bosworth/Finaldi (2014); for the Ottoman Empire, cf. Aksakal (2014); for Russia, cf. Sanborn (2014); and for the US, cf. Capozzola (2014).

[28] The French 3 % perpetual was traded before and after but not during the war; and British bonds were not officially admitted to trade in the observation period, at all.

[29] As outlined earlier, it was not unusual for the time that an unofficial market existed beside the official market, even in peacetime. Paris and also Amsterdam are examples; cf. Brenninkmeyer (1920: 129) and Hautcœur/Riva (2012). Principally, we face an information efficiency issue here. Regarding the peacetime issues on which I focus, I can say that the German 3 % had been traded on the unofficial market as well. But this happened very infrequently, as I have been able to gather a mere eight price quotes for it during wartime.

[30] Cf. the discussion in Chapter II.

[31] I have argued for the appeal of using the non-zero-returns measure of liquidity in Subchapter II.3 However, I have also emphasized that this measure has to be taken as a *lower bound* estimate of a bond's liquidity. The upper bound estimate is given by the sheer number of price observations in comparison to total trading days. If we used this measure to determine the representative bonds, a slightly different set would arise: 1) England – 6 % war loan (0.97); 2) Germany – Prussian 3 % (0.97); 3) Ottoman Empire – 4 % Baghdad Railway 2nd series (0.91); 4) Russia – 4 % Southwest Railway 625r (0.97); 5) Romania – 4.5 % of 1913 (0.99); given in parentheses is the correlation coefficient of the two raw price series – the one I factually selected as representative and the one implied by the sheer incidence of observations.

Table 22: The sample bonds' financial characteristics

Country	England	France
Coupon rate	5 %	5 %
Addition	War bond	War bond
Year of initial issue	1915/16?	1915
Coupon frequency	n/a	n/a
Payments in	Pound Sterling	Franc
Redemption (maturity until …)	n/a	n/a
Nominal value outstanding at the turn of 1913/1914	n/a	n/a
In default during war?	n/a	n/a
Bond-specific liquidity		
Pre-war period	-	-
War period	0.163	0.207
Post-war period	0.380	0.187
Average liquidity in the country's cross-section during war (no. of bonds)	*0.099 (6)*	*0.125 (2)*
Analysis period	27/11/1915–19/12/1919	06/05/1916–18/12/1919

Table 22 continued

Country	Serbia	Austria
Coupon rate	4 %	4 %
Addition	500	Perpetual
Year of initial issue	1895	1892
Coupon frequency	Jan/Jul	Jan/Jul
Payments in	Franc	Kroner
Redemption (maturity until …)	Each year until 1968	None specified
Nominal value outstanding at the turn of 1913/1914	≈ 334 million franc	≈ 2.2 billion kroner
In default during war?	×	✓
Bond-specific liquidity		
Pre-war period	0.375	0.709
War period	0.245	0.599
Post-war period	0.251	0.837
Average liquidity in the country's cross-section during war (no. of bonds)	*0.163 (3)*	*0.174 (10)*
Analysis period	22/09/1914–27/12/1919	24/08/1915–29/12/1919

Sources: Wynne (1983) and Suter (1990: App. A): default status; *Gids bij de Prijs-Courant* and *Effectenboek*: nominal value outstanding; and cf. Tables A.2 and A.3 in online Appendix 1.2.
Notes: Pre-war period: 1 Jan 1914–28 Jul 1914. War period: 9 Feb 1915–11 Nov 1918. Post-war period: 12 Nov 1918–31 Dec 1919. Liquidity measured as proportion of days with non-zero

Italy	Romania	Russian Empire
3.5 %	4 %	4 %
–	2 500–5 000	Hope & Co (625)
1862	1910	1890
Jan/Jul	Mar/Sep	Mar/Jun/Sep/Dec
Lira	Franc	Rouble
None specified	Each year until 1950	Each year until 1971
≈ 3.9 billion lire	≈ 124 million franc	≈ 125 million gold ruble
×	×	Since Feb 1918
0.042	0.054	0.679
0.017	0.009	0.649
0.014	0.023	0.720
– (1)	*0.002 (17)*	*0.221 (77)*
30/09/1915–14/05/1919	06/03/1916–25/11/1919	03/09/1915–29/12/1919

Bulgaria	German Empire	Ottoman Empire
5 %	3 %	4 %
Tobacco	Imperial loan	Baghdad railway
1902	1890	1904
Mar/Sep	Apr/Oct	Mar/Sep
Franc	Mark	Franc
Each year until 1953	None specified	Each year until 2001
≈ 100 million leva of franc	≈ 1.3 billion mark	≈ 54 million franc
Partly (against Allies)	Partly (against Allies)	Partly (against Allies)
0.327	0.176	0.448
0.234	0.127	0.320
0.205	0.144	0.265
0.110 (5)	*0.038 (8)*	*0.082 (10)*
24/08/1915–16/09/1919	03/09/1915–27/12/1919	26/08/1915–27/12/1919

returns in all trading days. The cross-sections of English and French bonds consist of several other unofficially traded war bonds. Anglo-French war loan of 1916 not counted. Nominal value outstanding converted with exchange rate parities in Buff.

the analysis period is even shorter. For technical reasons outlined in the next subsection, observations for 1919 have to be taken into account; possible breaks in the immediate post-war period are not of interest here, though.

5. Empirical findings

5.1. Shifting mean regressions as the technical point of departure

The methodological departing point of this approach is the notion that bond prices can be understood, most basically, as the present value of all future payments to the bondholders – that is, regular interest payments and the principal to be redeemed at maturity (cf. Subchapter I.3). By collecting (economically) relevant information, investors form expectations on the e*x-ante* probability with which the (sovereign) issuer would serve its debts. Provided that investors' rates of time preference, empirically proxied by (real) interest rates, do not change, a falling (climbing) price signals that investors have adjusted expectations on default risk upwards (downwards).

For the purpose of this study, I am interested in *sudden* shifts in default expectations which persisted over a longer time interval. Technically, these shifts can be associated with a shifting mean in a time series process – i. e., a fundamental break in the level of the series. More substantially, such shifts indicate that some information instantly hit investors as a true surprise. These unanticipated shocks may have been due to economic news in the more narrow sense in the first place,[32] but also due to diplomatic, geopolitical, and war news, as long as investors saw economic implications regarding the credibility of the sovereign issuer.

For the sake of data processing, I analyze the evolution of the selected bonds in terms of the current yield here, which is simply the annual coupon payment divided by day *t*'s price. This is a standard measure of a bond's performance said to better highlight the risk attached to a bond. The current yield has to be distinguished from the yield-to-maturity (YTM) which to compute requires information on the time to maturity and assumptions on all future interest payments as it is a present value concept. For a bond with a long remaining duration, the difference between the current yield as a lower bound yield estimate and the YTM as the standard yield measure is, in fact, marginal. As Table 22 shows, all eight peacetime issues in my sample were still far from reaching their maturity when war broke out, or had no formal date of maturity at all, implying that duration effects do not matter in the study period for these bonds.

[32] Such news might, for example, refer to the central bank increasing the money supply and thereby impacting on market players' inflation expectations and, possibly, inflation itself.

Table 23: Descriptive statistics on the sample bonds' prices

Period	Mean	Minimum	Maximum	Standard deviation	*N*
Price					
Pre-war	82.0	66.0	94.4	6.3	*1 275*
War	53.2	20.1	100.7	14.9	*4 662*
Post-war	42.3	4.1	99.5	25.5	*1 353*
Yield					
Pre-war	4.8	3.8	6.1	0.5	*1 275*
War	8.5	5.1	19.9	2.4	*4 662*
Post-war	16.2	6.7	97.6	12.0	*1 353*

Sources: Author's own computations.
Notes: The price is given in percent of par value. Current yield is [((100 * coupon rate)/price) * 100] and nominal. Raw data with gaps used. Values rounded to one decimal place.

However, this is different if we look at bonds with a short duration, such as the English and French ones. Here, duration effects may play a role.[33] Despite that the French and English bonds very likely had a much shorter duration, I will nonetheless use current yields in the main analysis to ensure consistency of measurement. But I will perform an additional, simple robustness check by also computing the YTM for the French and English bonds and screening them for break dates such that we can compare them to the ones suggested by the current yield series.

Descriptive statistics on the yields in the sample as well as, for comparative purposes, in the entire cross-section are given in Table 23. Note that I do not use bond spreads in the following because I am interested in events specific to the country and to the market alike. If I used spreads in the form of the difference of a bond's yield over a risk-free rate of return, I would potentially miss a market-specific event that would be cancelled out this way but that I would actually like to report on.[34]

[33] Theoretically, a bond's price is supposed to approach its par value the closer the point in time when the bond matures.

[34] On the idea of a risk-free rate of return in economic theory, cf. e. g. Jordà et al. (2019) and Schmelzing (2017). In historical research, when looking at the pre-1913 period, for example, it is common to use the yields of the UK consols to proxy the risk-free rate. This is because the British Empire was deemed the paragon of the credible sovereign debtor serving its debts most accurately. The UK consols even serve as a proxy in case it is not the market in the UK itself that is under observation; cf. e. g. Fischer (1997), Ferguson/Schularick (2006), Dincecco (2010, 2011, 2013), Ellison/Scott (2017), Jordà et al. (2019), Le Bris/Rezaee (2017), and Pammer (2017). Apart from the main argument against the use of spreads – that certain events might be missed out unwantedly –, there is the general question of whether there was a risk-free rate under the conditions of war, at all. The closest to such a rate in the Amsterdam market probably is the yield of a very liquid Dutch bond. But, as discussed above, even the neutral Netherlands and, thus, the Dutch capital market had been under enormous pressure coming from both

To determine significant sudden shifts in the yield series, I apply the methodology proposed by Jushan Bai and Pierre Perron (1998, 2003a, 2003b) for detecting multiple structural breaks. This is one of two methods most regularly applied in this kind of analysis among economic historians; the other being that of Anindya Banerjee et al. (cf. Subchapter I.4).[35] Implementing this methodology comes at the advantage that no *a priori* historical knowledge is necessary to specify potential break dates. Rather, they are determined endogenously from information solely contained in the yield series which is equal to letting investors – or the market – speak. In the following, I keep the description of the Bai-Perron-method brief and refer the reader for a more extensive discussion to online Appendix 2.1.

So, according to Daniel Waldenström and Bruno S. Frey (2008) and Kim Oosterlinck and Uredana Ureche-Rangau (2012), for example, I start with estimating the following simple specification for each of the ten bonds in the sample, namely

$$y_t = \beta_j + u_t,\ t = T_{j-1} + 1, \ldots, T_j,\ j = 1, \ldots, m + 1, \qquad \text{(Equation 3)}$$

where y denotes the yield, β the intercept to be estimated with least squares, and u the error term.[36] The intercept is allowed to vary due to the occurrence of m breakpoints, separating the data into $m + 1$ regimes. I solve Equation 3 using the Bai-Perron-test on sequentially determined breaks – i. e., the "sequential $l + 1$ breaks vs. l"-test. Since the number of observations per series is quite large, a trimming parameter $\varepsilon = 0.05$ is used allowing for a maximum number of ten breaks that may be endogenously determined by the procedure. All break points are determined at the five-percent significance level, allowing for heteroscedasticity- and autocorrelation-consistent (HAC) standard errors. As a first step, I discuss fundamental adjustments of investors' expectations for the war period without taking additional explanatory variables into account. In a second step, I check for the robustness of the detected breaks by including additional explanatory variables which may principally explain part of the yield series' development over time from an economic point of view.

For the sake of clarity, it should be mentioned that the Bai-Perron-methodology allows for detecting breaks in either mean or trend, or in both simultaneously (cf. Figure 5 in Subchapter I.3). However, I decided to concentrate on breaks in the *mean* of the yield process because this better matches with the theoretical considerations on investor behavior. While a break in the mean reflects a sudden adjustment of default expectations, a break in the trend (i. e. slope) not even

war factions. As has been shown, Dutch country risk did increase, reflecting this situation in bond prices (cf. Subchapter II.1). Taken together, I abstain from using spreads in this step of the analysis.

[35] Cf. Bai/Perron (1998, 2003a, 2003b) and, for comparative purposes, Banerjee et al. (1992).

[36] Cf. Waldenström/Frey (2008: 114) and Oosterlinck/Ureche-Rangau (2012: 235).

implies a step-wise, but a continuous fundamental adjustment over a certain time-span. This raises interpretational difficulties in the light of how investors formed their thoughts and acted upon them. Principally, though, the advantage of detecting breaks in the trend is that the time series process can, statistically, be better accommodated. This would be especially helpful with regard to accommodating the Austrian and Russian bonds' time pattern. However, my argument against this kind of trend is that it is not reasonably well interpretable in historical terms.

5.2. Turning points in investors' perception at a glance

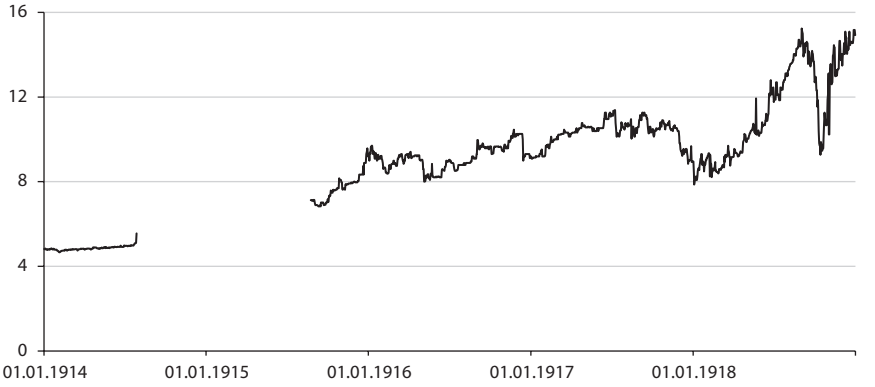
To begin with, Figures 27 and 28 depict the yield series on the ten players under observation running from 1 January 1914 to 31 December 1919 – the full range of my dataset. The yields of the German 3 %, the Austrian 4 %, the Ottoman 4 %, and the Bulgarian 5 % are plotted in five panels in Figure 27. For illustrative purposes, because yields had climbed considerably in 1919 since about late summer, I plotted this year separately in Panel (e). As to be expected, country risk was generally higher during the war, and immediately after, than it was in the last pre-war month. What is more, yields show considerably more variance during the war. All in all, the yield of the German 3 % (Austrian 4 %; Ottoman 4 %; Bulgarian 5 %) increased – in net terms – from 4.0 to 5.2 (5.5 to 7.1; 5.6 to 8.0; 5.4 to 6.7) over the first, yet itself unobserved, year of the war. When fighting formally ceased on 11 November 1918 with the Armistice of Compiègne, German, Austrian, and Bulgarian yields had risen in net terms to 8.3 and, respectively, 13.9, and 7.9, while the Ottoman issue's yield had temporarily decreased to a level even below the one reached in August 1915.[37]

Figure 28 plots the yields on the French and English 5 % war loans, the Russian, Romanian, and Serbian 4 % loans, and the Italian 3.5 %. The French issue started being traded at a yield of 6.8; the English one at 5.0. In all, variation seems to have been slightly less pronounced compared to the Central Powers' bonds. In sharp contrast, the Russian 4 % had traded at levels between 5.8 and 8.0 for a long time – the last pre-war yield was 5.2 – before the October Revolution, the defeat by Germany, and the Bolshevik repudiation of all Tsarist bonds in February 1918 would boost country risk to levels far above. Italian risk increased in steps from 5.8 to 15.7 in summer 1918 and fell back to 10.0. For the Romanian 4 %, it holds that it started at 8.4, decreased to its long-term level of 7.2 and recovered back to 8.2. Finally, Serbian risk increased in the long term from 8.0 to 15.9 during the Allied counteroffensive in late summer/early fall and then fell back to a level corresponding to the level when first traded in the war.

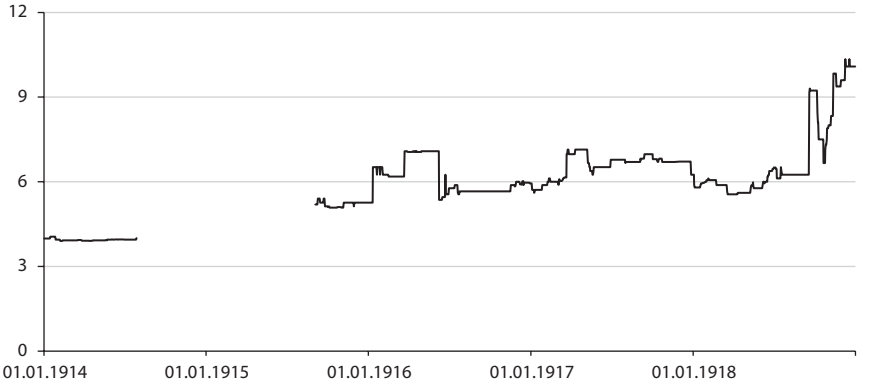
[37] For a possible explanation of the Ottoman 4 %'s pattern, cf. the turning points analysis below.

Figure 27: Current yields of four Central Powers' bonds traded in Amsterdam

(a) German 3 % imperial loan (1914–1918)



(b) Austrian 4 % kroner perpetual (1914–1918)



(c) Ottoman 4 % Baghdad Railway (1914–1918)

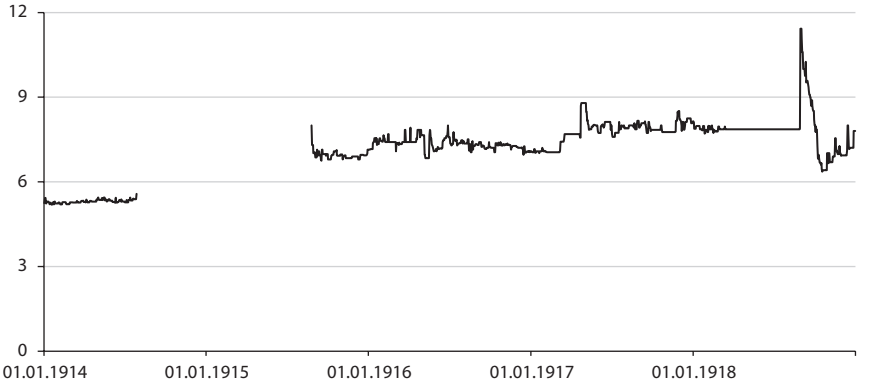
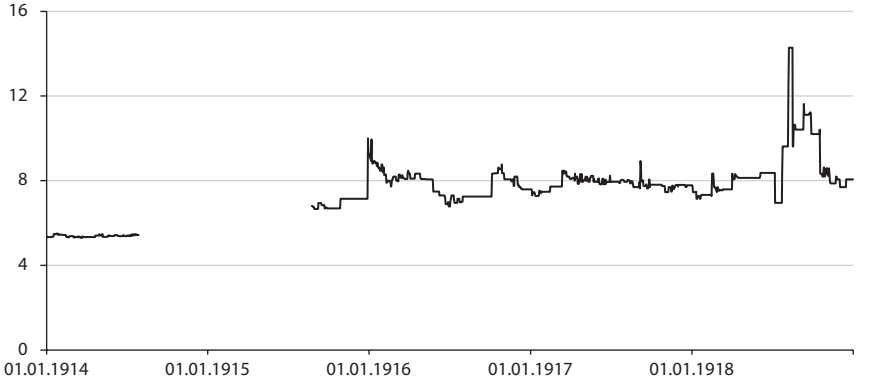
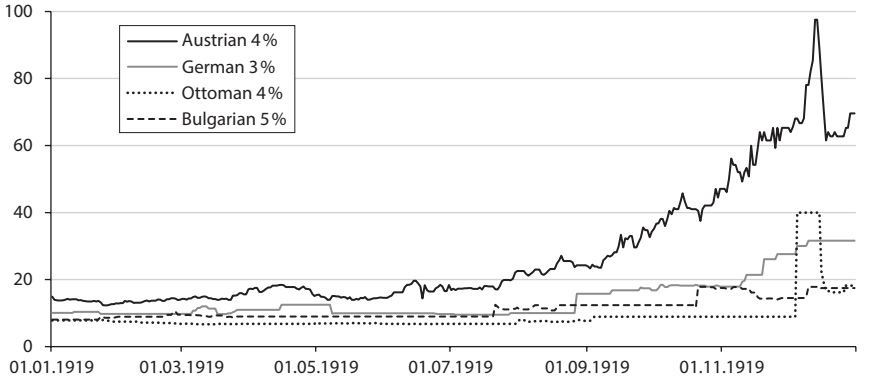


Figure 27 (continued)

(d) Bulgarian 5 % (1914–1918)



(e) Yields in 1919



Sources: Cf. Chapter II. *Notes:* Current yields computed from interpolated price series.

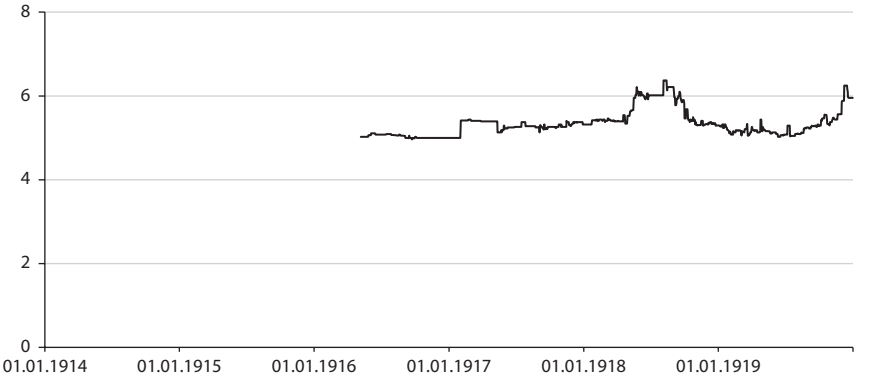
In addition to the current yield depicted in Figure 28, Figure 29 also depicts my estimates of the YTM for the English and French war loans. This comparison is necessary in order to check for potential duration effects. As is obvious, the time pattern of the YTM is much more pronounced. But it is not basically different as to the location of spikes or sudden level shifts.

Let us now turn to the results of the structural break analysis. Results are given for the six major powers and the four minor powers in my sample. For the fact that I estimated Equation 3 over the whole range of war and post-war observations – beginning with 24 August 1915 at the earliest and ending with 31 December 1919 – I found turning points during the war period itself as well as during the immediate post-war period. Since my primary interest is on

Figure 28: Current yields of five Allied Powers' bonds traded in Amsterdam

(a) French 5 % war loan of 1915

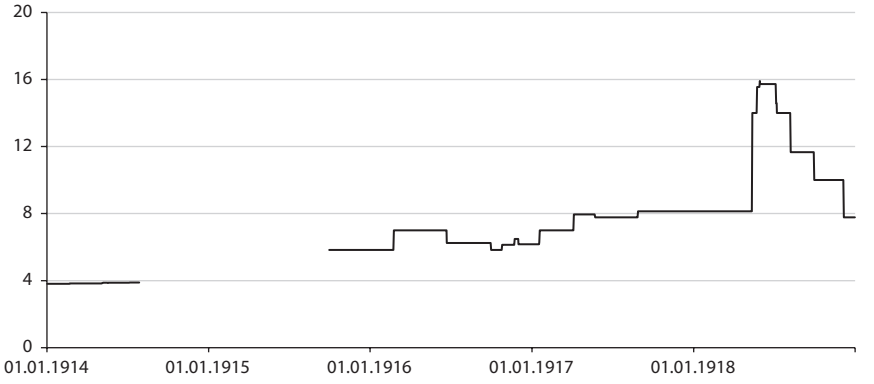
(b) English 5 % war loan (1919)



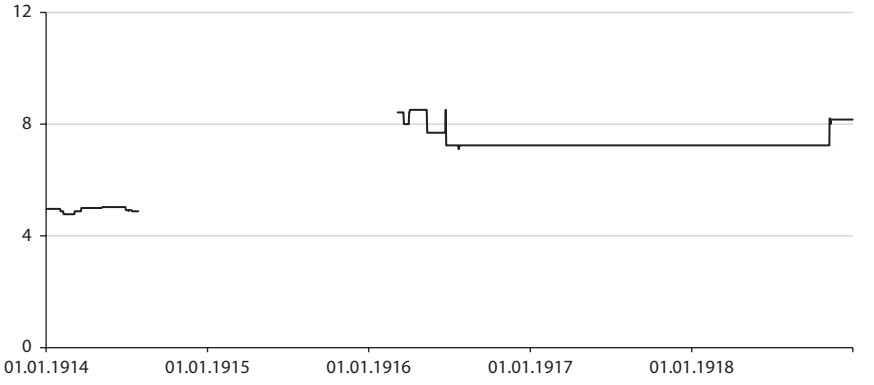
(c) Russian 4 % Hope & Co (625)

Figure 28 (continued)

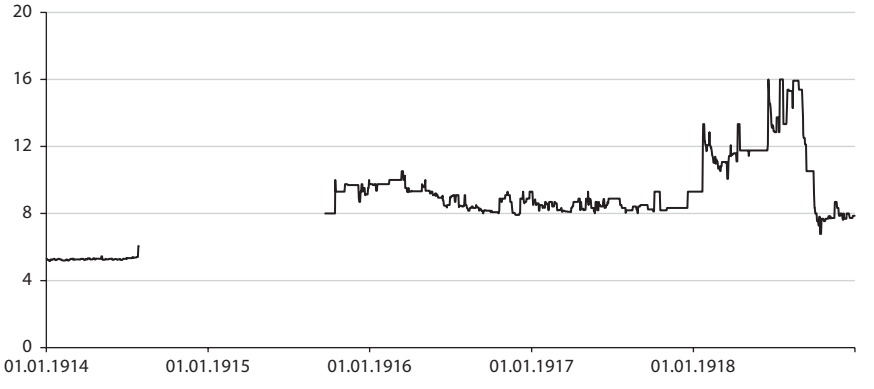
(d) Italian 3.5 %



(e) Romanian 4 % of 1910 (2 500–5 000)



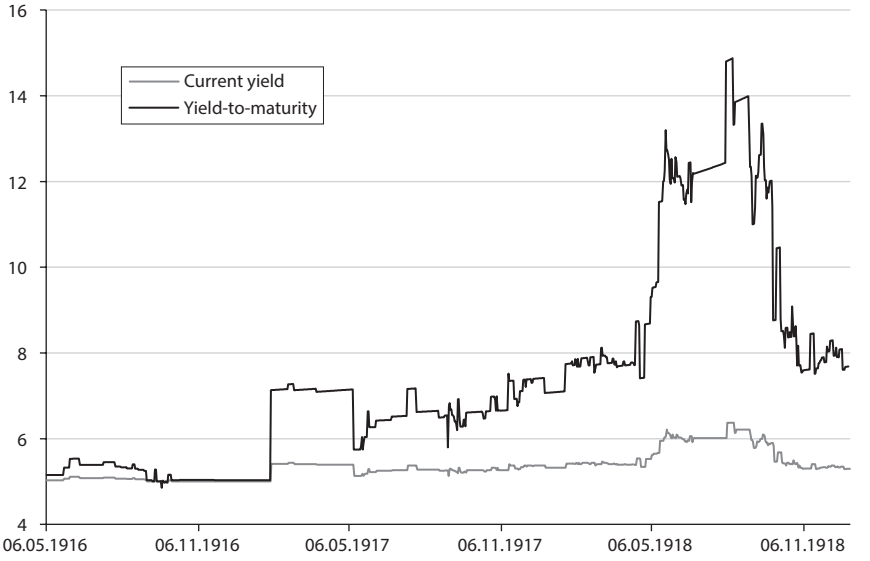
(f) Serbian 4 % of 1895 (500)



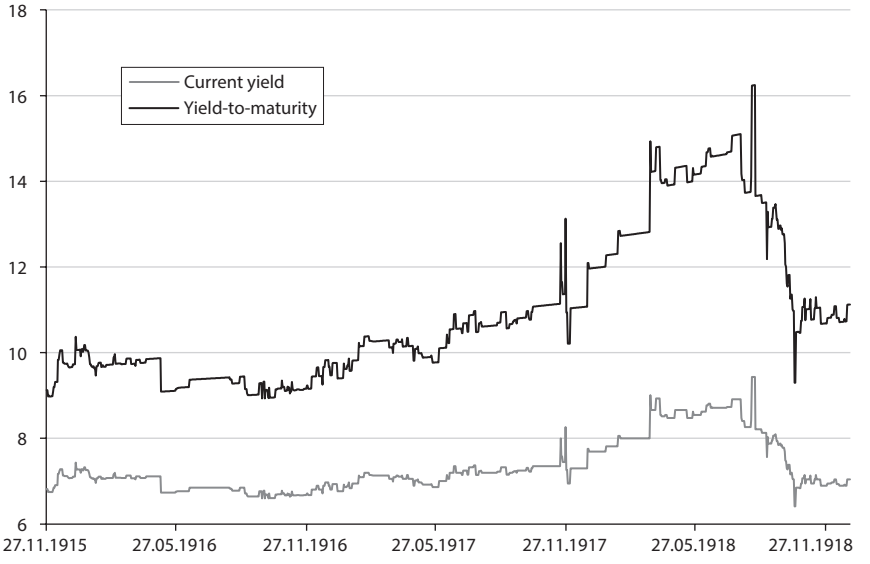
Sources: Cf. Chapter II. *Notes:* Current yields computed from interpolated price series.

Figure 29: Comparison of English and French loans' current yield and yield-to-maturity

(a) English 5 %



(b) French 5 %



Sources: Cf. the text.
Notes: English (French) bond assumed to mature five (ten) years from first observation. On the YTM, cf. Subchapters II.3.1 and III.5.1.

turning points in investors' perception of the war itself, I do not discuss breaks in the post-war period here.[38]

Table 24 documents the statistically significant shifts in mean yields during the war that I found using the Bai-Perron-method.[39] The presented evidence is based on a revision of the preliminary estimates presented in Jopp (2016). It principally holds that breaks have been found *additionally* to those that I put forward in the pre-study based on a different set of technical assumptions than made here.[40] Column one states the identified dates of statistically significant structural breaks. Columns two and three inform on the corresponding *estimated* absolute and percent change in the mean yield. Regarding the first break in the Austrian series, the cells state that, firstly, the estimated mean yield has increased, going from regime one to regime two, by +1.5 percent – from a yield of 7.5 percent to a yield of 9.0 percent (the means per regime are not displayed) – and that, secondly, this *estimated* level increase equals a growth rate of 20.0 percent ((9.0–7.5)/7.5*100). For illustrative purposes, columns four and five additionally state the *observed* absolute and the corresponding *observed* percent change in the data following from a comparison of the yield at the date of the break with the preceding yield quote. Colum six states the date of this last available reported price. Column seven reports the *estimated* volatility in the different regimes – that is, the variance of the error term which is allowed to vary across regimes; I standardized the variance using the coefficient of variation.[41] Column eight reports the "regime liquidity". Volatility is of course linked with liquidity, in that phases of low liquidity should be phases of low volatility. Finally, column six states the event(s) which I think are most likely implicated by the timing

[38] These breaks date as follows (absolute change in estimated mean yield in parentheses): Austria – 24/03/1919 (+3.0), 09/07/1919 (+9.6), and 13/10/1919 (+33.0); Bulgaria – 23/01/1919 (+1.0), 21/07/1919 (+3.1), and 14/10/1919 (+4.0); Germany – 07/12/1918 (+12.9) and 04/10/1919 (+1.4); Ottoman Empire – 25/02/1919 (–0.4), 27/07/1919 (+1.4), and 14/10/1919 (+6.8); England – 24/01/1919 (–0.2), 04/08/1919 (+0.2), and 27/10/1919 (+0.4); France – 28/03/1919 (+0.4), 12/07/1919 (+0.7), and 19/10/1919 (+1.5); Italy – 06/12/1918 (+0.2) and 14/05/1919 (–3.0); Romania – 27/02/1919 (–0.3) and 09/10/1919 (+5.2); Russia – 30/03/1918 (+7.0), 01/10/1918 (–3.1), and 04/09/1919 (+1.5); and Serbia – 29/07/1919 (+1.3) and 15/10/1919 (+2.6).

[39] Principally, the Bai-Perron-method requires series to be stationary – that is, to exhibit the property of mean-reversion. Table A.10 in the online Appendix shows that not all bond yield series are stationary in either the war or combined war-post-war period. However, as the breaks are estimated sequentially, and not globally, the presence of a unit root in a series is arguably negligible.

[40] In comparison to the estimates presented in Jopp (2016), the estimates presented here are based on heteroscedasticity-and-autocorrelation-consistent (HAC) standard errors and, in addition, allow for the variance of the error term to vary over the different regimes; cf. online Appendix 2.1.

[41] The variance per regime is the sum of squared deviations of the observed yield from the estimated mean yield. The coefficient of variation is the standard deviation (i. e., the square root of the variance) divided by the mean. Hence, volatility is given by the standard deviation as a measure of the average deviation to either side in percent of the mean.

Table 24: Suggested turning points in investor perception of the belligerents' war effort

Turning point (dd/mm/yyyy)	Change in *estimated* mean yield …		Change in *observed* mean yield …		Previous price quote dating …	Implied volatility in the preceding regime	Bond's liquidity in the preceding regime	Suggested event(s)
	absolute	relative	absolute	relative				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Austria								
[A1] 11/12/1915	+1.5 %	+20.0 %	+0.3 %	+3.6 %	(10/12/1915)	0.60	0.53	Reich Chancellor Bethmann-Hollweg's speech and British opinion; Serbian theater[1]
[A2] 03/05/1916	–0.4 %	–4.4 %	–0.3 %	–3.4 %	(02/05/1916)	0.44	0.70	Favorable news from the fronts[2]
[A3] 31/08/1916	+1.0 %	+11.6 %	+0.2 %	+2.2 %	(29/08/1916)	0.38	0.55	Romanian (Italian) declaration of war on Austria-Hungary (Germany)[3]
[A4] 03/03/1917	+1.0 %	+10.4 %	+0.2 %	+2.0 %	(02/03/1917)	0.52	0.57	Allied naval blockade; unrestricted submarine warfare and US-German relations[4]
[A5] 03/12/1917	–1.7 %	–16.0 %	–0.3 %	–3.0 %	(01/12/1917)	0.47	0.68	Peace negotiations with Russia; German war loan approved[5]
[A6] 02/04/1918	+1.2 %	+13.5 %	+0.0 %	+0.0 %	(28/03/1918)	0.50	0.92	Foch becomes Commander-in-Chief of Allied troops[6]
[A7] 20/06/1918	+3.2 %	+31.7 %	+0.8 %	+7.4 %	(19/06/1918)	0.51	0.88	Austrian offensive against Italy; interior turmoil in Bulgaria[7]
Bulgaria								
[B1] 29/12/1915	+1.4 %	+20.3 %	+2.9 %	+40.8 %	(30/11/1915)	0.35	0.07	Unfavorable news from the Serbian theater[8]
[B2] 25/05/1916	–1.1 %	–13.2 %	–0.5 %	–6.2 %	(24/05/1916)	0.57	0.41	Verdun theater[9]
[B3] 05/10/1916	+0.6 %	+8.3 %	+1.1 %	+15.3 %	(31/08/1916)	0.26	0.15	Unfavorable news from the fronts; the case of Greece[10]
[B4] 25/07/1918	+3.0 %	+38.5 %	+1.2 %	+14.3 %	(24/07/1918)	1.16	0.29	Unfavorable news from the Western Front[11]

[B5] 18/10/1918	−2.8 %	−25.9 %	−2.1 %	−20.2 %	(17/10/1918)	1.12	0.19	US President Wilson's second peace note; dissolution of Habsburg monarchy[12]
Germany								
[G1] 11/01/1916	+1.5 %	+24.1 %	+1.2 %	+22.6 %	(31/12/1915)	0.20	0.12	Conscription controversy in Britain[13]
[G2] 08/06/1916	−1.1 %	−16.4 %	−1.8 %	−25.3 %	(29/04/1916)	0.73	0.13	End of Battle of Jutland on 1 June; Lord Kitchener drowned on 5 June; German conquest of Fort Vaux near Verdun on 7 June[14]
[G3] 16/11/1916	+0.3 %	+5.3 %	+0.2 %	+3.5 %	(01/11/1916)	0.27	0.07	Final phase of the Battle of the Somme[15]
[G4] 22/03/1917	+0.9 %	+15.2 %	+0.9 %	+0.9 %	(16/03/1917)	0.24	0.27	February Revolution in Russia (7–15 March); British offensives on the Western Front[16]
[G5] 27/12/1917	−0.8 %	−9.5 %	−0.5 %	−7.5 %	(01/12/1917)	0.47	0.12	Russia defeated; peace negotiations at Brest-Litovsk[17]
[G6] 18/03/1918	−0.3 %	−5.0 %	−0.2 %	−3.4 %	(22/02/1918)	0.20	0.18	Russia signs Treaty of Brest-Litovsk; Romania accepts German terms, too; German Spring offensive about to commence[18]
[G7] 07/06/1918	+0.5 %	+8.8 %	+0.1 %	+1.7 %	(06/06/1918)	0.20	0.14	Unsuccessful operation Blücher-Yorck on the Western Front as part of German spring offensive[19]
[G8] 19/09/1918	+ 2.4 %	+38.7 %	+3.0 %	+48.4 %	(31/07/1918)	0.22	0.17	Allied summer offensive; Austria's piece offer[20]

Turning point (dd/mm/yyyy)	Change in *estimated* mean yield …		Change in *observed* mean yield …		Previous price quote dating …	Implied volatility in the preceding regime	Bond's liquidity in the preceding regime	Suggested event(s)
	absolute	relative	absolute	relative				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ottoman Empire								
[O1] 11/01/1916	+0.5 %	+7.1 %	+0.3 %	+4.2 %	(10/01/1916)	0.25	0.33	Conscription controversy; unfavourable news from the Middle Eastern theater[21]
[O2] 06/05/1916	–0.2 %	–2.7 %	–0.7 %	–9.2 %	(05/05/1916)	0.22	0.39	German reply to US concerning submarine warfare; Western Front[22]
[O3] 12/12/1916	–0.2 %	–2.7 %	–0.0 %	–0.0 %	(11/12/1916)	0.36	0.57	Central Powers take Bucharest[23]
[O4] 17/03/1917	+0.9 %	+12.7 %	+0.2 %	+2.7 %	(16/03/1917)	0.16	0.37	Revolution in Russia and continuation of war[24]
[O5] 07/10/1918	–0.8 %	–10.0 %	–0.5 %	–6.1 %	(05/10/1918)	1.44	0.29	German and Austrian peace offer to US president Wilson; tensions arising between Ottoman Empire and Germany[25]
England								
[E1] 04/09/1916	–0.1 %	–2.0 %	–0.0 %	–0.0 %	(01/09/1916)	0.09	0.13	Romania enters into the war[26]
[E2] 01/02/1917	+0.4 %	+8.0 %	+0.4 %	+8.0 %	(04/10/1916)	0.02	0.09	Germany declares unrestricted submarine warfare[27]
[E3] 12/05/1917	–0.2 %	–3,7 %	–0.3 %	–5.5 %	(05/04/1917)	0.03	0.05	Food situation in Germany[28]
[E4] 15/11/1917	+0.1 %	+1.9 %	+0.1 %	+1.9 %	(02/11/1917)	0.20	0.25	Bolsheviks' win over Kerensky[29]
[E5] 23/01/1918	+0.1 %	+1.9 %	+0.1 %	+1.9 %	(29/12/1917)	0.08	0.21	Carson's resignation from British war cabinet; peace with Ukraine[30]
[E6] 16/05/1918	+0.6 %	+11.1 %	+0.2 %	+2.5 %	(13/05/1918)	0.17	0.38	Peace with Romania (Treaty of Bucharest)[31]

[E7] 01/10/1918	−0.7 %	−13.2 %	−0.3 %	−5.2 %	(30/09/1918)	0.27	0.45	Allies breaching Hindenburg line; Austria-Hungary's piece offer[32]
France								
[F1] 06/05/1916	−0.3 %	−4.3 %	−0.4 %	−5.6 %	(15/04/1916)	0.21	0.36	Battle of Verdun[33]
[F2] 08/02/1917	+0.2 %	+2.9 %	+0.2 %	+2.9 %	(30/01/1917)	0.23	0.25	Unrestricted submarine warfare; neutrals undecided toward resistance against Germany[34]
[F3] 16/06/1917	+0.2 %	+2.8 %	+0.2 %	+2.8 %	(14/06/1917)	0.17	0.27	Abdication of King Constantine of Greece[35]
[F4] 09/10/1917	+0.1 %	+1.4 %	+0.1 %	+1.4 %	(06/10/1917)	0.10	0.25	Inner turmoil in Russia; unfavorable news from the Western Front; Germany drafting foreigners[36]
[F5] 27/12/1917	+0.6 %	+8.2 %	+0.4 %	+5.5 %	(07/12/1917)	0.21	0.14	Defeat of Russia and Romania[37]
[F6] 25/03/1918	+0.6 %	+7.9 %	+1.0 %	+12.5 %	(11/02/1918)	0.16	0.07	Begin of German spring offensive (e. g., 2nd Battle of the Somme)[38]
[F7] 01/10/1918	−1.8 %	−21.2 %	−0.2 %	−2.6 %	(30/09/1918)	0.57	0.27	Allied counterattacks on the Western Front; Bulgaria surrenders[39]
Italy								
[I1] 23/02/1916	+1.2 %	+20.7 %	+1.2 %	+20.7 %	(30/09/1915)	0.07	0.01	Bad news from the Southern Front[40]
[I2] 22/06/1916	−0.8 %	−11.4 %	−0.8 %	−11.4 %	(21/06/1916)	0.00	0.01	Russian advances on the Eastern Front; Paris Economic Conference[41]
[I3] 18/01/1917	+0.8 %	+12.9 %	+0.7 %	+11.1 %	(17/07/1916)	0.34	0.04	Switzerland under pressure[42]
[I4] 05/04/1917	+0.8 %	+11.4 %	+0.9 %	+12.8 %	(18/01/1917)	0.00	0.01	Revolution in Russia[43]
[I5] 28/08/1917	+0.3 %	+3.8 %	+0.3 %	+3.8 %	(24/05/1917)	0.14	0.02	Stockholm Conference of antiwar socialists[44]

Turning point (dd/mm/yyyy)	Change in *estimated* mean yield …		Change in *observed* mean yield …		Previous price quote dating …	Implied volatility in the preceding regime	Bond's liquidity in the preceding regime	Suggested event(s)
	absolute	relative	absolute	relative				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
[I6] 13/05/1918	+6.7 %	+82.7 %	+5.9 %	+72.8 %	(28/08/1917)	0.08	0.00	Defeat of Russia/Romania; massive setbacks on the Southern Front[45]
[I7] 08/08/1918	–4.1 %	–27.7 %	–2.3 %	–16.4 %	(07/08/1918)	0.53	0.09	Allied summer offensive about to commence[46]
Romania								
[B1] 09/11/1918	+1.0 %	+13.9 %	+1.0 %	+13.9 %	(01/08/1916)	1.47	0.01	Romania's defeat; Czech Republic and Yugoslav independence proclaimed[47]
Russia								
[R1] 27/11/1915	+0.4 %	+6.2 %	+0.1 %	+1.5 %	(26/11/1915)	0.18	0.74	Central Powers' advance against Serbia[48]
[R2] 16/05/1916	–0.6 %	–8.8 %	–0.3 %	–4.5 %	(15/05/1916)	0.39	0.79	British war aims declaration[49]
[R3] 03/08/1916	–0.2 %	–3.2 %	–0.0 %	–0.0 %	(02/08/1916)	0.14	0.79	Battle of the Somme; Eastern Front[50]
[R4] 08/02/1917	+0.5 %	+8.3 %	+0.1 %	+1.6 %	(07/02/1917)	0.21	0.74	Unrestricted submarine warfare[51]
[R5] 13/06/1917	+1.0 %	+15.4 %	+0.7 %	+10.9 %	(05/06/1917)	0.30	0.57	Wilson's note to Russia and Russia's reply; Russia's interior turmoil[52]
[R6] 25/09/1917	+1.7 %	+22.7 %	+0.1 %	+1.3 %	(24/09/1917)	0.38	0.79	Russia's interior turmoil[53]
[R7] 13/12/1917	+3.7 %	+40.2 %	+0.5 %	+4.6 %	(12/12/1917)	0.97	0.78	Russia's interior turmoil[54]
Serbia								
[S1] 03/06/1916	–0.9 %	–9.6 %	–0.2 %	–2.2 %	(02/06/1916)	0.93	0.20	Verdun theater; news from the Southern Front[55]
[S2] 22/01/1918	+3.1 %	+36.5 %	+3.2 %	+34.4 %	(21/01/1918)	1.09	0.30	Peace negotiations at Brest-Litovsk[56]

[S3] 19/06/1918	+2.9 %	+25.0 %	+3.9 %	+32.2 %	(18/06/1918)	0.63	0.34	Unfavorable news from the Southern Front[57]
[S4] 13/09/1918	–6.3 %	–43.4 %	–1.6 %	–13.2 %	(12/09/1918)	0.82	0.43	Bulgaria surrenders; Battle of Flanders commences; Serbian advance[58]

Sources: Author's own computations.
Notes: If not stated otherwise, corresponding major news headlines are taken from the *Algemeen Handelsblad* (AH); "DTe" is *De Telegraaf*; "DT" is *De Tijd*; "HC" is *Het Centrum*); and "NRC" is *Nieuwe Rotterdamsche Courier*. In a few instances a reference to Edward Gleichen's compendium is given: [1] "Rijkskanselier geeft een overzicht van den militairen en politieken toestand", "De sociaal-democratische vredesinterpellatie en het antwoord van v. Bethmann Hollweg" and "De gevechten aan de Servisch-Montenegrijnsche grens" (10 Dec) (DTe, No. 9 233) and "De redevoeringen van Bethmann Hollweg" and "De Engelsche pers over de rede van Bethmann Hollweg" (10 Dec) (NRC, No. 344); [2] "De strijd om Verdun", "Een gevecht op het gletscher-ijs aan het Italiaansche front", "Het gevangenkamp te Wittenberg" and "De Engelsche nederlag bij Koet-el-Amara" (2 May) (AH, No. 28 413); [3] "De pers over de Rumeensche oorlogsverklaring" (29 Aug) and "De oorlogsverklaring van Roemenië" (31 Aug) (AH, No. 28 532–28 534); [4] "Een mededeeling in het Engelsche Lagerhuis over de resultaten der blokkade", "De verscherpte Duikbootoorlog" and "Duitschland en Japan" (2 Mar) (AH, No. 28 715); [5] "De duitsche oorlogsleening door den Rijksdag aangenomen" and "Het vredesaanbod" (2 Dec) (AH, No. 28 988); [6] "Foch opperbevelhebber der Fransch-Engelsche legers" (31 Mar) (AH, No. 29 106); [7] "Het Oostenrijksche offensief in Italië" (19 Jun and 20 Jun) and "De kabinetscrisis in Bulgarije" (20 Jun) (AH, No. 29 184–29 185); [8] "De strijd in het Sandsjak" and "Montenegrijnen zetten hun offensief voort" (28 Dec, similar in the weeks before) (DTe, No. 9 251); [9] "Hevige gevechten om Verdun" (25 May) (AH, No. 28 436); [10] "Aan de Somme" and "De strijd aan de fronten in Rusland en Roemenie" (3 Oct) (AH, No. 28 567), "De toestand in Griekenland" (4 Oct) (AH, No. 28 568), and "Het Grieksche Ministerie afgetreden" (5 Oct) (AH, No. 28 569); [11] "De Duitschers wijken stelselmatig terug" and "Nieuwe Fransche vorderingen aan de Ourco" (24 Jul) (DTe, No. 10 182); [12] "Een rede van minister Burian", "Graaf Burian blijft optimistisch ook na Wilson's tweede nota" and "Oostenrijk een statenbond" (17 Oct) (AH, No. 29 304); [13] "De dienstpflichtquaestie in Engeland" (1 Jan, but also 3–8 Jan) (AH, No. 28 291); [14] "De zeeslag by Jutland" (3 Jun; also 5–6, and 8 June), "Rouw over Lord Kitchener" (7 Jun, but also 8 Jun), and "Fort Vaux door de Duitschers genomen" (8 Jun) (AH. No. 28 448–28 450); [15] "De Britsche overwinning aan de Ancre" (15 Nov, AH No. 28 610; similar in the days before); [16] "De revolutie in Rusland" (16 Mar, also 17 and 21–22 Mar), "De oorlog wordt voortgezet" (16 Mar 16), "Anti-Duitsche gevoelens in Rusland" (17 Mar), and "De terugtocht der Duitschers aan het Westfront" (19 Mar) (AH, No. 28 729–28 732); [17] "De wapenstilstand aan het Russische front gesloten" and "De vredesonderhandelingen beginnen" (17 Dec 17; similar 18–27 Dec) (AH, No. 29 003); [18] "De stille voor den storm. Het offensief een domheid?" (16 Mar) (HC, No. 10 248) and "De vrede tusschen Rusland en de Centralen door de Sovjets geratificeerd" (18 Mar) (AH, No. 29 093); [19] "Het Duitsche offensief" (5 Jun, but also 6 Jun) (AH, No. 29 170–29 171); [20] "Het Entente-offensief op het Westfront" and "De Ostenrijksche vredesnota" (both 18 Sep, more battle news before) (AH No. 29 275); [21] "Het dienstplichtontwerp" and "Britsch succes in Mesopotanië" (10 Jan) (AH, No. 28 301); [22] "De strijd aan het Westelijk front" (5 May) and "De antwoord nota van Duitschland aan de Vereenigde Staten" (6 May) (AH, No. 28 415–28 416); [23] "De opmarsch der centralen in Roemenië" and "De inneming van Boecharest" (11 Dec) (AH, No. 28 636); [24] "De revolutie in Rusland" and "De oorlog wordt

voortgezet" (16 Mar) (AH, No. 28 729); [25] "De opvatting der Centraln over Turkije's houding", "Turkije – De houding tegenover Duitschland" (both 5 Oct) and "De Duitsche rijkskanselier doe teen vredesaanbod aan president Wilson" (6 Oct) (AH, No. 29 292–29 293); [26] "Aan het Roemeensche front", "Het Russische offensief" and "Minister-president Tiza over de oorlogsverklaring van Roemenie" (3 Sep) (AH, No. 28 537); [27] "Onbeperkte onderzeeërsoorlog" and "Duitsche mijnenblokkade om England, Frabkrijk en Italië" (1 Feb) (AH, No. 28 686); [28] "De voedingsquaestie in Duitschland" (12 May) (AH, No. 28 785); [29] "De nederlaag van Korensky" and "De Russische ambassade te London wigert de nieuwe Russische regeering te erkennen" (14 Nov) (AH, No. 28 970); [30] "Vrede met de Oekraine in 't zicht" (21 Jan) and "Eduard Carson afgetreden als lid van het Engelsche oorlogskabinet" (22 Jan) (AH, No. 29 037–29 038); [31] "De samenkomst der Keizers in het Duitsche hoofdkwartier" (14 May), "Keizer Wilhelm in optimistische stemming", and "Koning Ferdinand van Roemenië over den vrede" (15 May) (AH, No. 29 149–29 150); [32] "Het offensief der geallieereden", "Engelsch-Amerikaansche frontaanvallen op de Hindenburglinie" and "Nieuwe Ostenrijksche vredespoging" (30 Sep) (AH, No. 29 087); [33] "De strijd om Verdun" (4 May) and "De strijd an het Westelijk front" (5 May) (AH, No. 28 415–28 416); [34] "De verscherpte duikbootoorlog" (8 Feb, similar news on days before) and "Het antwoord van Brazilië op de nota van Duitschland" (8 Feb) (AH, No. 28 693); [35] "Fransche troepen bezeten Thessalieë" (14 Jun) and "Het aftreden van koning Konstantin van Griekenland" (15 Jun, similar on day before) (AH, No. 28 817–28 818); [36] "De strijd in Vlaanderen" and "Dienstplicht voor buitenlanders in Duitschland" (6 Oct) and "Een coalitieregeering in Rusland" and "Voorlopig slechts kleinere actie aan het Vlaamsche front" (8 Oct) (AH, No. 28 931–28 933); [37] "De vredesonderhandelingen te Brest-Litowsk" (27 Dec, similar on the days before) (AH, No. 29 012); [38] "Het Duitsche offensief" (24 Mar, similar on the days before) (AH, No. 29 099); [39] "Het vredesaanbod van Bulgarije" (28 Sep) (AH, No. 29 285) and "Een Engelsch offensief in Vlaandéren" (29 Sep) (DTe, No. 10 249); [40] "Hoe Montenegro wird opgeofferd" (22 Feb) (AH, No. 28 343); [41] "De Russische doorbraak in de Boekowina" and "De economische conferentie te Parijs" (22 Jun) (AH, No. 28 463); [42] "Wordt Zwitserland bedreigd" (17 Jan) (HC, No. 9 894) and "Versterking van de Zwitsersche grenstroepen" (17 Jan) (AH, No. 28 671); [43] "De revolutie in Rusland" (4 Apr) (AH, No. 28 748); [44] "De soc.-dem. Conferentie te Stockholm" (28 Aug) (AH, No. 28 892); [45] Gleichen (2000: 240, 275, part II), and Gleichen (2000: 6, 53, part III); [46] "De Franschen maken nieuwe vorderingen" (7 Aug) (DTe, No. 10 196); [47] Gleichen (2000: 24, part III), and Gleichen (2000: 17, part III.); [48] "De strijd in Westelijk Servië" (26 Nov) (DTe, No. 9 210); [49] "De Engelsche pers over de uitlatingen van Sir Eduard Grey" (15 May) (AH, No. 28 426); [50] "De strijd aan de Somme", "De gevechten op het oostelijke front" and "Aan het Russische front" (2 Aug) (AH, No. 28 505); [51] "De verscherpte duikbootenoorlog" (7 Feb) (AH, No. 28 692); [52] "Oorlogsmoeheid in Rusland" (11 Jun) and "De geallieerden en de Russische oorlogsbedoelingen" (12 Jun) (AH, No. 28 814–28 815); [53] "Een nieuwe opstand van Kaledin?" (24 Sep) (AH, No. 28 919); [54] "Gevecht tusschen maximalisten en Kaledin" (12 Dec) (AH, No. 28 999); [55] "Om Verdun" and "De strijd aan het italiaansche front" (2 Jun) (AH, No. 28 444); [56] "De Russische Constituante ontbonden" and "De onderhandelingen te Brest-Litowsk" (21 Jan) (AH, No. 29 037); [57] "Het Oostenrijksche offensief in Italie", "De strijd aan de Piave" and "Het Turksche Bondgenootschap met Duitschland" (18 Jun) (AH, No. 29 183); [58] "De indruk van de Bulgaarsche vredesactie", "De Serviers rukken op naar Uskub" and "Een Engelsch offensief in Vlaanderen" (12 Sep) (DT, No. 21 745).

of the breaks to have induced the significant adjustments of investors' default expectations. Note that the information presented in column five is crucial for the reason that any event falling into the period between the actual official price quote (or yield estimate) and the last available one, may have caused the adjustment in investors' perception. The longer the period of missing values in the raw data – that is, a period of illiquidity –, and thus the greater the supply of events, the less certain we can actually be about having found the true, implicated event.

In order to impose some structure on the event selection process, events likely implied by the break dates as triggering investors' reaction were selected based on what was reported in the war news section of the Dutch print media.[42] I concentrated on the *Algemeen Handelsblad* and asserted that this newspaper had been a readily available public source for the *average* investor serving him as a good starting point to assess the war factions' performance.[43] In this regard, I focus on the *major* headlines one could not overlook when opening the newspapers. Given that it is impossible to trace how the average investor's information gathering process at the time practically worked, I actually favored the simplest possible assumption on that process here. In addition, I used Edward Gleichen's *Chronology of the Great War*, and Randal Gray's *Chronicle of the First World*

[42] When turning to the press in World War One, we certainly face another information issue as, principally, the press was subject to influence, or even censorship, by domestic as well as foreign authorities. The degree to which this was truly problematic may have varied considerably between countries, though; cf. e. g. Luckhurst (2016). We know from Eversdijk (2010) that German (but also British) authorities took action to influence the image that the Dutch people had of Germany (Britain) and of the war; influencing the picture of Germany given in the press was one major cornerstone to that action. I therefore cannot exclude that the reporting of events in the Dutch newspapers is in some way biased. But, firstly, this would hold regardless of which trading place we look at. And, secondly, I am not going to investigate the newspapers' textual sentiment in detail. My investigation primarily rests on what has been reported about, and not so much on how things were reported. If the analysis of textual sentiment was the aim, a state-of-the-art approach would have to rest on sentiment analysis (as done in finance, for example) and on proper methods of text mining. This comes with a lot of effort and, what is more, the effort's outcome is highly dependent on the quality of the underlying digital sources. As has been argued in Subchapter II.2, quality, indeed, is an issue. On sentiment analysis in finance, cf. e. g. Kearny/Liu (2014); and on text mining methods, cf. Wehrheim (2019).

[43] Since transactions had to be executed during one and a quarter hour at late noon (cf. Subchapter II.4), I consulted the morning issue of the day of the break or the evening issue(s) of the preceding day(s). Regarding the possible influence of, for example, Germany on Dutch press products, the *Handbuch der Auslandspresse* of 1918 is a valuable source, as it provides a German view on the various Dutch newspapers, and especially on the *Algemeen Handesblad*; cf. Handbuch der Auslandspresse (1918: 98). On the circle of readers and coverage, it reads, for example: "In all circles of the Netherlands" ("*In allen Kreisen der Niederlande*"); on orientation domestically, it reads: "liberal, free trade-oriented" ("*liberal, freihändlerisch*"); on orientation as regards foreign policy, it reads: "Preservation of Dutch independence and neutrality" ("*Wahrung der niederländischen Neutralität und Unabhängigkeit*"); and on the attitude towards Germany, it reads: "Moderate in tone, with few exceptions in the 'daily overview'" ("*Gemäßigt im Ton, mit einigen Ausnahmen in der 'Tagesübersicht'*"). Such statements are made in the *Handbuch* on every newspaper that I consulted.

War for cross-checking; these are the apparently most comprehensive day-by-day compilations of military, financial, and political happenings during World War One.[44]

I am including two helpful additions to the evidence presented in Table 24. While the growth rates on the estimated and observed yields at the date of the breaks given in the table already present some idea of how big or small the breaks are, Table 25 expands on this matter by comparing the breaks to the standard deviation of the respective yield series and to that of the entire cross-section. Both the pre-war and war period standard deviations are used as reference. To gather the meaning of the reported figures, take the first turning point in the German series as an example: The estimated break of +1.5 percent – the level change in the conditional mean – is about 43 (2.0) times larger than the German 3 % imperial loan's own standard deviation over the immediate pre-war (war) period, as defined in this study. Moreover, it amounts to five quarters (almost two-fifths) of the standard deviation taking into account the entire pre-war (war) cross-section of bonds. A fair share of the breaks turns out to be quite big if bigness is measured this way. Note that since the standard deviation in the cross-section is naturally larger, the change in mean yield expressed as a proportion of that standard deviation is naturally smaller than the proportion expressed in the bond series' own standard deviation.

The second addition comes in the form of ten figures – one per bond series – illustrating the timing and location of the detected breakpoints in the original price series, in the analyzed current yield series, and in a rolling measure of the bond's liquidity which is again the proportion of non-zero returns. Liquidity is calculated for each 60-day window between the first day the respective bond was traded during wartime and 31 December 1918. The window is shifted by one day at a time, rolling over the entire observed period. Each data point in the series reflects liquidity of the *past* 60 days making the measure a *lagged* rolling measure.

5.3. Explaining turning points in the major powers' series

I begin with discussing the turning points I found for Germany as the major Central Power. I found eight breakpoints in the German 3 % which partly coincide with the ones that I put forward in an earlier pre-study. In this I applied the Banerjee et al. (1992) method test-wise to the German 3 % after having merged the two available subseries into one.[45] On 11 January 1916, the mean yield significantly increased by not less than one and a half percent (or by a

[44] Originally, Gleichen's chronicle was compiled between 1918 and 1920 under supervision of the British Ministry of Information. Happenings are documented separately for the "Western Front", the "Eastern Front", the "Southern Front", the "Asiatic and Egyptian Theatres", "Naval and Overseas Operations", and the "Political etc." sphere; cf. Gleichen (2000: parts I, II, and III).

[45] Cf. Jopp (2014).

Table 25: How big are the breaks in the yield series?

Turning point (TP)	Pre-war period yields as reference: absolute change linked with TP divided by standard deviation of …		War period yields as reference: absolute change linked with TP divided by standard deviation of …	
	Bond in question	All bonds	Bond in question	All bonds
GER: TP 1	43.10	1.25	2.03	0.37
GER: TP 2	–31.61	–0.92	–1.49	–0.27
GER: TP 3	8.62	0.25	0.41	0.07
GER: TP 4	25.86	0.75	1.22	0.22
GER: TP 5	–22.99	–0.67	–1.08	–0.20
GER: TP 6	–8.62	–0.25	–0.41	–0.07
GER: TP 7	14.37	0.42	0.68	0.12
GER: TP 8	68.97	2.00	3.25	0.59
AUT: TP 1	16.10	1.27	0.98	0.38
AUT: TP 2	–4.24	–0.33	–0.26	–0.10
AUT: TP 3	10.59	0.83	0.64	0.25
AUT: TP 4	10.59	0.83	0.64	0.25
AUT: TP 5	–18.01	–1.42	–1.10	–0.42
AUT: TP 6	12.71	1.00	0.77	0.30
AUT: TP 7	33.90	2.67	2.06	0.79
TUR: TP 1	8.17	0.42	0.88	0.12
TUR: TP 2	–3.27	–0.17	–0.35	–0.05
TUR: TP 3	–3.27	–0.17	–0.35	–0.05
TUR: TP 4	14.71	0.75	1.59	0.22
TUR: TP 5	–13.07	–0.67	–1.41	–0.20
BUL: TP 1	28.00	1.17	1.69	0.35
BUL: TP 2	–22.00	–0.92	–1.33	–0.27
BUL: TP 3	12.00	0.50	0.72	0.15
BUL: TP 4	60.00	2.50	3.61	0.74
BUL: TP 5	–56.00	–2.33	–3.37	–0.69
ENG: TP 1	n/a	–0.08	–0.30	–0.02
ENG: TP 2	n/a	0.33	1.20	0.10
ENG: TP 3	n/a	–0.17	–0.60	–0.05
ENG: TP 4	n/a	0.08	0.30	0.02
ENG: TP 5	n/a	0.08	0.30	0.02
ENG: TP 6	n/a	0.50	1.80	0.15
ENG: TP 7	n/a	–0.58	–2.10	–0.17
FRA: TP 1	n/a	–0.25	–0.47	–0.07
FRA: TP 2	n/a	0.17	0.31	0.05
FRA: TP 3	n/a	0.17	0.31	0.05
FRA: TP 4	n/a	0.08	0.16	0.02
FRA: TP 5	n/a	0.50	0.94	0.15
FRA: TP 6	n/a	0.50	0.94	0.15
FRA: TP 7	–	–1.50	–2.83	–0.45

Turning point (TP)	Pre-war period yields as reference: absolute change linked with TP divided by standard deviation of …		War period yields as reference: absolute change linked with TP divided by standard deviation of …	
	Bond in question	All bonds	Bond in question	All bonds
ITA: TP 1	40.00	1.00	0.34	0.30
ITA: TP 2	–26.67	–0.67	–0.23	–0.20
ITA: TP 3	26.67	0.67	0.23	0.20
ITA: TP 4	26.67	0.67	0.23	0.20
ITA: TP 5	10.00	0.25	0.08	0.07
ITA: TP 6	223.33	5.58	1.89	1.66
ITA: TP 7	–136.67	–3.42	–1.16	–1.01
ROM: TP 1	12.50	0.83	2.17	0.25
RUS: TP 1	6.84	0.33	0.10	0.10
RUS: TP 2	–10.26	–0.50	–0.15	–0.15
RUS: TP 3	–3.42	–0.17	–0.05	–0.05
RUS: TP 4	8.55	0.42	0.13	0.12
RUS: TP 5	17.09	0.83	0.26	0.25
RUS: TP 6	29.06	1.42	0.44	0.42
RUS: TP 7	63.25	3.08	0.95	0.92
SER: TP 1	–9.00	–0.75	–0.56	–0.22
SER: TP 2	31.00	2.58	1.91	0.77
SER: TP 3	29.00	2.42	1.79	0.72
SER: TP 4	–63.00	–5.25	–3.89	–1.56

Sources: Author's own computations.
Notes: "All bonds" refers to the population of government bonds traded in Amsterdam. Standard deviation of the raw series used. "n/a" is "not available".

quarter expressed in growth rates). As can be gathered from Figure 30, panel (c), this break occurs at the end of a downward trend of liquidity. This is one of two exceptionally large breaks in the German series. Bondholders likely reacted so negatively, and lastingly, to the conscription controversy in Britain right at the time and the foreseeable coming of the Military Service Act which called for all single men between age 18 and age 41 to be drafted. It entered the House of Commons on 5 January 1916 and finally passed successfully on 25 January.[46]

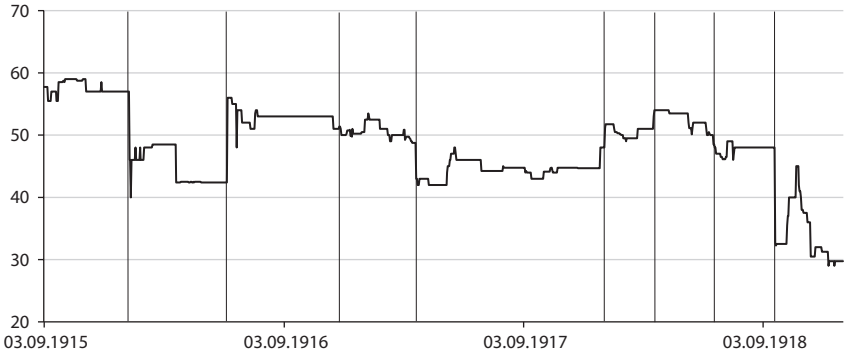
In contrast to all other belligerents which had, sooner or later, had committed themselves to maintaining a standing army based on compulsory military service, the British stuck with voluntary enlistments into military branches up until December 1915.[47] However, after the initial sequence of campaigns in 1914,

[46] Cf. Gleichen (2000: 7–13, part II).

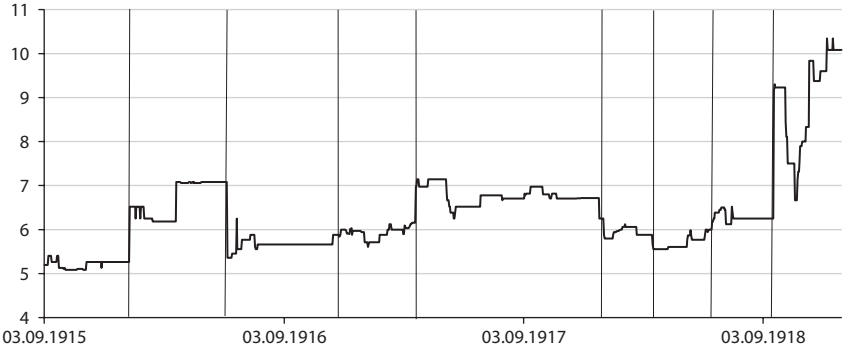
[47] Approximately 2.4 million men, coming from all quarters of the British Empire, volunteered to fight in World War One – almost half of all British soldiers that would have been deployed overall; cf. Stevenson (2005: 202).

Figure 30: The breaks in the German 3 % – price, yield, and liquidity compared

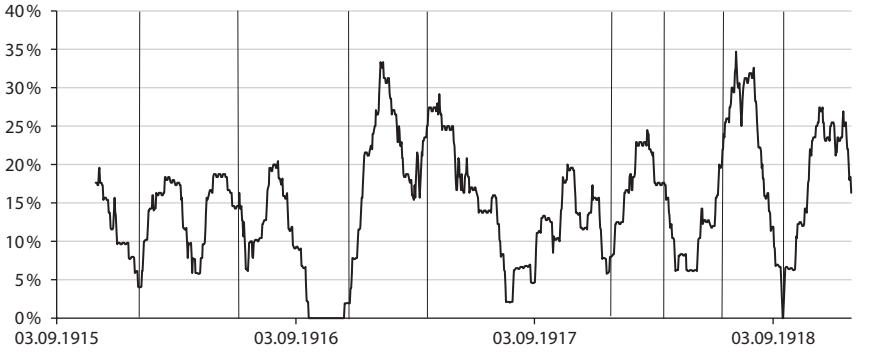
(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

both the Allied and Central Powers soon recognized that the war would take longer than widely expected and that even more resources – human resources, in particular – would have to be made available to hold ground. While British authorities had entered the war without a grand design of mobilizing human resources on a really competitive scale, they apparently tried to correct this flaw in January 1916. At least since mid-1915, when the number of volunteers for the military began to fall, the question of introducing compulsory military service arose and was discussed more intensely among politicians and the public. After two unsuccessful measures – the National Registration Act of July 1915 and the Derby Scheme of October/December 1915 – British Prime Minister Asquith openly advocated the Military Service Act as a workable solution despite any ambivalence spotted.[48]

The debate on whether compulsory military service should be introduced was, in fact, quite present in the *Algemeen Handelsblad*'s war news section between the beginning of January and the 11th of the month.[49] Following David Stevenson,

> [t]he conscription controversy was the most important political debate in Britain during the year following the formation of Asquith's first coalition government in May 1915 [and] [h]is authority [i. e., that of Asquith; author's comment] never recovered, and the imbroglio hastened the decline of the Liberal Party as well as confirming Britain's commitment to total war.[50]

According to contemporary investors' real-time opinion and in line with Stevenson's hindsight judgment, the coming of compulsory military service arguably had a clear negative bearing on Germany's stand in the war in that additional resource mobilization in Britain would shift the odds in favor of the Allied Powers. Financially interpreted, bondholders either expected that the war would end with the defeat of Germany considerably sooner – with the Allied Powers shifting their war costs over mainly to the German Empire by levying reparations;

[48] Cf. Stevenson (2005: 198–204). Fundamental critique came from Lloyd George, who, as head of the recently founded Munitions Office, claimed that conscription would likely deprive the munitions industry of its highly skilled workforce that was indispensable for maintaining a high level of shell production.

[49] We do find news from the fronts, too, including, for example, news on the Dardanelles theater (Southern Front). But Ottoman troops' efforts leading to the Allied Powers eventually evacuating the Gallipoli Peninsula on 8 January, not having reached their aim to secure a path for Russia's Black Sea Fleet into the Mediterranean, should have arguably been rather positive news for Germany, and so for bondholders. According to Gleichen, there was also bad news from the Eastern Front as Russia had launched the *Offensive on the Strypa and the Styr* on New Year's Day. Moreover, Austrian troops had to withdraw, for example, from Czernowitz. But I doubt that these military events alone can explain the exceptional and long-lasting downward shift in investors' confidence as reflected in the rise in yield; cf. Stevenson (2005: 117–120), Gleichen (2000: 6, Part II), and the *Algemeen Handelsblad*, No. 28 295, 5 January 1916 ("Tsjernowitsy door de Ostenrijkers ontruimd").

[50] Cf. Stevenson (2005: 202–203).

or they simply expected the war to be prolonged and *Reich* finances to get under even more stress. Either way, a debt moratorium became more likely.

The next turning point followed on 8 June of the same year. It seems to be connected to the issue of naval power and, more specifically, to surface *and not* submarine warfare. This turning point ended a regime which showed a comparatively high implied volatility while liquidity stayed about constant. We may thus say that the trading frequency (which is only imperfectly approximated by my liquidity measure) did not change, but investors' assessments on what to make of this five-month period following the initial January shock quite differed; hence the high volatility as an expression of less unanimity. Which news likely aligned investors' differing angles and thus caused the break? During the past week, there was news from the battlefield that bondholders obviously perceived with some euphoria. First and foremost, rumors spread that the German High Seas Fleet won the Battle of Jutland (31 May to 1 June) against the British Grand Fleet – de facto the first clash of the belligerents' fleets during the war. Based on sheer numbers, the German fleet under Admiral Scheer might seen as having indeed achieved victory. The long-term effects of the battle were, however, negligible if we follow historians' judgment.[51] Recall that David S. Adams (2015) finds the same turning point in the French war loan that he analyzed (cf. Subchapter III.2); interestingly, or maybe: unsurprisingly, the average London investor attributed the victory to the Allies. Besides the Battle of Jutland, Lord Kitchener – head of the British War Office at the time and thus being one of the highest-ranking "administrators of war" on the side of the Allied Powers – died on a sea passage to Russia. Finally, German troops gained a prestigious victory during the Battle of Verdun, when they took Fort Vaux, an important part of the French fortifications, on 7 June. In net terms, these events were appreciated with a decrease in yield compensating for two thirds of the previous reaction to the conscription controversy.[52]

The third turning point in the German series is comparatively small in effect. On 16 November 1916, the estimated mean yield climbed by 0.3. This turning point falls into the final phase of the Battle of the Somme which would formally come to an end only some days later. Concretely, there was news on the final British attack known as the "Battle of the Ancre". Investors obviously saw Germany as having lost ground in the Battle of the Somme, all in all.[53]

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[51] Cf. Stevenson (2005: 253). According to Stevenson, 14 British ships were sunk representing 110 000 tons (against 11 German ones of 62 000 tons overall), and some 6 100 British seamen died (against 2 550 German ones); cf. also Bönker (2009) on Germany's way of maritime warfare.

[52] I stress "in net terms" because there also was negative news such as the beginning of the "Brusilov-offensive" by the Russians on 4 June; cf. Gleichen (2000: 38, part II).

[53] Cf. Steveneson (2005: 170–171) and also Greenhalgh (1999) on this final phase.

Data suggest a fourth turning point in bondholders' perception connected to 22 March 1917, when the mean yield made a sudden jump by +0.9 percent. This adjustment very likely was a reaction to previous news on the revolution in Russia. However, what really mattered for bondholders was apparently not the revolution's outbreak on 7 March or its provisional ending on 15 March, with Tsar Nicolas II abandoning his throne, but rather news that the new government would continue the war efforts. As Lawrence Sondhaus puts it,

> [t]he Central Powers welcomed the downfall of the Russian monarchy and hoped the Provisional Government would sue for peace. When it did not, [...], Germany set in motion its plan to return Lenin to Russia, trusting that he and the Bolsheviks would cause a second revolution and force Russia out of the war.[54]

In line with German authorities, any expectations beforehand that interior turmoil would potentially keep Russia from battling Germany any longer, turned out to be too optimistic at this stage in bondholders' eyes. This fourth turning point is quite compatible with hindsight view. To quote David Stevenson again,

> [s]pring 1917 marked the second turning point in the history of the war. [...]. At this point the overthrow of Tsar Nicholas in March 1917 and American intervention in April seemed to revolutionize the international political constellation. Yet the shockwaves from these events travelled slowly.[55]

Indeed, regarding the mere timing of the turning point, there is a match between what the bond yield suggests and what other historical sources suggest. However, with respect to the event(s) that caused the turning point, bond prices seem to suggest that emphasis must be put on the happenings in Russia rather than on the deterioration of US-German-relations. In bondholders' eyes, the long-term trend was not affected, so much we can say, by the threat of or by actual American intervention.[56]

A fifth turning point occurred on 27 December 1917 and relates to *the* major event in the previous days, namely the defeat of Russia sealed with the armistice on 15 December and the beginning of the peace negotiations in Brest-Litovsk on 22 December.[57] The German Empire achieved a long-cherished goal since it had become clear at the end of 1914 that the two-front war would continue and make highest demands on resources. Now that there was calm on the Eastern Front, which had actually ceased to exist, remaining resources could be concentrated in the Western theater.[58] Against this background, the order of magnitude of bondholders' reaction appears rather small. In all, the capital market appreciated

[54] Sondhaus (2011: 247).

[55] Stevenson (2005: 297).

[56] By the way, in my understanding, Stevenson locates the first turning point in fall 1915 when at both the Western and Eastern Fronts a "stalemate" had arisen; cf. Stevenson (2005: 297).

[57] Cf. Gleichen (2000: 15, part II); and cf. also Robinson (2015) on how Russia fared in the early stages of war.

[58] Cf. e. g. Hussey (1997) and Fong (2000).

the defeat of Russia only with a decrease in mean yield by –0.8 (or –9.5 percent if expressed in growth rates). The sixth turning point on 18 March 1918 matches with the fifth in that it likely was a reaction to the formal signing of the Treaty of Brest-Litovsk, and to the defeat of Romania. However, note that the German spring offensive was launched only three days later. So, the decrease in yield might also be seen as a reaction to this event, as the newspapers commented on a big "offensive to come". But, if any, investors very modestly rethought their long-term expectations thereupon.

In contrast, the turning point on 6 June 1918 very likely is a reaction to the German spring offensive getting stuck. More specifically, it seems to have been the so-called "Blücher-Yorck"-advance (Battle of Chemin des Dames) that brought about the modest negative structural break. While the advance began encouragingly for German troops, it eventually failed and helped to pave the way for the Allied Powers' revival.[59]

The last turning point on 19 September 1918, although preceded by almost two months with no officially reported price quote, must be viewed as a reaction to the allied summer offensive – in retrospect, *the* major blow against the Central Powers' stand. Following David Stevenson once more, the Central Powers' odds of winning World War One had never been as high as in spring and early summer 1918 at any other point in war.[60] The Allied summer offensive then turned the tables once and for all. It consisted of a chain of battle events that apparently fundamentally changed bondholders' perception once more. Up until at least June 1918, Germany and its allies still predominated and perhaps were closer to victory than ever before. However, while the Central Powers had exhausted their reservoir of military resources, the Allied Powers apparently had greater staying power because they launched a series of large-scale counter-offensives, thereby regaining, step by step, full dominance on all fronts; at sea, in the air, and on land.[61] Especially two battles on the Western Front were instrumental in putting Germany on a direct path to speedy and ultimate defeat: the Battle of the Marne, between 16 July and 4 August, opened with a German offensive that backfired terribly;[62] and the Battle of Amiens between 8 and 12 August, launched by the Allied Powers, that ended with a ground-breaking strike on German lines and induced the ultimate retreat of German troops back to the Hindenburg line (and beyond).[63] Regarding the Southern Front, Bulgaria's defeat was almost completed on 19 September, and definitely so on 22 September; a Bulgarian armistice offer followed another three days later.[64] Before, on 15 September, the Austro-

[59] Cf. Stevenson (2012: 88).
[60] Cf., for example, Stevenson (2005: 370–371).
[61] Cf. Stevenson (2005: 421–427).
[62] Cf. Gleichen (2000: 76–82, part III).
[63] Cf. Gleichen (2000: 84, part III).
[64] Cf. Gleichen (2000: 104–107, part III).

Hungarian Empire had already signaled willingness to seriously negotiate about peace.[65] In all, bondholders perceived the sequence of events between 31 July and 19 September 1918 as driving the probability of default enormously up and, thus, the probability of a German victory down. The Franco-British-US revival from the summer of 1918 onwards appears to mark *the* decisive turning point of war.[66] Yet, the implication of this eighth turning point somewhat contrasts with David Stevenson's judgment on the significance of the Allied summer offensive: "The months before rather than after July 1918 determined the war's outcome. The Allies' success on the defensive was the precondition for their success on the offensive and would enable them to end the fighting on their terms."[67] However, the severe increase in yield by 2.4 percent (or 38.7 percent if measured in growth rates) tells vividly that bondholders reckoned with the Central Powers' defeat at the earliest about 50 days before it would become reality.

Turning to Austria(-Hungary), my procedure identifies seven turning points in the 4 % kroner perpetual which was in default since the beginning of war, in contrast to, for example, the German 3 % (cf. Table 22). The first turning point on 11 December 1915 coincides with news on Austria's ally, Germany, and specifically with a speech Reich Chancellor von Bethmann-Hollweg gave in Parliament on 9 December, as well as with news on the Serbian theater. The turning point implies a negative net reaction by bondholders to these events. Regarding the Reich Chancellor's speech, a reason for the negative assessment might be seen in what triggered the speech: on the one hand, an approach by the social democrats to bring in the possibility of peace; and, on the other hand, rumors spread by the Allies that Germany was economically, and especially regarding the food situation, almost broken.

Bethmann-Hollweg set out to refute on the food crisis and rejected ideas about a peace.[68] But if bondholders reacted to this news, they were not convinced but rather pessimistic about the effect of the discord among German politicians and about the effect of the possible food problem on Germany's allies. Alternatively, the negative reaction might reflect the fact that the remains of the not yet defeated Serbian army fled over the Greek border into neutral territory and was, for now, out of reach as German Commander-in-Chief Falkenhayn had forbidden troops to follow. So, bondholders might, too, have acknowledged the fact that the operations in the Balkan theater up to 11 December had not been too successful, after all.[69]

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[65] Cf. Gleichen (2000: 101, part III).

[66] Cf. Stevenson (2012: 112–113).

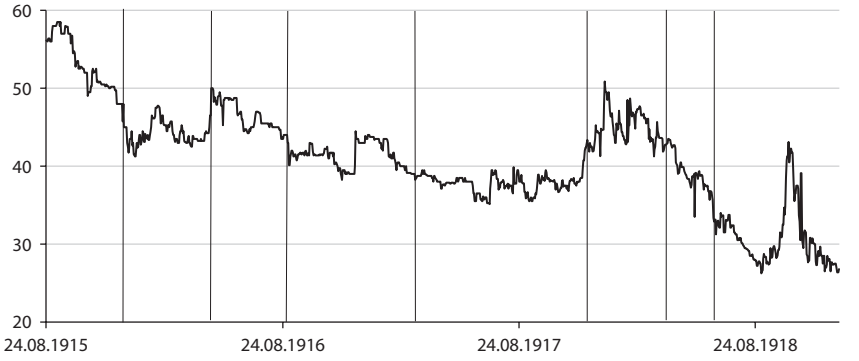
[67] Stevenson (2012: 30–31).

[68] On the food question – and more broadly: living standards – in Germany during World War One, cf. e. g. Burchardt (1974), Offer (1991), Allen (2003), Blum (2011, 2013, 2015), and Eloranta/Blum (2013).

[69] On Austria and Serbia, cf. e. g. Gumz (2013).

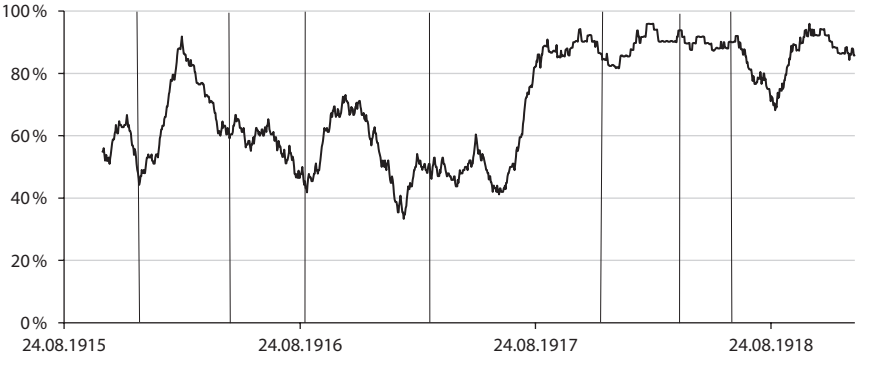
Figure 31: The breaks in the Austrian 4 % – price, yield, and liquidity compared

(a) Price in percent of par value; (b) Current yield; (c) Rolling lagged 60-day liquidity



(b) Current yield

(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

The next break date is 3 May 1916 and implies that bondholders adjusted their expectations upwards again, but only slightly. News the day before and in the morning of the third brought about favorable news from the fronts; on the one hand, from the Verdun theater and referring to ally Germany and, on the other hand, from the Middle Eastern theater referring to Austria's other big ally, the Ottoman Empire, as it had defeated British troops in the First Battle of Kut shortly before.

Bondholders adjusted their fundamental expectations a fourth time on 3 March. One may instantaneously think of news concerning the involvement of the United States which formally entered the war a month later, on 6 April. In fact, news on the day before addressed US-German relations in two ways. On the one hand, there were news on how the Allied Powers evaluated the naval blockade; their evaluation was, as one can imagine, optimistic.[70] On the other hand, and this is probably the issue weighing more heavily, it was reported on unrestricted submarine warfare which Germany had started again at the beginning of February as the answer to being subject to a blockade. By sinking every vessel regardless of its nature or origin, it was intended to balance the supply chains or, respectively, the problem coming with a disrupted supply chain.[71] This step especially shocked the neutrals and finally led to the US entering into the war. One piece of news on 2 December is particularly interesting in this regard. It was about the German plan to win Mexico that had a strained relation to the US as an ally. In case the US would not remain neutral, Mexico was supposed to attack the US and redirect their attention away from Germany. Mexico would be compensated with any conquered territories, weapons, and also financial help. As this was not enough pressure on Mexico, it was also supposed to help convince Japan to switch sides and to attack the US, too, in case. The envisaged arrangement with Mexico and Japan would not come true, but the US did enter into the war. Bondholders apparently observed that Germany strongly doubted the US to remain neutral, thus corrected their expectations downwards.

The fifth turning point dating 3 December of the same year – a reduction in perceived Austrian country risk of 1.7 percent – coincides with news headlines on another war loan approved in Germany and, what is more, on the start of peace negotiations between Germany and Russia at Brest-Litovsk. There is no doubt that the closing of the Eastern Front had taken pressure off Austria-Hungary, too, and would allow Germany to dispatch additional troops towards to the Southern Front.

[70] The winter 1916/1917, characterized by a severe famine, has gone down in historiography as the "turnip winter" (the German term is "Steckrübenwinter"); cf. Hardach (1987: 108–138) for evidence on food supply regarding all major belligerents as well as Hardach (1987: 118–119) specifically on the turnip winter 1916/17.

[71] Cf., for example, Klovland (2017) on the effect of submarine warfare on freight rates in shipping; and Luis-Lobo (2012: 57–80) on maritime insurance.

The second-to-last break date implying another downward adjustment of bondholders' expectations coincides well with news especially on the fact that Ferdinand Foch, as an answer to the spring offensive just being launched by Germany, became the first Commander-in-Chief of the combined Allied troops at the Western Front. In bondholders' eyes, this very likely implied a hitherto unprecedented level of coordination or, respectively, concerted action among the Allies.[72] It is noteworthy that this turning point ended a regime of extremely high liquidity. The Austrian 4 %, together with the Russian 4 %, was the most liquid issue among the representative bonds analyzed in this chapter, and generally belonged to the most liquid ones in both the pre-war and war period. Insofar, we should not interpret too much into the fluctuations in liquidity in the six regimes preceding 3 December 1917 (cf. Table 24, column [7]). However, the drastic increase in liquidity in 1918 is remarkable.

Finally, the turning point on 20 June 1918 is a likely reaction to discouraging news on the Battle of the Piave which investors apparently thought Austria was about to lose. The defeat was actually finalized only three days later, suggesting that investors rightfully attached importance to that battle.[73] Apart from the Battle of the Piave, negative news concerned Bulgaria struggling in the interior, as the ruling government that had led Bulgaria into the war resigned, implicating a further destabilization of the Central Powers' stand at the Southern Front.

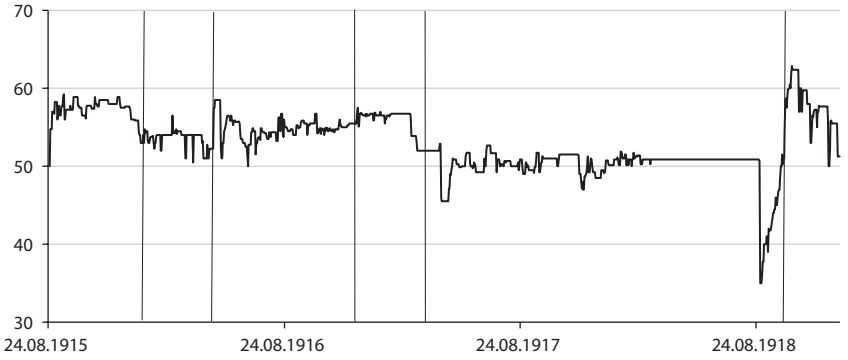
Five turning points are identified in the yield series on the first Baghdad bond, three in 1916, one in 1917, and one in 1918. The first one dates 11 March 1916, like the first turning point in the German series. Country risk modestly upgraded upwards which is a likely reaction to the coming of conscription in Britain, the major opponent of the Ottoman Empire in the Middle Eastern theater. News on "British successes in Mesopotamia" can also be found on 10 January. But considering the general situation in the Middle Eastern theater – the defeat of the British in the First Battle of Kut in December 1915 (cf. above) and their retreat from Gallipoli few days earlier (also a major headline), I doubt that one piece of negative battle news can explain the turning point.

The second turning point in 1916 likely reflects bondholders' view on two matters related to the Ottoman Empire's ally, Germany: Firstly, on how Germany was faring in the Verdun theater; according to bondholders, it did well, apparently. Secondly, it may relate to a détente in US-German-relations, as Germany stopped the first round of unrestricted submarine warfare after having received an ultimatum by US President Wilson, following the torpedoing of the US merchant vessel "Sussex" by a German submarine. Bondholders apparently appreciated the pacifying tone of Germany's reply to US critique regarding the conduct of submarine warfare. This second turning point in combination

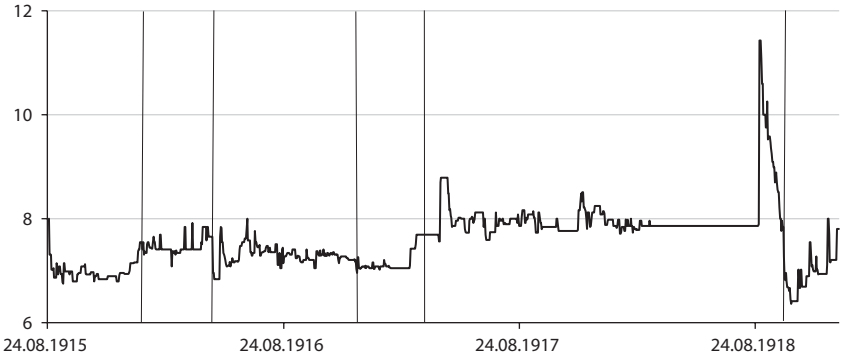
[72] Cf., for example, Philpott (1995) on English-French relations on the Western Front.
[73] Cf. Gleichen (2000: 68, part III).

Figure 32: The breaks in the Ottoman 4 % – price, yield, and liquidity compared

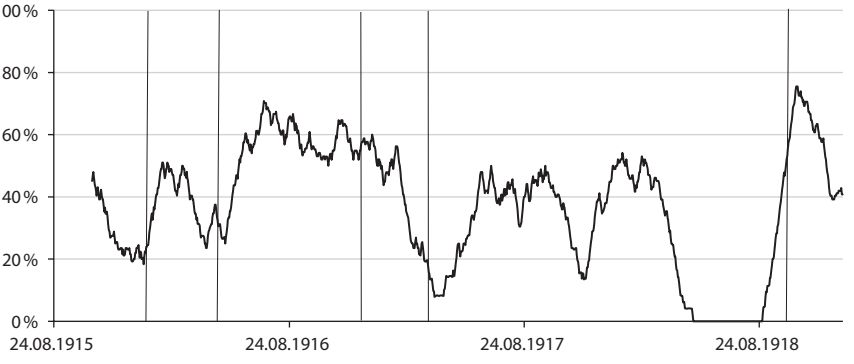
(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

with 12 December almost compensates for the initial increase in country risk in January. The third turning point is a likely reaction on the Central Powers' advances on Romania with, for example, the taking of its capital, Bucharest.

The one break date in 1917 dates 17 March, and the associated sudden – and lasting – increase in yield of around 0.9 coincides well with news on the revolution in Russia that was the major theme right at the time in the *Algemeen Handelsblad* (besides the US-German relations, of course), and specifically to news saying that Russia would maintain its war efforts instead of, as investors might have expected in concert with others, being held from fighting by inner turmoil. Besides, if we follow Edward Gleichen's (2000) timeline, Russia achieved battle successes in Mesopotamia, and the "general mobilization of Turks [was] ordered" on 16 March. This news may, too, be responsible for the negative reaction.[74]

The final break date in the Ottoman series dates 7 October 1918 and signals a *declining* country risk in investors' eyes which is, of course, interesting for the fact that similar turning points in the series on the Ottoman Empire's allies implied the opposite, an increase in perceived country risk. Dominant news on the preceding two days, firstly, concerned Prince Max von Baden assuming chancellorship and making an armistice offer to the Allies; and, secondly, the Ottoman-German-Austrian relations. News on 5 October, in particular, reported of tensions having arisen between the Ottoman Empire and Germany. Investors seem to have taken the news positively, possibly because there was negotiated peace in the air for an instance of time (instead of forced peace after complete defeat). Basically, the way the Ottoman 4 % behaved after early September suggests that investors assessed the fate of the Ottoman Empire quite positively and as not being interwoven too much with the fate of Germany and Austria-Hungary. The turning point's "odd" sign might actually be linked with the nature of the bond used. It might have been that investors were confident about the Ottoman debt at that point in time being taken over by a good creditor. This might have been especially true with regard to the 4 % loan that I studied because it was linked with the strategically important Baghdad railway.[75]

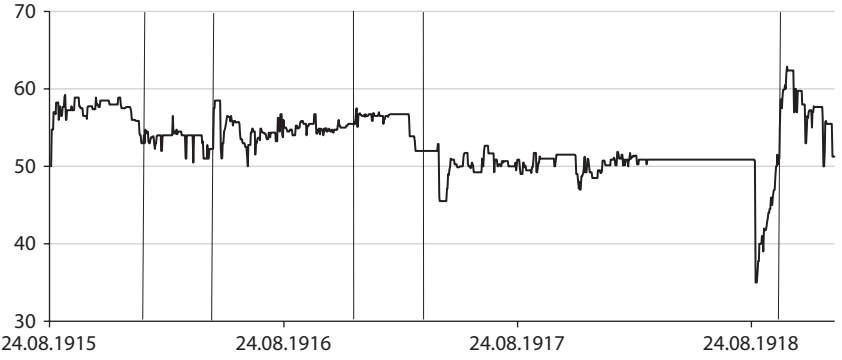
Turning to the Allies, I start with looking into turning points in the English 5 %. Overall, I detected seven breaks which, compared to the Central Powers' series, generally imply less severe adjustments. The first break occurred on 4 September 1916 and coincides with news on Romania's entry into the war; this break, however, is very small. Further three breaks were detected for 1917. The first of these dates 1 February 1917 – a shift of English country risk upwards

[74] Cf. Gleichen (2000: 187, part III).

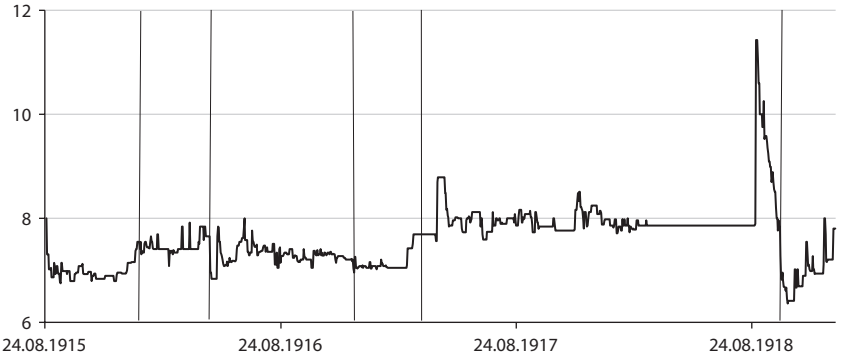
[75] Cf. Moore/Kaluzny (2005) for more information on that possibility. Al (2012) investigates possible guarantee effects in Ottoman bonds for the nineteenth century; and Besirli (1999) and Birdal (2010) look into the Great Powers' financial control exercised over the Ottoman Empire between 1910 and 1914. Extending the view of financial supervision, one may also have a look at Tooze/Ivanov (2011) who focus on Bulgaria between 1902 and 1938.

Figure 33: The breaks in the English 5 % – price, yield, and liquidity compared

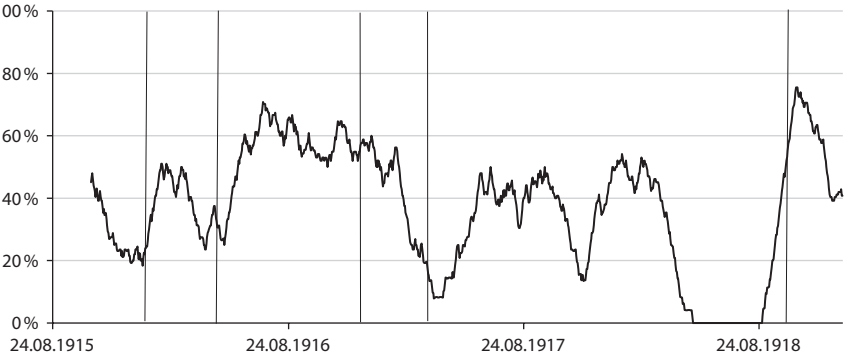
(a) Price in percent of par value; (b) Current yield; (c) Rolling lagged 60-day liquidity



(b) Current yield



(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

by 0.4. The break perfectly coincides with news on Germany having declared the second round of unrestricted submarine warfare most recently. This was certainly an issue of exceptional importance for the naval power England.[76] The following breaks in 1917 were, again, rather small. The drop on 12 May 1917 may be explained by news on the interior state of Germany and especially the nutritional situation; recall the fourth break in the Austrian 4 %. One major headline reads "The food question in Germany" and was apparently taken by investors as an indication that the naval blockade bore fruit.[77] The break dating 15 November 1917 is best explained as a reaction to news on the situation in Russia stating that the Bolsheviks won over Kerensky, the provisional government's leader. Even if not concerning England directly, this had implications for the interior stability of an ally and, thus, the Triple Entente. Furthermore, the mean shift of +0.1 on 23 January 1918 coincides with news on Lord Carson's resignation from the war cabinet (on the Ireland question) potentially signaling, in investors' eyes, internal friction, and also with news on the separate peace between the Central Powers and the Ukraine, foreshadowing the peace with ally Russia.[78]

The last two breaks in 1918 are the biggest ones among the breaks detected in the English 5 %. The break on 16 May coincides with prior news on the peace with Romania and may thus be seen as a delayed reaction to the fact that Romania had factually exited the war at the end of 1917. The break is all the more plausible as investors had already seen Romania entering in on the Allied Powers' side as an important factor in English country risk. The last break occurring on 1 October is a reaction to news on Allied forces breaching the Hindenburg line, the major and final blow to the Central Powers' stand on the Western Front. Additional news on Austria-Hungary's peace offer shortly before matches the picture. From the perspective of the English 5 %, the Central Powers' defeat had become fait accompli by then, roughly two weeks later than implied by the German 3 % (recall the discussion above).

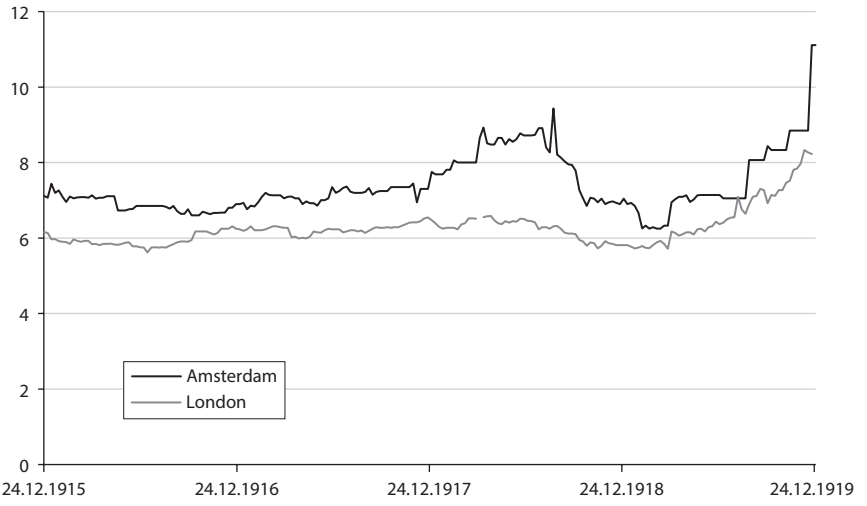
My procedure also detected seven break dates in the French 5 %. It suggests itself to compare the breaks in the French 5 % as traded in Amsterdam with the breaks of the French 5 % as traded in London which David S. Adams (2015) analyzed. Figure 34 plots both series to convey an impression of the comparative time pattern of both series. While Adams analyzed the French 5 % at daily frequency, I collected prices on it at weekly frequency (Friday prices); I adjusted the Amsterdam series accordingly. Observing both series at weekly frequency

[76] The British government had decided to extend conscription to Ireland shortly before. Lord Carson, Irish Unionist and a prominent member of the war cabinet, was in opposition to this step and resigned thereupon.

[77] Present in the news also was the Stockholm Socialist Conference.

[78] News on peace with Ukraine can be found, too. On Germany and the Ukraine, cf. e.g Dornik/Lieb (2013).

Figure 34: The French 5 % compared – Amsterdam versus London



Sources: Author's own depiction.
Notes: Depicted is the current yield at weekly frequency.

is sufficient enough to see the main difference. While the long-term patterns are broadly similar, the Amsterdam series' pattern is much more pronounced, though, meaning that it exhibits much more variation. This observation is especially interesting, as Figures 27 and 28 in conjunction have shown that the English and French war loans' unofficial prices themselves show much lower variation – or, formally: variance – than the official price series. On the one hand, the obvious difference between the London and Amsterdam trade in the French 5 % might be due to genuine differences in how investors in London and those in Amsterdam assessed French country risk. On the other hand, it might also be due to biases introduced into price formation through the wartime regulations.

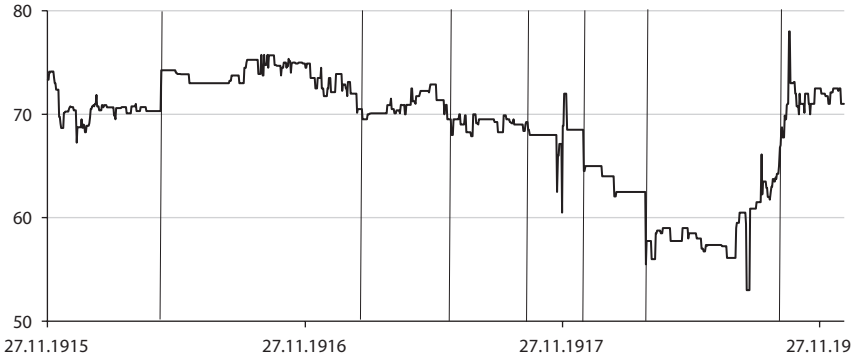
Let us turn to the breaks detected in the Amsterdam series. The first break on 6 May 1916, a drop in country risk, may especially be understood as investors' appreciation of France's efforts during the Battle of Verdun as likely as of Germany's step to end the first round of submarine warfare; the same break actually did occur in the Ottoman 4 %.[79]

Moreover, roughly matching with the second break in the English 5 %, the break on 8 February 1917 is investors' likely reaction to Germany resuming unrestricted submarine warfare again and, possibly, also to news stating that many neutral countries were reluctant to side with the Allies when asked (e. g., the Netherlands). Here, my finding differs from David S. Adams's (2015) who

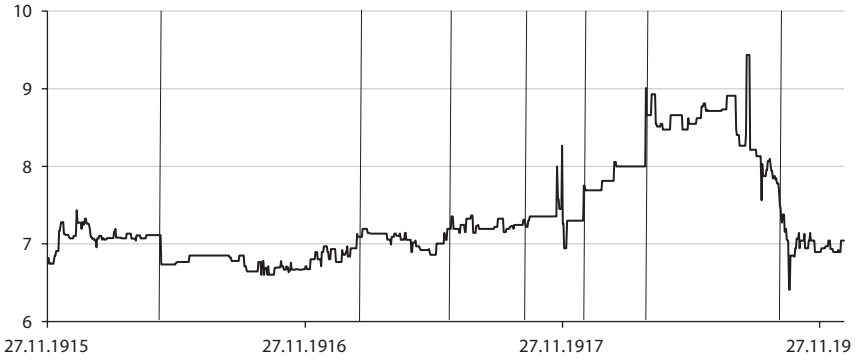
[79] Adams (2015) finds such a positive reaction, too, but linked with 20 March 1916.

Figure 35: The breaks in the French 5 % – price, yield, and liquidity compared

(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity

Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

found no break linked with news on submarine warfare, but instead found a break linked with the Battle of Jutland; a break present in the German 3 %, in turn. Adams concludes that British investors at the time trading in the French 5 % National Defense Loan were, if any, concerned with surface naval warfare while historians emphasize the submarine warfare to have been more important in retrospect.[80] The real-time Dutch – that is, *neutral* – view apparently lends support to historians' ex post judgment.

The third break on 16 June 1917 is harder to explain. The situation in Greece, with the king abdicating and a new war-prone government about to be installed under Venizelos fighting alongside the Allies, is a possible candidate. But this ought to have qualified as rather positive news, so that I am lacking a convincing explanation for this break. It might be that investors reacted negatively, especially to news stating that French troops had just landed in Thessaloniki as part of Allied support for Venizelos and to strengthen the Macedonian Front. Investors' reaction could be interpreted as saying that deploying French troops to another front overstretched French capacities.

The fourth break (+0.1) on 9 October 1917 matches unfavorable battle news concerning the Western Front, the revolution in Russia, and Germany willing to draft foreigners. The following turning point, 27 December, more clearly matches news on the defeat of Russia and also Romania, thus the closing of the Eastern Front and the likely reallocation of resources towards the west. A further increase in country risk of the same magnitude – an increase in yield of 0.6 – occurred on 25 March 1918 and signals investors' reaction to the spring offensive having just been unleashed by Germany.

Finally, the last break – the biggest break in the French series as it is a drop in yield of 1.8 – occurred on 1 October 1918 and exactly matches the last break in the English series and more or less the last break in the German series. The break more than compensated for the increase in country risk due to the preceding five breaks between early February 1917 and late March 1918. The break can, of course, be understood as investors' reaction to the successful Allied counter-strike(s) on all fronts since summer that brought war to a head, and especially to the breach of the Hindenburg line, the last German line of defense. This last break is also well in line with the last break found by David S. Adams (2015).[81]

I performed a robustness check on the English and French war loans since these were, as discussed, short-term bonds, and so it might matter for the results if we screen the current yield or the yield-to-maturity for breaks (cf. Figure 29). Table 26 reports the turning points detected in the YTM series assuming the English bond matured after five years and the French bond after ten years. As can be gathered from the table, the two sets of breaks are equal regarding the break

[80] Cf. Adams (2015: 13–15).
[81] Cf. Adams (2015: 8).

Table 26: Breaks in the English and French yield-to-maturity series

English 5 % war loan		French 5 % war loan	
Turning point (dd/mm/yyyy)	Absolute change in estimated mean yield	Turning point (dd/mm/yyyy)	Absolute change in estimated mean yield
04/09/1917	–0.3 %	06/05/1916	–0.4 %
01/02/1917	+2.1 %	08/02/1917	+0.8 %
12/05/1917	–0.6 %	16/06/1917	+0.6 %
15/11/1917	+0.7 %	09/10/1917	+0.4 %
23/01/1918	+0.8 %	27/12/1917	+1.3 %
16/05/1918	+4.6 %	25/03/1918	+1.7 %
01/10/1918	–4.6 %	01/10/1918	–3.2 %

Sources: Author's own computations.
Notes: English (French) bond assumed to mature five (ten) years from first observation. Deviations from findings for the current yield series would be in italics.

dates. However, the breaks in the YTM – whether negative or positive – are a little bit larger. This comes expected, as the YTM is larger than the current yield for short remaining durations.[82]

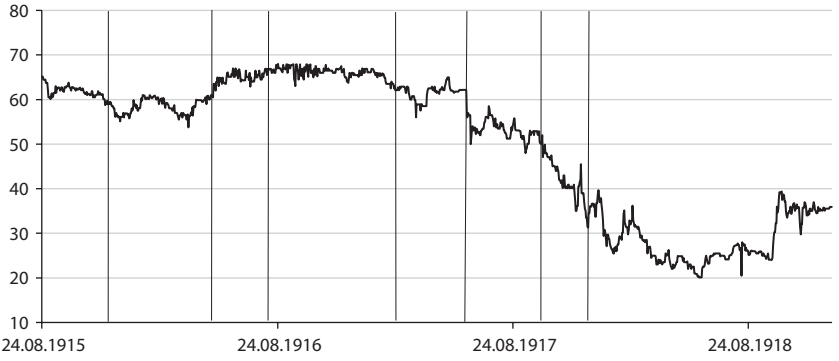
Let us have a look at Russia, the third major Allied Power. Up to the point when Russia ceased to be a war party, at the turn of 1917/1918, seven turning points occur in the series. It is worth noting that the 1917 breaks deviate in timing from those that Kim Oosterlinck and John S. Landon-Lane (2006) and Kim Oosterlinck (2016) detected in the Russian 5 % bond of 1906 as traded in Paris.[83] The initial break date of 27 November 1915 can be matched with negative news on the Balkan theater where the Serbian army was being pushed farther south by the Central Powers. In particular, *De Tijd* made mention of some 10 000 Serbian soldiers taken POW on one day. So, besides the event's relevancy for Russia as the protective power in the Balkan, this turning point lends some support to Niall Ferguson's considerations that it was especially news on the *body count* severely impacting public opinion in one direction or another.[84]

For almost all of the nine other series screened, I find a turning point in May or June 1916, and so I do for the series on the Russian 4 %, too. This second turning point falls on 16 May 1916, and the implied decline in country risk is best linked to rumors on the British war aims declaration or, respectively, the related Sykes-Picot Agreement with France. This agreement put forward a plan for dividing the territories of the Ottoman Empire between England and France after its defeat – with prospective territorial gains for Russia, too. Investors

[82] The difference to Jopp (2016) is, again, explainable by the fact that the estimation settings regarding the variance of the error term have been adjusted.
[83] Cf. Oosterlinck/Landon-Lane (2006: 528) and Osterlinck (2016: 167).
[84] Cf. the discussion in Subchapter III.2, and also Ferguson (1998: 282–317, 2004) and Dollery/Parsons (2007).

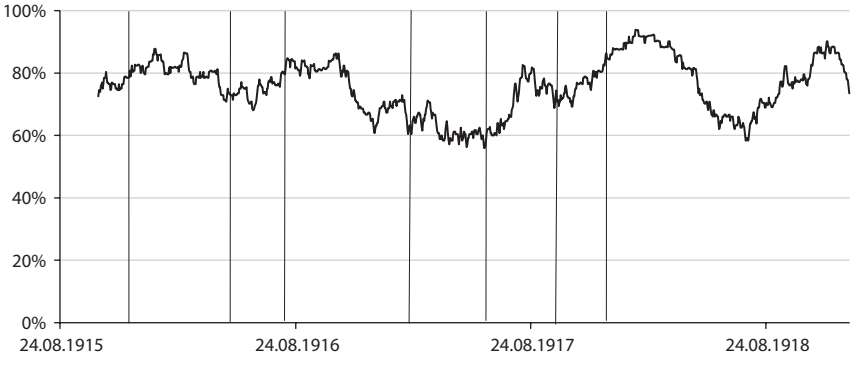
Figure 36: The breaks in the Russian 4 % – price, yield, and liquidity compared

(a) Price in percent of par value



(b) Current yield

(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

apparently expected the Russian Empire's financial situation to improve thereupon.[85] The third turning point on 3 August 1916 coincides with positive news from both main fronts, but especially the Eastern Front.[86]

The remaining four breaks in 1917 are predominantly linked with the revolutionary turmoil in Russia and show investors' deep concerns about how a change in government would impact Russia's ability-to-pay, and even more so the willingness-to-pay, its debts. The reaction on 13 June specifically matches news on "combat fatigue" of the Russian people and, besides, might also capture Woodrow Wilson promoting the idea of a post-war order based on sovereign nations – a potential threat to the stability of the multi-ethnic Russian Empire and its territorial ambitions.

The breaks on 25 September and 13 December were preceded especially by reports on Alexey Kaledin and a (possible) further uprising of the Don-Cossacks.[87] Only the fourth break on 8 February 1917 does not match the "interior turmoil" pattern but coincides well with recent news on Germany resuming unrestricted submarine warfare, a tactical move putting Russia's allies – and especially England – under pressure.

5.4. Explaining turning points in the minor powers' series

My procedure detects five turning points in the yield of the Bulgarian 5 %. The first occurs on 29 December 1915 and implies an upward shift in Bulgarian country risk of 1.4 percent in yield or, put differently, an increase by no less than a fifth. Looking at the reaction in observed yields, the increase was, with two-fifth, even larger. The break's timing and sign match well with how the Central Powers had been faring with their Balkan campaign since 30 November, the day of the last price quote available for the Bulgarian bond series in question. After all, the Serbian army had not been defeated, but its remnants managed to flee into Greek territory covered, among others, by Montenegrin troops. This prolonged the fighting in the Balkan theater and finally led to the opening of the

[85] Cf. on the Western Front Neiberg (2008).

[86] Cf. on the Eastern Front Neiberg/Jordan (2008).

[87] If the 4 % Hope & Co was a railway bond – that is, a bond issued to finance the extension of the Russian railway network, a purpose of many Russian bonds at the time – the difference to Oosterlinck and Landon-Lane's findings can be conveniently explained by investors viewing those bonds differently due to the fact that they were not equipped with a state guarantee on interest payment. There is actually no explicit indication in the *Gids bij de Prijs-Courant* that this bond was a railway bond, though. But, as Hope & Co was a Dutch banking house located in Amsterdam that is known to have specialized in bringing railway securities to the market, it is likely that the bond was a railway bond, indeed. Besides, referring back to the discussion on the nature of investors in Subchapter II.4, it is very likely that this bond was traded by domestic investors entirely, as a Dutch bank had underwritten it. So, in the end, the difference might simply reflect the particular view of Dutch traders. On the history of Russian bonds in general, cf. Freymond (1995).

Macedonian Front. Investors obviously acknowledged that Bulgaria had not yet reached a vital war aim after entering the war in mid-October 1915, namely a quick defeat of Serbia.[88]

There are further two turning points detected in 1916 – the one on 25 May and the other on 5 October. The former break best matches recent news on the Verdun theater and thus on Bulgaria's main ally, the German Empire. As the mean yield dropped, investors perceived Germany to incur successes there, obviously. The latter break on 5 October matches news about the Allied Powers having gained ground in the Southern theater and also about events in still neutral Greece – that is, the instalment of the Provisional Government under Venizelos on 30 September. Bondholders perceived the probability of Greece entering the war on the Allied Powers' side to rise. This would have opened a new front and put especially Bulgaria under more pressure.

Finally, two turning points in investor opinion occurred in 1918, after a long stretch of time with no reaction. The first one dates 25 July and implies a notable rise in perceived country risk of 3.0 percent (which equals a growth rate of roughly forty percent in estimated mean yield). Major news concerned the Western Front where the Allies were engaged in pushing German troops back to the Hindenburg line, and beyond, from where they had started the spring offensive (Second Battle of the Marne).[89] The timing and severity of the last turning point coincides with similar breaks in the other series. However, its sign is negative, like in the case of the Ottoman bond. It dates 18 October and is preceded specifically by news on US President Wilson's second peace note to the Central Powers and by news on the dissolution of the Habsburg Empire.

So, for one, investors might have appreciated the second peace note, as it included a passage saying that Austria-Hungary is not to be dealt with in the same merciless way as Germany is supposed to be dealt with.[90] If Austria-Hungary could expect mercy, Bulgaria would likely, too. But it may also have been the news on the dissolution of the Habsburg Empire that turned investors optimistic, as this would fundamentally change the balance-of-power in the Balkan and probably improve Bulgaria's prospect for gaining territory or, at least, its standing. Note that only few days earlier, Hungary had denounced the real union with Austria. Consequently, news headlines concerned Austria "becoming a federal state".[91]

[88] Seeing beyond the state of the Balkan campaign as of end of December, Bulgaria's efforts certainly helped to control the Balkan front and provide the Central Powers with a continuous geographical connection reaching from the German Empire's to the Ottoman Empire's territory.

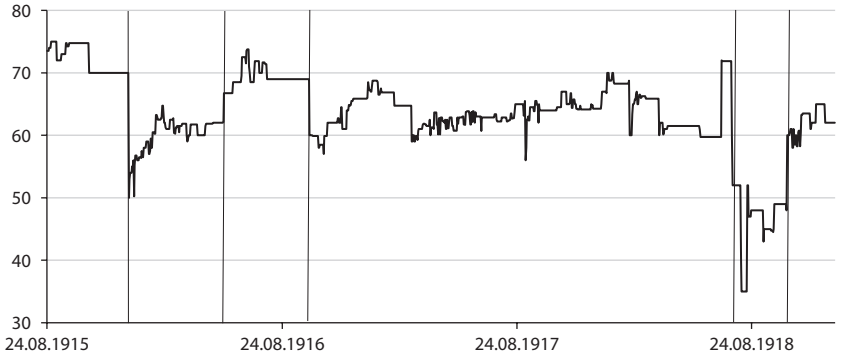
[89] Cf. Hall (2004) on the morale of the Bulgarian army in summer 1918.

[90] Cf. Umbreit (1918: 6).

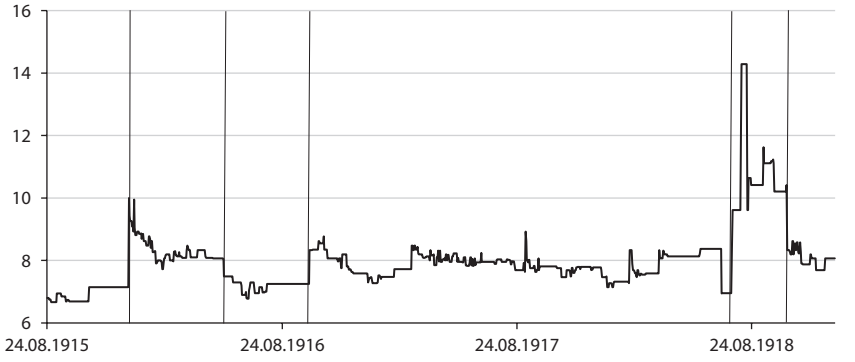
[91] Cf., basically, Rauchensteiner (2014).

Figure 37: The breaks in the Bulgarian 5 % – price, yield, and liquidity compared

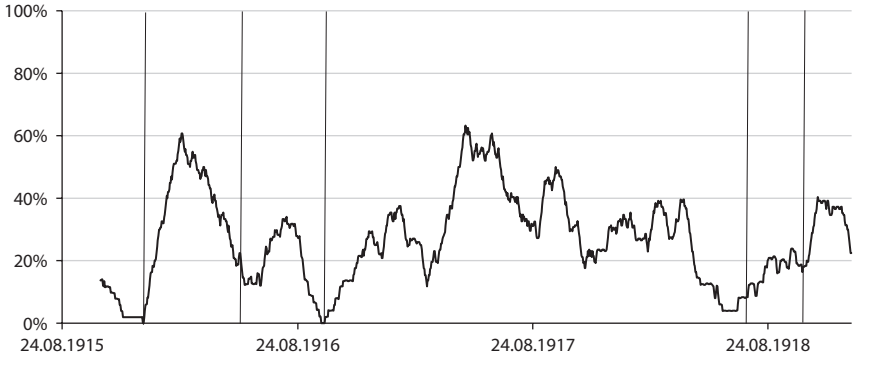
(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

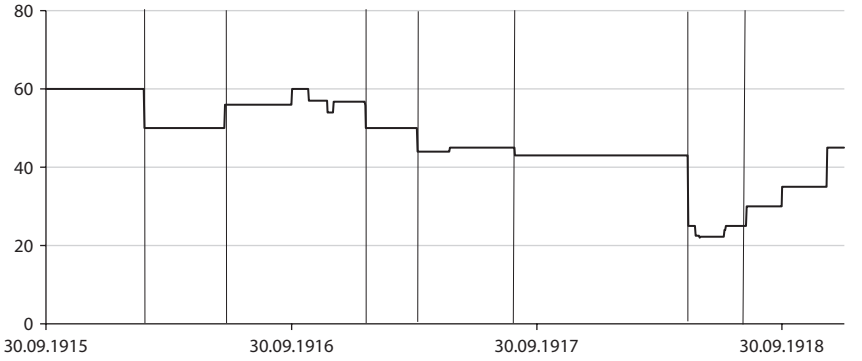
Turning to Italy, my procedure detected seven structural breaks in the yield of the Italian 3.5 % which is the series with the second-lowest liquidity; only the Romanian 4 % was even less liquid. The first break – a pronounced increase in Italian country risk – dates 23 February 1916 and can be related to news on the Southern Front where the Central Powers, after they had taken Serbia and the Kingdom of Montenegro in the meantime, were just entering Albania to push back Italian troops, having been sent there end of January to make a stand. The Italian troops had to retreat back into home territory which bondholders apparently perceived to be a military fiasco. The subsequent turning point on 22 June of the same year is one of only two downward breaks. Looking at the newspapers, we find positive news on Russia's advance on the Eastern Front reported. These advances as part of the Brusilov offensive were launched on 4 June. Alternatively, we may also consider the outcome of the Paris economic conference led by the US as causing the break, because the Allied Powers agreed on isolating the Central Powers after the war by severe trade restrictions. Bondholders could well have thought that this agenda would enhance Italy's position in European and World trade in the long term.

Three more breaks occurred in 1917. The first dates 18 January and nicely matches a preceding headline on rumors that the Central Powers might be attempting to push troops through Switzerland. This would have meant a broadening of the Italian front which bondholders acknowledged with a pessimistic reaction (yield increase of 0.8). The second break dates 5 April and might be interpreted as a reaction to the Russian Revolution. The increase in yield, then, implies that bondholders were rather skeptical about Russia's ability, or willingness, to continue battling Germany on the Eastern Front which, in the longer term, would allow the Central Powers to divert resources to other war theaters and thus would likely increase pressure on the Southern Front. The third 1917 break dates 28 August and may be investors' skeptical reaction on the already mentioned Stockholm Conference of Anti-War Socialists; at least, a major headline on the conference occurred in the *Algemeen Handelsblad* on the day preceding the break, which can explain the timing.

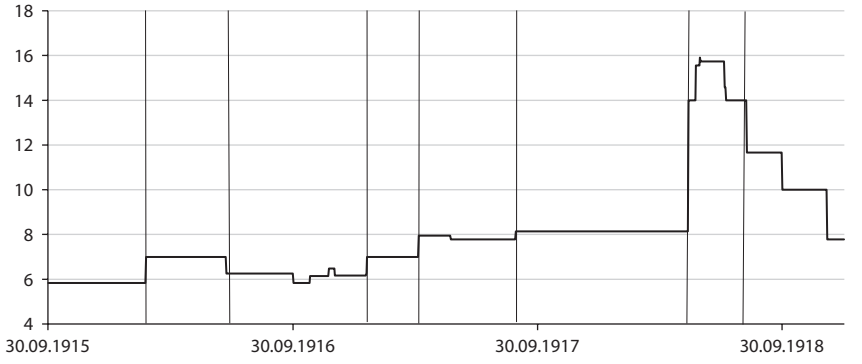
The final two turning points occurred in 1918 and fall on 13 May and, respectively, 8 August. The former constitutes the largest shock in the Italian series and, by far, the largest of all shocks identified for the sample of bonds analyzed in this chapter. This is because the estimated mean yield increased by no less than three quarters. Yet, it is evident from Table 24, column six, that the risk increase has to be understood as a net reaction to the course of the war over nothing less than the previous nine months. So, in this case, in particular, it is hard to come up with the one plausible explanation. Basically, bondholders might have downgraded their expectations so fundamentally because of two major allies – Russia and Romania – having been defeated during that stretch of time. This set the stage for a re-allocation of German troops and other resources to the remaining

Figure 38: The breaks in the Italian 3.5 % – price, yield, and liquidity compared

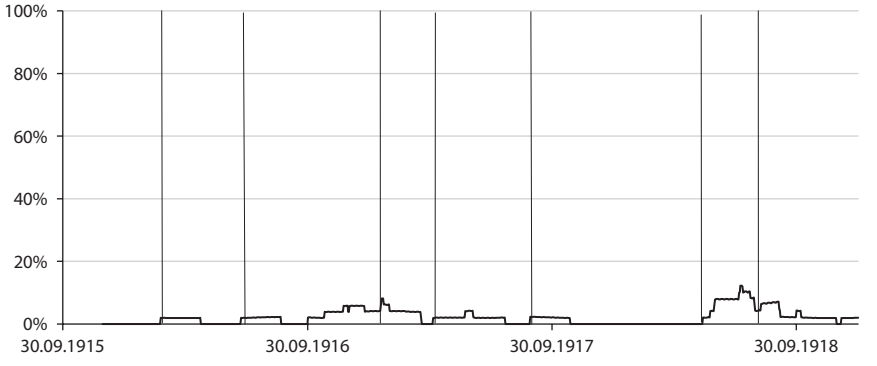
(a) Price in percent of par value



(b) Current yield



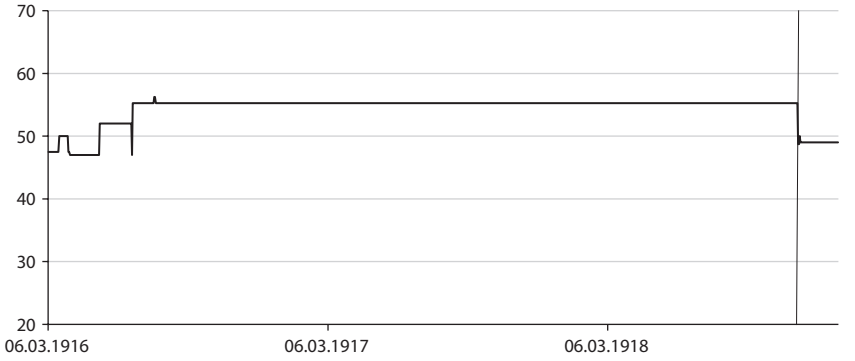
(c) Rolling lagged 60-day liquidity



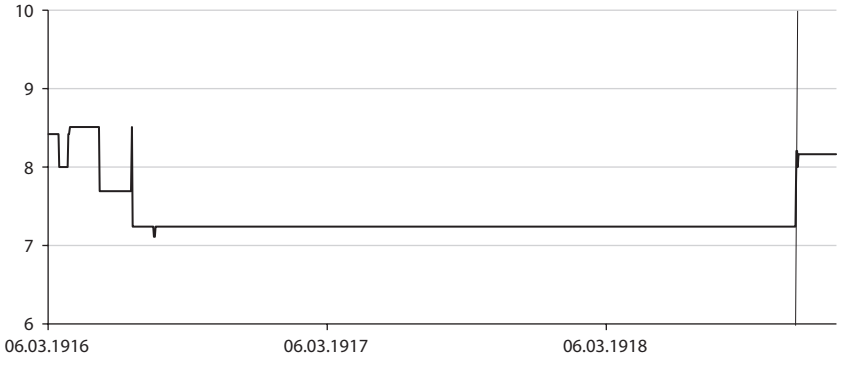
Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

Figure 39: The breaks in the Romanian 4 % – price, yield, and liquidity compared

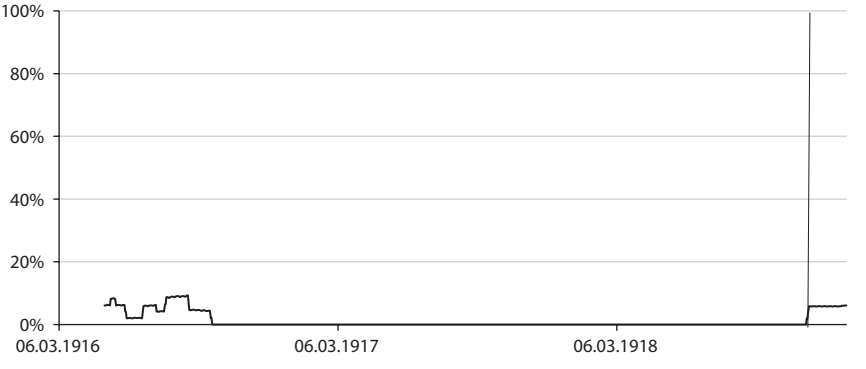
(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity



Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

war theaters including the Southern Front. Insofar, this break matches with the concern about the Russian Revolution expressed in the fourth break. The last break on 8 August matches the launching of the Allied Hundred Days Offensive starting with the Battle of Amiens. Apparently, as in other cases, bondholders appreciated that a belligerent took the initiative and was on the offensive, rather than being on the defensive.

I could only identify one turning point in the Romanian yield series which is due to its extremely low liquidity; the last official price quote before the one on 9 November dates back more than two years. Thus, it is reasonable to view the turning point as a cumulated reaction on many events having taken places since. However, we can ask which recent events caused investors to actually trade in the bond again. I suppose it was, first and foremost, a delayed reaction to Romania's defeat around the turn of 1917/1918 in combination with a reaction to the proclamation of independence of the Czech Republic and, what is more, of the direct neighbor Yugoslavia, which fall into the two weeks preceding the turning point. Bondholders possibly saw the threat of border disputes which would have been a conflict about economic resources in the broadest sense, eventually.

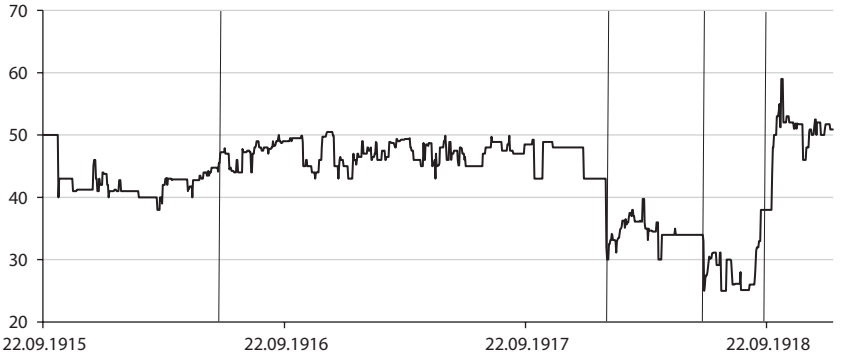
To end the discussion of detected turning points, I turn to making plausible the breaks in the Serbian 4 %. Four turning points are detected in the series of which three fall into 1918. Looking at both the price and yield series depicted in Figure 40, it is worth mentioning that the first big drop (increase) in price (yield) occurs on 15 October, the day after Bulgaria had declared war on Serbia. This is a risk increase well comparable in severity with the first two breaks in 1918. However, this break is not detected by my procedure, as 15 October falls into the range of observations used to trim the structural break regressions.

The first turning point dates 3 June 1916 and is preceded by battle news on the Verdun theater and the Southern Front. The turning point implies a bettering of country risk which does, however, not match the news on the Western Front, as they concerned the German advance on Fort Vaux which should have been rather negative news on Serbia's ally, France (cf. above). Alternatively, the turning point may be viewed as an appreciation of the British efforts in the Battle of Jutland on 1 June. However, the Battle did not make it into major headlines, rendering it a rather weak explanation. Another alternative would be to see the decline in risk as an appreciation of the Russian efforts yet to come on 4 June – efforts to become known as the Brusilov offensive directed against the Austro-Hungarian standing on the Southern Front. But like with the Battle of Jutland, we lack major rumors in the news of 2 June.

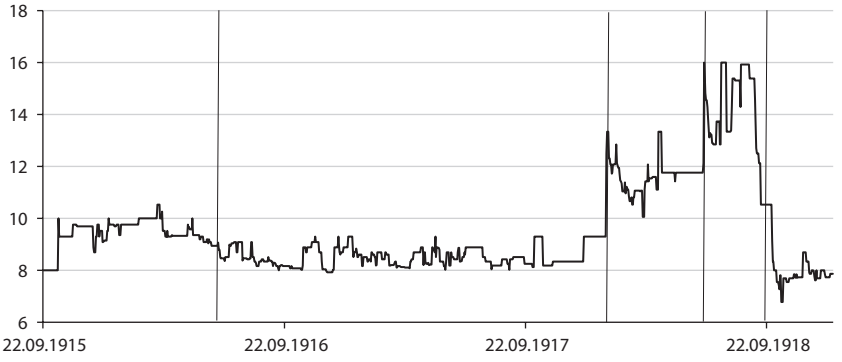
The 1918 breaks date 22 January, 19 June, and 13 September, and each imply each a remarkably huge break. The sudden risk increase by 3.1 percent in January coincides with news on the peace negotiations between Germany and Russia at Brest-Litovsk. On the day preceding the turning point, the Central

Figure 40: The breaks in the Serbian 4 % – price, yield, and liquidity compared

(a) Price in percent of par value



(b) Current yield



(c) Rolling lagged 60-day liquidity

Sources: Cf. Chapter II. *Notes:* Depicted are the interpolated price and current yield series; and for rolling liquidity, cf. the text.

Powers had sealed the separate peace with the Ukraine.[92] This turning point is most plausibly viewed as an overall pessimistic reaction to the bringing-down of Russia, putting the remaining allies under enormous pressure. Moreover, it seems plausible to link the turning point in June – a risk increase almost as severe as the previous one in January – with bad news from the Southern Front, occurring right on the previous day, on the Second Battle of the Piave induced by a heavy Austrian offensive.

The last turning point in mid-September more than compensates for the rise in risk over the previous nine months. It perfectly matches news on the final surrender of Bulgaria as well as on Serbian troops pushing backing into Serbian territory.

6. Checking for the turning points' robustness

6.1. Including economic variables

This subsection is dedicated to the second step of my approach, namely, to testing whether the break dates determined previously are robust against the inclusion of certain economic variables which potentially explain (part of) the variation in sovereign yields. I seek to estimate a statistical model of the form

$$y_t = X'_t * \beta + D'_{tj} * \gamma + u_t \qquad \text{(Equation 4)}$$

for the market as well as separately for all ten bond series that have hitherto been analyzed. X' denotes the vector of explanatory variables, and D' the vector of structural break dummies taking on the value one for the particular regime and all days after, and zero prior to the regime; the dummies are created according to the break date information reported in Table 24. Note that, technically, the regressions for the market are time series cross-section regressions as the time, or longitudinal, dimension of the dataset is much larger than the cross-sectional dimension. Regarding all time series regressions to be estimated, potential heteroscedasticity and autocorrelation are issues we have to deal with. As is standard, I implement Newey-West standard errors which correct for both potential problems.[93]

As the cursory overview in Subchapter I.4 has shown, it is *not* usual in the (methodologically) relevant historical literature to perform such a robustness test. The main reason might be seen in the fact that the researcher needs to gather variables that have the same frequency as the analyzed bond price or yield series. Especially when using daily data, which to use for this kind of analysis is highly justified, the array of theoretically relevant variables that also have that

[92] Cf. Gleichen (2000: 10, part III).

[93] Autocorrelation up to lag 14 is considered.

Figure 41: Daily market liquidity as a centered 31-day moving average

Sources: Cf. Chapter II.

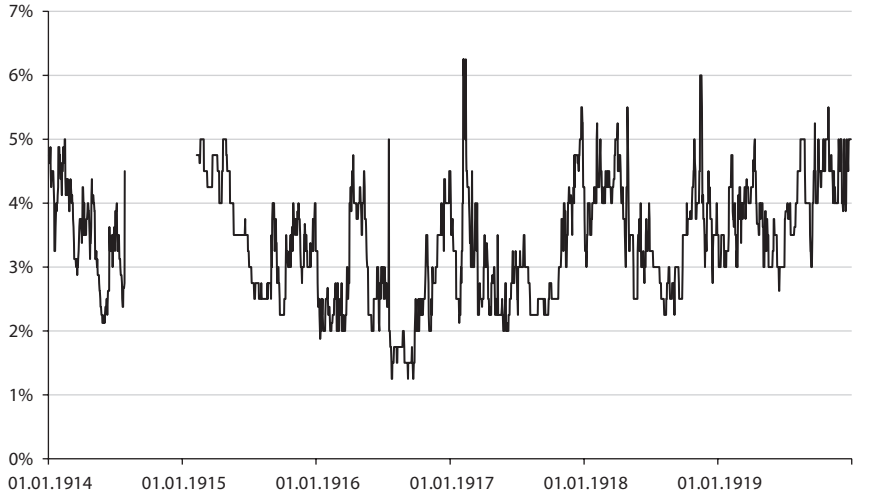
high frequency is extremely limited. In all, I have been able to gather data on seven variables which I will take into account with their first lags.

My first variable is daily market liquidity as one potentially major factor explaining a security's market value. Figure 41 depicts the derived time series on government bond market liquidity for Amsterdam as a centered 31-day moving average. For each trading day, market liquidity is measured as the sum of non-zero returns over all traded bonds divided by the number of potentially tradable bonds (i. e., those officially admitted to the stock exchange).[94] Between August 1915, when trade in the majority of bonds was reinstalled, and late 1917, market liquidity fluctuated around a level of approximately 12.5 percent, which was close to the average for the immediate pre-war period (cf. also Subchapter II.3). Liquidity peaks occurred around the turn of 1917/1918 – coinciding with the defeat of Russia and the peace negotiations at Brest-Litovsk – and the Armistice of Compiègne in November 1918. After the war, market liquidity trended towards its pre-1918 level.

A further variable I consider is the *prolongatie koers*, the most important short-term interest rate at the time. The *prolongatie koers* was the interest to be paid by a borrower on a one-month loan intermediated via the Amsterdam Stock Exchange. The borrower had to bring in securities as collateral, and the loan was prolonged automatically for another month provided that neither

[94] Recall that returns were computed from the interpolated price series; cf. the notes on yields and the logic of the non-zero returns measure of liquidity above.

Figure 42: The daily nominal interest rate on one-month loans (*prolongatie koers*)



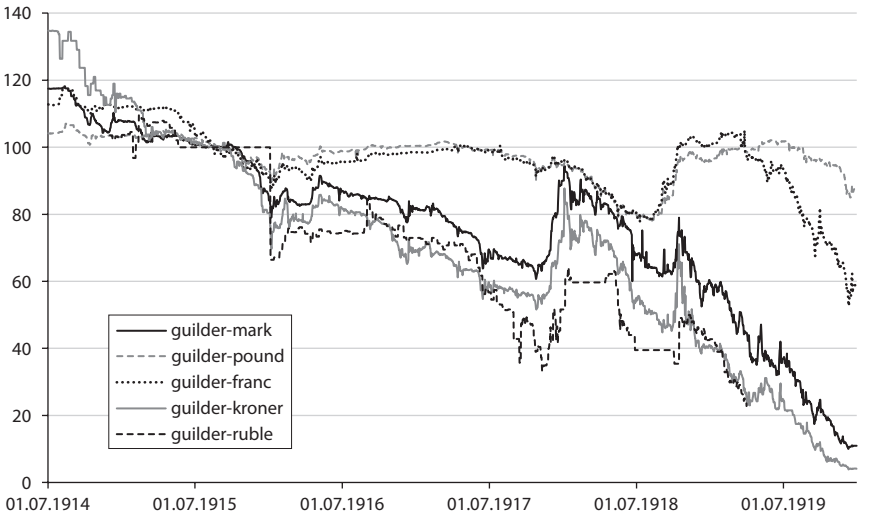
Sources: Cf. Chapter II.

borrower nor lender had demanded to end the contract.[95] Figure 42 plots the available daily rates from January 1914 to December 1919. It is pretty obvious that the series exhibits much variation. Except for a few days, the interest rate generally fluctuated between two and five percent and was seldom stable over more than a week. Inclusion of the *prolongatie koers* serves the purpose here to proxy for changes in investors' discount rates (i. e., time preference; cf. Subchapter I.3).

Since all payments linked with the bonds in my sample are denominated in foreign, and therefore not Dutch, currency, and since all countries abandoned the international gold standard back then, the respective nominal exchange rates to the guilder should matter, too, as a third explanatory variable. This should hold, at least, as long as interest was still paid by the borrowing country. Since Germany, for example, kept paying interest to its (non-Allied) lenders in marks, it is reasonable to expect that the guilder-mark exchange rate turns out to be statistically significant in explaining part of the German 3 %'s course over time. It should have mattered for Dutch bondholders how strong or weak their own currency was against German currency. Provided that Dutch bondholders, or those from other countries, were inclined to hold Dutch guilders rather than German marks, a declining value of the mark vis-à-vis the guilder would have

[95] Three forms of collateralized loans were known at the time: a loan over one month; a loan over three months; and a loan over an indeterminate period of time where both sides had the right to cancel the contract at any time ("on call"); cf. Subchapter II.4 and Brenninkmeyer (1920: 70–74).

Figure 43: Indices of nominal exchange rates at Amsterdam (24/8/1915=100)



Sources: Cf. Chapter II.

made it increasingly expensive to exchange mark for guilder. Put differently, per unit of interest payment, anyone willing to go into Dutch currency would *ceteris paribus* have lost money. Figure 43 depicts indices of the exchange rates taken into account. They are normalized to one hundred on 24 August 1915.[96] Besides the fact that exchange rates were noted over the first year of the war, it is also interesting to note that the time pattern of the pound and franc exchange rate indices quite resemble one another, as well as did the mark, kroner, and ruble exchange rates.[97]

My fourth and fifth variables are two cumulative average returns indices for the domestic municipal bonds and domestic shares segments at the Amsterdam Stock Exchange. The idea behind this is to account for portfolio effects. Investors might have also reacted to price developments in other segments by trading, for example, foreign governments bonds for domestic shares or bonds.

[96] Besides these exchange rates, I also gathered rates of the guilder to the US dollar, the Danish kroner, the Swedish kroner, and the Swiss franc. Coverage regarding the former three is quite low, though.

[97] Note that gaps were interpolated and that the ruble exchange rate is constructed somewhat inconsistently. I found three exchange rates reported labelled "bank paper 100", "bank paper 500," and "telephone" in the newspapers only from 17 September 1917 onwards and running up to 31 March 1919. In order to get observations before 17 September 1917, I estimated the implicit ruble-guilder exchange rate at London via the respective exchange rates to the pound.

Table 27: The sample of Dutch municipal bonds

Bond	Initial year of issuance	Amount in guilders issued up until 1914	Run-time	No. of obs.
[1] Amsterdam 4.5 %	1913	20 000 000 (over 1913–1914)	01/01/1914–29/12/1919	915
[2] s'Gravenhage 4.0 %	1908	26 000 000 (over 1908–1914)	01/01/1914–20/11/1919	731
[3] Groningen 4.5 %	1914	500 000 (in 1914)	23/05/1914–10/12/1918	73
[4] Haarlem 4.0 %	1911	2 000 000 (in 1911)	01/01/1914–24/09/1919	92
[5] Rotterdam 4.0 %	1900	49 000 000 (over 1900–1913)	01/01/1914–22/12/1919	1 025
[6] Utrecht 4.5 %	1914	4 500 000 (in 1914)	17/07/1914–30/10/1919	95

Sources: Cf. Chapter II.

The index for the municipal bonds segment is based on daily prices of six Dutch cities' bonds. The number six is arbitrary and was chosen in order to keep the data-collecting effort small. However, the six bonds are chosen such that, firstly, rather young peacetime issues are considered to rule out duration issues; and, secondly, to display bonds of the most important Dutch cities. Table 27 reports the selected municipal bonds along with four pieces of information: (i) the year of initial issuance; (ii) the amount of the bond in Dutch guilders issued up to 1914; (iii) the run-time of the series in my dataset; and (iv) the number of price observations gathered by bond. The index for the shares segment is based on the development of twelve domestic companies' share prices (common stocks). For each of the twelve sectors to which companies were ascribed in the official price listing, I simply chose the largest company in terms of share capital according to the stock exchange handbook of 1919. Table 28 displays the chosen companies along with (i) the sector to which they belonged, (ii) the run-time of the share price series that I gathered on the them, and (iii) the number of price observations by share. As a matter of fact, almost all companies selected by me were already the largest ones in their sectors as of 1914.

Figure 44 plots the two indices along with an index for the government bond market.[98] All indices are based on simple equal-weighted averages over the return series and are normalized to one on 24 August 1915. It is not surprising that the bond market indices coincide with one another, though not perfectly (especially between September 1915 and June 1916, and between

[98] The returns index for the government bond segment is based on the entire cross-section of bonds. On the computation of (historical) returns indices for stocks and bonds, cf. e. g. Frennberg/Hansson (1991, 1992, 1993).

Table 28: The sample of Dutch companies' stocks

Share	Sector affiliation	Run-time	No. of obs.
[1] Nederlandsche Handel-Maatschappij	Banking	02/01/1914–29/12/1919	1 307
[2] Anton Jurgens' Vereenigde Fabrieken	Manufacturing	31/05/1915–29/12/1919	647
[3] Nederlandsch-Indische Maatschappij tot voortzetting der zaken Van der Linde & Teves en R. S. Stokvis & Zonen	Agriculture and trade	02/01/1914–29/12/1919	984
[4] Mijnbouw-Maatschappij Highland	Mining	01/01/1914–10/12/1919	515
[5] Koninklijke Nederlandsche Maatschappij tot Exploitatie van Petroleumbronnen in Nederlandsch-Indië	Oil	02/01/1914–29/12/1919	1 434
[6] Nederlandsche Rubber-Maatschappij	Rubber	01/01/1914–29/12/1919	1 274
[7] Nederlandsche Scheepvaart-Unie	Shipping	02/01/1914–29/12/1919	1 408
[8] Deli-Maatschappij	Tobacco	01/01/1914–29/12/1919	1 254
[9] Algemeene Nederlandsch-Indische Thee- Cultuur	Tea	01/01/1914–29/12/1919	773
[10] Hollandsche Ijzeren Spoorweg-Maatschappij	Railroads	01/01/1914–29/12/1919	306
[11] Samarang-Joana Stoomtram- Maatschappij	Tramways	01/01/1914–10/12/1919	1 043
[12] Naamlooze Venootschap Blaauwhoedenveem-Vriesseveem	Mixed	01/01/1914–22/12/1919	428

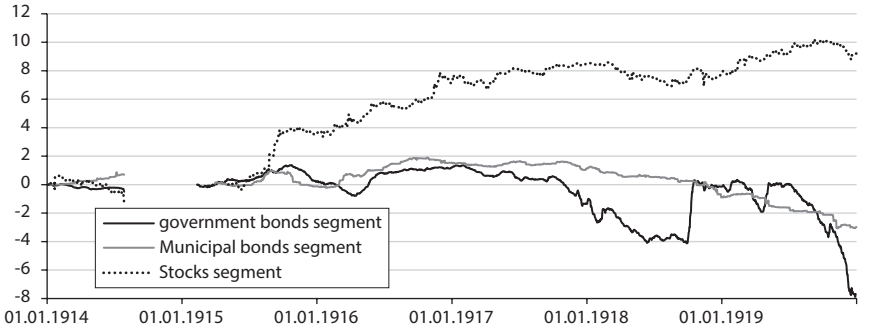
Sources: Cf. Chapter II.
Notes: It seems as if reported stock prices generally included dividends because in some cases it was explicitly mentioned in the price list that the reported price is exclusive of them.

September 1917 and September 1918), and broadly behave inversely to stock returns.[99]

Finally, as variables six and seven, I consider the growth rates of bank note circulation in the Netherlands and in the respective country under observation (if available) as a proxy for the inflation rate. I am only able to observe notes circulation once per week, so I had to interpolate a lot of gaps. Figure 45 plots the notes circulation as well as, in particular, the growth rates of the interpolated

[99] Principally, it matters for the comparison of bonds and stocks whether they were taxed differently. According to the Stamp Duty Act of 1917, foreign securities were taxed higher than domestic securities; and within foreign securities, stocks were taxed slightly higher (1.8 percent to 1.6 percent) than bonds; cf. Schacher (1931: 102).

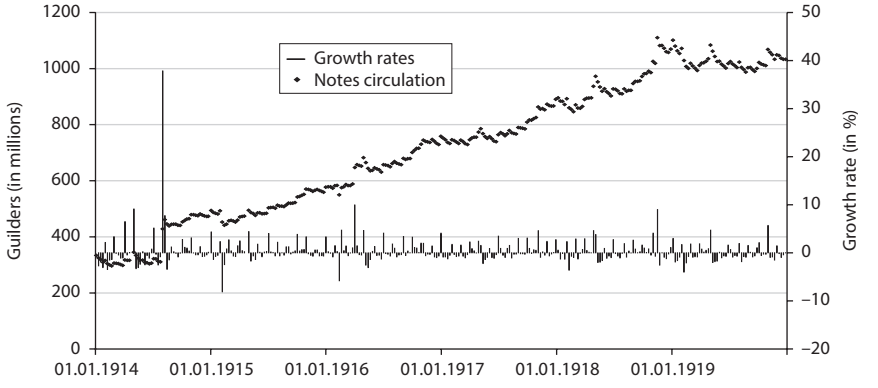
Figure 44: Cumulative average returns indices (24/8/1915 = 1)



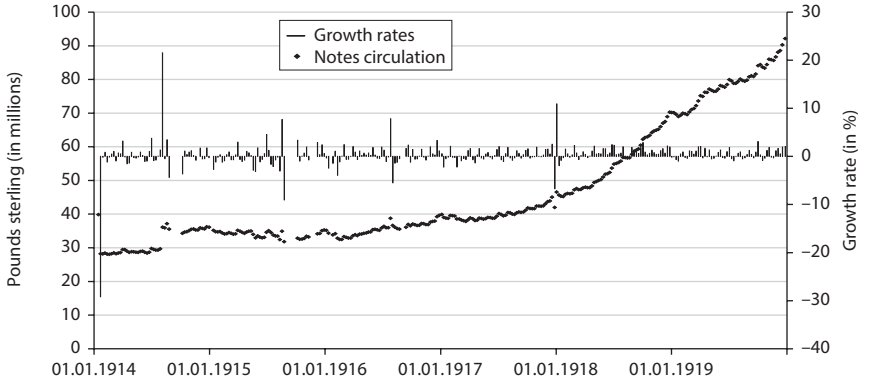
Sources: Cf. Chapter II.

Figure 45: Growth rates of notes circulation

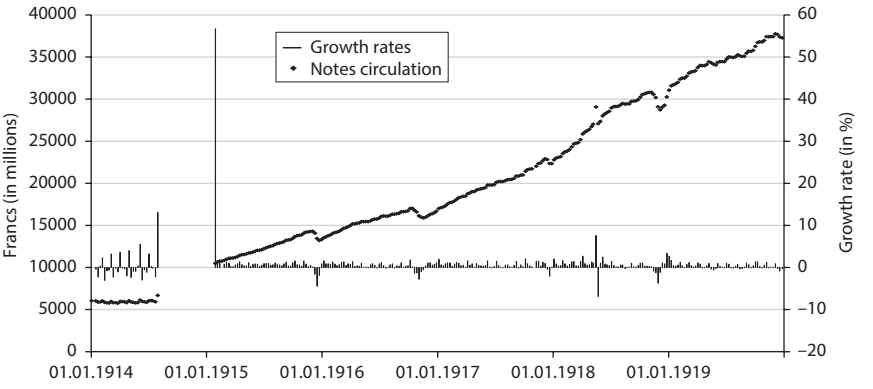
Panel (a): Netherlands



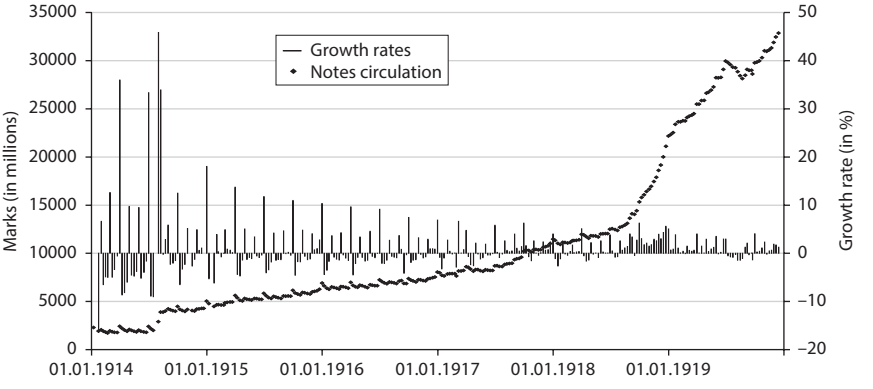
Panel (b): England



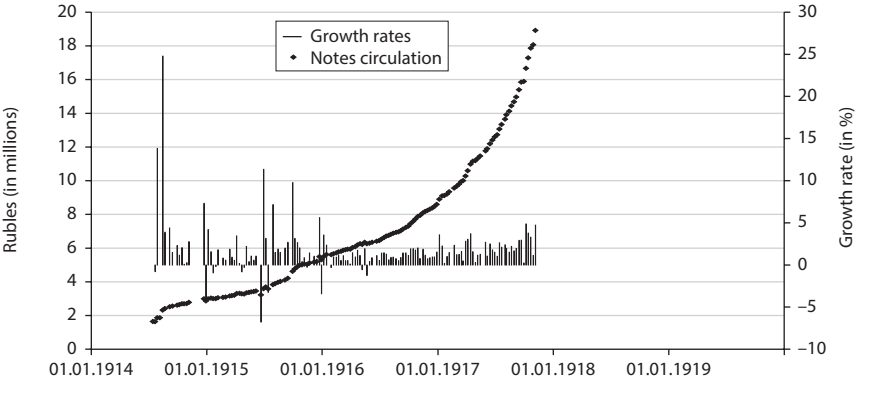
Panel (c): France



Panel (d): German



Panel (e): Russia



Sources: Cf. Chapter II. *Notes:* Growth rates estimated on the basis of interpolated series.

series for all countries for which I could locate the appropriate data in my source. The dotted lines show constant expansion of the notes volume in circulation. The lines on the growth rate of notes circulation show distinct inflationary shocks that might well explain a sudden shift in the bonds' yields. One can certainly ask how exchange rates, as introduced above, and inflation rates link or, respectively, what it means to have both variables in a regression, as there certainly is a link between them (running from inflation to exchange rates). I will discuss this issue when delving deeper into the results on the robustness check.

6.2. Results of the robustness check

Table 29 contains the results of the robustness check. For illustrative purposes, I begin with the cross-sectional time series models (with panel-corrected standard errors) referring to the market as a whole. These models serve as a benchmark. I define the market to consist of the representative bonds of all countries the bonds of which were traded at the Amsterdam Stock Exchange, so essentially all bonds assembled in Table 15 in Chapter II. I estimated two versions of the market model – "Market I" and "Market II" – where the former is estimated using the full set of regressors and the latter is estimated for a reduced set, excluding *exchange rate growth* and *foreign inflation*. Three things should be noted upfront: Firstly, I use the growth rate of the exchange rates and not the differenced series, as the latter have the dimension of the respective currencies (i. e., mark, franc, and so on). The growth rate, in contrast, is dimensionless, so that we can define one consistent variable. In the bond-specific regressions, I will use the differenced series, though. Secondly, in model I, a great number of observations were dropped from the estimation, as I was not able to observe the variables *exchange rate growth* and *foreign inflation* for all bonds.[100] This is the reason for estimating model II in addition which includes the set of variables observable for the entire sample of representative bonds giving us over 50 000 daily observations. Finally, thirdly, three variables entered the regressions with their lagged first difference instead of their lagged absolute value because of their non-stationarity property.[101]

Four variables turn out as statistically significant in model I and two variables in model II, two purely economic models explaining sovereign yields. First of all, the lagged short-term (nominal!) interest rate is significant in both models. The positive coefficient implies that an increase in the *prolongatie koers* on the previous day is strongly associated with an increase in yield on the actual day. Argued from the supply side, bondholders tended to sell bonds in case the

[100] For example, there are a couple of bonds denominated in US dollar, Japanese yen, Italian lira, Spanish peseta, and other currencies for which I do not have the exchange rates. The same goes for the inflation variable.

[101] Results on unit roots test are reported in Table A.10 in the online Appendix.

Table 29: Explaining sovereign yields

Variables	Market I (1)	Market II (2)	Austrian bond (3)	Bulgarian bond (4)	German bond (5)
Interest rate$_{t-1}$	0.290***	0.495***	3.771***	0.410***	1.063***
	(0.01)	(0.04)	(0.36)	(0.05)	(0.12)
Market liquidity$_{t-1}$	–0.005*	–0.004	–0.495***	–0.080***	–0.200***
	(0.00)	(0.01)	(0.06)	(0.01)	(0.02)
ΔMunicipal bonds$_{t-1}$	–0.053	–0.261	2.354	–0.545	2.143
	(0.34)	(0.84)	(8.88)	(2.07)	(2.34)
ΔShares$_{t-1}$	–0.575***	–0.819*	–6.263**	–0.594	–1.814
	(0.19)	(0.47)	(2.97)	(0.51)	(1.21)
Exchange rate growth$_{t-1}$ /	–0.042***		0.210	–0.162	0.099
ΔExchange rate$_{t-1}$	(0.02)		(0.42)	(0.25)	(0.11)
Domestic inflation$_{t-1}$	–0.018	–0.036	–0.256	–0.020	–0.021
	(0.01)	(0.04)	(0.31)	(0.07)	(0.09)
Foreign inflation$_{t-1}$	–0.014			–0.012	–0.065
	(0.02)			(0.08)	(0.06)
Break 1			2.409***	1.507***	1.772***
			(0.43)	(0.07)	(0.12)
Break 2			1.023**	–0.795***	–0.349**
			(0.47)	(0.08)	(0.14)
Break 3			–0.024	0.222***	–0.805***
			(0.49)	(0.08)	(0.20)
Break 4			0.690***	3.533***	1.034***
			(0.37)	(0.18)	(0.14)
Break 5			–5.518***	–0.727***	–1.158***
			(0.63)	(0.19)	(0.21)
Break 6			1.925***		–1.109***
			(0.60)		(0.21)
Break 7			14.236***		2.164***
			(0.93)		(0.23)
Break 8					6.375***
					(0.28)
Constant	6.095***	6.106***	3.534***	6.878***	5.077***
	(0.06)	(0.14)	(1.26)	(0.21)	(0.44)
No. of obs.	31 476	50 556	1 588	1 588	1 578
R-squared	0.02	0.01	0.38	0.48	0.54
Wald chi2/F-stat.	408.0***	200.1***	44.3***	148.8***	82.2***

Sources: Author's own computations.
Notes: Variable "exchange rate growth$_{t-1}$" used in models I and II. (Newey-West) Standard errors are given in parentheses. R-squared values in columns (3) to (12) are from linear regressions with robust standard errors. ***, **, and * denote significance on the one-, five-, and ten-percent levels. Only breakpoints during war are considered.

Ottoman bond (6)	English bond (7)	French bond (8)	Italian bond (9)	Romanian bond (10)	Russian bond (11)	Serbian bond (12)
0.319***	0.040***	0.191***	–0.212***	0.343***	–0.236***	0.280***
(007)	(0.01)	(0.02)	(0.03)	(0.04)	(0.05)	(0.04)
–0.090***	–0.04***	–0.343***	0.020***	–0.049***	–1.01***	–0.052***
(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
1.016	–0.015	–0.033	0.043	–0.903	0.077	0.559
(1.29)	(0.11)	(0.55)	(0.53)	(1.61)	(1.52)	(0.90)
–1.648	–0.073	–0.336	–0.052	–0.057	–0.858**	–0.310
(1.08)	(0.07)	(0.26)	(0.32)	(0.46)	(0.40)	(0.60)
–0.105	0.019	0.023	0.047	–0.045	–0.035	0.117
(0.67)	(0.11)	(0.13)	(0.02)	(0.17)	(0.03)	(0.31)
–0.039	0.002	–0.007		0.002	0.028	–0.007
(0.05)	(0.00)	(0.01)		(0.04)	(0.05)	(0.03)
0.020	0.006	–0.001		–0.033	–0.032	–0.039
(0.10)	(0.00)	(0.02)		(0.06)	(0.03)	(0.05)
0.653***	–0.074***	–0.231***	1.187***	1.608***	0.276***	–0.862***
(0.07)	(0.01)	(0.02)	(0.02)	(0.09)	(0.06)	(0.04)
–0.048	0.380***	0.204***	–0.930***		–0.853***	2.859***
(0.06)	(0.00)	(0.02)	(0.03)		(0.07)	(0.07)
–0.425***	–0.130***	0.187***	0.987***		0.151**	2.749***
(0.10)	(0.00)	(0.02)	(0.04)		(0.07)	(0.18)
0.922***	0.039***	–0.079**	0.711***		0.403***	–5.182***
(0.06)	(0.10)	(0.04)	(0.04)		(0.07)	(0.20)
0.700**	0.096***	0.608***	0.511***		0.793***	
(0.29)	(0.01)	(0.04)	(0.04)		(0.07)	
	0.654***	0.697***	6.605***		1.878***	
	(0.02)	(0.04)	(0.10)		(0.15)	
	–0.770***	–1.061***	–6.257***		5.396***	
	(0.02)	(0.05)	(0.12)		(0.18)	
7.364***	5.040***	7.072***	6.125***	7.025***	8.831***	9.447***
(0.29)	(0.02)	(0.06)	(0.12)	(0.13)	(0.22)	(0.13)
1 586	1 332	1 493	1 551	1 404	1 315	1 559
0.06	0.78	0.50	0.87	0.33	0.87	0.60
52.9***	1 201.2***	422.8***	2 792.1***	41.8***	475.8***	374.8***

interest rate, which they could alternatively earn by lending the money earned from that sell, increased. Argued from the demand side, a rising interest rate raised the potential borrower's credit cost and would thus decrease the demand for bonds as necessary collateral. Prices (yield) would consequently decrease (increase). Argued from the angle of time preference (c. f. Subchapter I.3), and although it may sound paradoxical, an increase in the *prolongatie koers* makes consumption in the present more attractive to the lender as the return on such loans is earned in due course.

Lagged market liquidity is another statistically significant variable, but only in model I and only on the ten-percent level. The inverse relationship suggests that the higher market liquidity – we may say, the trading activity – was on the previous day, the lower the yields were due to additional demand searching for an investment opportunity. This finding is in line with the notion that security prices also contain a liquidity premium compensating the buyer for purchasing a security that may be hard to resell once acquired.[102]

The third statistically significant variable is the lagged differenced cumulative returns index for stocks. The coefficient's sign tells us that in case the returns index had climbed up previously, the market faced an excess demand of bonds driving prices up or, respectively, yields down.

This is somewhat at odds with my ex-ante expectation that increasing stock returns would induce bondholders, by tendency, to go out of government bonds and into stocks rather than go deeper into bonds. However, empirically, both a positive and a negative relationship between equity and bond performance have been observed. For example, the economic literature points to the fact that the relationship was positive in the 1980s and 1990s and turned negative in the 2000s.[103]

Finally, the variable *exchange rate growth* turns out to be highly statistically significant. As expected, the coefficient is negative and implies that a deterioration in the nominal external value of a currency – that is, in this case, the value of the mark, the French franc, the pound, the Austrian kroner, or the ruble vis-à-vis the Dutch guilder – was answered, *ceteris paribus*, by selling the bonds denominated in the respective currency, hence by notifying increased country risk.

[102] It follows that securities prices tend to make a heavy jump at the end of a longer stretch of illiquidity as a lot of past information is factored in at once; cf. e. g. Gernandt et al. (2012).

[103] Cf. e. g. Pericolli (2018). One major factor proposed to explain this change is changes in the relationships between growth, inflation, and real interest rates; the latter two impact on stock returns and bond returns alike. In the 1980s and 1990s, the correlation between growth and inflation is found to have been negative, while after the turn of the century it became positive. Principally, for many countries, the period of World War One resembles the 1980s and 1990s in that GDP declined while inflation increased – even if hidden to some extent due to extensive price controls as, for example, in the case of the German war economy; cf. e. g. Baten/Schulz (2005) for the extent of price controls in Germany and Nenovsky/Dimitrova (2006) on the interest rate-exchange rate link in the context of the interwar period.

In model II, which is based on all observations available on representative bonds, only the interest rate and the returns index on stocks are statistically significant, with the coefficients having the same signs as in model I. It is common practice in the economics literature to not discuss statistically insignificant coefficients. Yet, it is a bit surprising that the inflation variables have not turned out to be statistically significant. This is because wartime inflation was evidently a topic back then. This might be due to technical reasons. For one, the inflation variable's construction might be fundamentally flawed. As outlined above, the lowest level on which I was able to measure inflationary shocks regarding the five currencies of Germany, France, England, the Netherlands, and Russia is the weekly level. This implies that exactly one observation is different from zero in each and every week. So, the explanatory value of this variable might thus be limited from the start. Beyond that, we might be facing a multicollinearity problem here between the exchange rate and inflation variables, because the stance of inflation in two countries certainly is one determinant (among a number of determinants) of the exchange rate between these two countries. So, both variables might, to some extent, be overlapping with regard to their explanatory value. That is to mean that they, so to say, explain the same part of the variation in yields due to being related. This might render both or, at least, one of these variables statistically insignificant although there is a clear theoretical relationship with the dependent variable.[104] There is no standard procedure to solve for the problem of multicollinearity. One possibility is to drop one of the variables supposed to cause the multicollinearity problem while keeping the other. Model II reflects such a "solution".[105] In fact, for theoretical reasons, we may also suspect multicollinearity to exist between the interest rate variable and the returns on shares variable. However, as I incorporated *nominal* interest rates instead of *real* interest rates, the problem might not be as severe. After all, both coefficients are statistically significant.

Apart from purely technical reasons, however, there is also a substantive explanation for why inflationary shocks might not have been important for determining yields. Turning to the bond-(or country-)specific models (3) to (12), we find that inflationary shocks obviously did not matter whatsoever, just

[104] A basic discussion of multicollinearity is to be found in Feinstein/Thomas (2002: 321–323).

[105] Note that if I had kept the exchange rate variable instead of the inflation variables, we would likely face an endogeneity problem. Endogeneity arises from the fact that an explanatory variable is correlated with the residuals (the error term *u*), that is, the unexplained part of the variation in the dependent variable. Model I can thus be viewed as a solution avoiding such an endogeneity problem by keeping both variables in the regression. Note that, usually, endogeneity requires other techniques to be applied (i. e., instrumental variables regression). This is because a variable that may cause the dependent variable is also supposed to cause another variable on the right side of the equation. However, this variable cannot be measured whatsoever and is thus omitted. This omitted variable can be thought of as being accounted for in the error term nonetheless; cf. again Feinstein/Thomas (2002: 324–326, 465).

as exchange rates did not. So, while we might well be facing a multicollinearity problem here, in few cases, it makes perfect sense to find none of these variables having explanatory power. These are the cases of Austria, Bulgaria, the Ottoman Empire, and also Russia, as all these countries, partly or completely, defaulted on coupon payments (cf. Table 22). Why should bondholders be interested in inflation in this situation? This reasoning, however, cannot explain why these variables are insignificant in the cases of which we know that coupon payment were sustained.[106] Here, the technical reasons outlined before may still apply.[107]

Regarding the remaining set of explanatory variables, we find that the nominal *prolongatie koers* as well as market liquidity are statistically significant in all bond-specific models. In addition, the returns on shares variable is also statistically significant in models (3) and (11) – the Austrian and Russian cases.

Finally, and most importantly for my question, almost all dummy variables on the break points determined in the main analysis are highly significant, and their inclusion considerably increases the regressions' fit.[108] So, the set of turning points I propose as indicating that some surprise hit investors – surprises in the form of war news – appears all the more robust. The two breakpoints that we should take with particular caution after controlling for economic variables are the third one for Austria dating 16 August 1916, concerning Romania's declaration of war on Austria-Hungary and Italy's one on Germany; and the second one for the Ottoman Empire dating 6 May 1916, concerning US-German relations.

7. Discussion

What are we to make of the structural break evidence? Is the hypothesis put forward in Subchapter III.3 to be rejected? How can we condense the bond- or, respectively, country-specific findings into a greater picture? In the following discussion, I address these points by, firstly, looking into another form of price changes which are called "blips" in the literature and which to address fosters our understanding of bondholders' perception beyond "mere" turning points; secondly, by imposing some structure on the proposed turning points so that the straightforward historical hypothesis established above can be tested; and, thirdly, by condensing the turning point evidence into country- and faction-specific perception indices.

[106] Another substantive reason, at least in some cases, might be that bonds had gold clauses working in the background and serving as inflation protection.

[107] I estimated all models in various ways with only exchange rates in the regression, only the inflation shock variables, or only Dutch inflation (as in model II). The results on these and the other variables remain the same, though.

[108] Results on regressions without dummy variables are available upon request.

7.1. Turning points versus blips – the example of Germany

The structural break approach to measuring perception via bond prices is reductionist – as is statistics, in general. Applying statistics to mass data does naturally come with a loss of information regarding the complexity of the historical situation – that is, of historical processes and actors. However, the appeal of reducing that complexity to a manageable level makes it possible to sort out patterns. Using statistics redirects focus away from specificities and the special case towards the average (behavior) and fundamental relationships at work. In my case, it helps to filter out which events mattered more than others. This is reflected in their impact on the *average* market player's long-term expectations as to the fate of the sovereign issuer the debt of which he bought or sold. Reducing the events that mattered for the course of World War One to the turning points detected previously is the proposal implicit in the method. Turning points, it has been argued, are the strongest form of an alteration in bondholders' perception; they imply a fundamental, long-lasting adjustment – that is, some state of perception that is not immediately reversed. However, adding again some complexity that the structural break approach has removed, we can ask which events, at least, had a significant *short-term* effect on bondholders' perception. This brings us to the detection of so-called blips in a time series, that is, upward or downward *spikes* in the series, which can be understood as local outliers compared to the observations close to them on both sides. We can make use of such blips in the data, as they are interpretable as *short-lived* investors' adjustments on events or, respectively, war news. Events turning out to have caused a blip did matter in bondholders' eyes, but not in a way that they were decisive for the long-term course of the war. More specifically, in line with the previous analysis, we can interpret blips as those events that shaped the volatility of investor sentiment in-between turning points, that is, within the regimes.

In the following, I briefly assess the occurrence of blips exemplary for the *German case* in order to show that perception is, and was, not all about turning points. I therefore follow the procedure applied by, for example, William O. Brown Jr. and Richard C. K. Burdekin (2002).[109] Their procedure estimates blips from the logged bond *price* series, and I stick to this by searching for blips in the logged price of the German 3 % imperial loan instead of the current yield. The baseline regression equation to be estimated with ordinary least squares (OLS)[110] is

$$\ln P_t = \beta_0 + \sum_{k=1}^{K} \beta_k \star \ln P_{t-k} + \gamma_s \star D_s + u_t \qquad \text{(Equation 5)}$$

[109] Cf. Brown/Burdekin (2002: 220–221).

[110] Easy-to-read introductions for historians into OLS as the standard regression technique are to be found in, for example, Feinstein/Thomas (2002: 103–105), Jopp/Spoerer (2017: 34–35), and Lemercier/Zalc (2019: 74–77).

where ln P_t denotes the bond's logged price on day t. The β_ks mark the coefficients of k lagged dependent variables.[111] D_s is a dummy variable taking the value 1 for observation s and zero for all observations before and after; and u_t denotes the error term. Note that s can be any day between 24 August 1915 and the end date.[112] The coefficient γ_s measures the deviation of the respective day's price from the conditions at the start of the estimation. In the first estimation of Equation 5, the first day for which the dummy variable is set to one is 20 October 1915. Thus, I allow for a relatively short trimming period of 49 days. In the second estimation of Equation 5, the dummy is rolled to the next day, to 21 October. In this fashion, I estimated another 1 228 regressions, rolling the dummy variable by one day in each regression.

Table 30 summarizes the statistically significant blips found this way. Given in the table is the date of the blip in column one; the percent change in price between the last available price quote and the actual price quote on the day of the blip (cf. Subchapter III.5 for a discussion of the problem behind this) in column two; a suggestion as to the event that caused the blip in column three; and for verification (translated) news headlines from the *Algemeen Handelsblad* and other Dutch newspapers in column four.

As can be gathered from the collection, there are a lot of events in the German case that shaped volatility. In all, I find 39 statistically significant blips of which 19 are downward and 20 are upward spikes. Among the blips are also dates which were identified before as break dates; have a look at, for example, the two major turning points detected in the German yield series – the ones connected to the conscription controversy in early 1916 and the successful Allied counterstrike in late 1918. These are also present as exceptionally strong blips with downward movements in price of 19.2 and 31.7 percent, respectively. In fact, these blips' effect did not fully reverse but show up in the long-lasting adjustment of bondholders' perception.

In the following, I will briefly go through the blips that do not constitute turning points at the same time. The blip occurring on 20 January was probably induced by the successfully completed Austro-Hungarian advance against Montenegro resulting in its surrender. In line with German military authorities, bondholders presumably expected that Austro-Hungary would now have the capacities to keep putting pressure on Russia in order to give its ally some room to concentrate on the Western Front.[113] The following blip on 17 March might be

[111] According to the modified Akaike information criterion (MAIC) reported as part of a Dickey-Fuller GLS (DFGLS) test in the statistical software I use (Stata), I chose to use $k = 8$; cf. Ng/Perron (2000).

[112] As with the Bai-Perron-method, this method needs additional observations to both sides of the actual estimation window as trimming observations. So, I chose the end date generously, with 11 August 1919 (nine months after the Armistice of Compiègne).

[113] Cf. Strachan (2003: 182). In fact, this did not really work out because Austria-Hungary began battling Italy more seriously.

understood as bondholders' reaction to the resignation of Grand Admiral Alfred von Tirpitz due to disagreement among German naval leaders over the question as to whether one should carry out unrestricted submarine warfare. Tirpitz, as the current head of the Imperial Naval Office and lead strategist, advocated the solution without restrictions, but those who practically controlled the operational business of the navy – the Chief of the Admiralty Staff and others – apparently favored a compromise in the form of sinking allied merchant vessels, but not neutral ones.[114] That bondholders reacted negatively can be explained by the fact that Tirpitz was certainly perceived as a symbol of German naval power. To support Germany's ambitions of ranking equally among the traditional imperialist powers, he essentially created the fleet that would perhaps not completely outmatch Britain's fleet, but that would still be a valuable deterrent and prerequisite for balanced negotiations in case of military conflict. Bondholders seem to have thought for a moment that Germany's strength at sea had gone with him.[115]

A sequence of blips occurred between 22 and 24 June 1916. The first fits with negative news concerning the Paris Economic Conference and also Russian successes at the Eastern Front. I think it is reasonable to assume that in this case especially economic news led to the temporary price discount of 6.2 percent. This is because, according to David Stevenson,

> [h]e [the French Secretary of Commerce Etienne Clémentel; author's comment] also wanted to end France's pre-war dependence on Germany for products such as chemicals for explosives, and ensure it had the raw materials needed for reconstruction. Briand therefore proposed, and the other Allies consented to, an economic conference that met in Paris in June 1916. It agreed to apply discriminatory tariffs against the Central Powers after the war, to assure the Allies' first claim on each other's natural resources, and to eliminate dependence on the enemy for strategic manufactures and raw materials.[116]

Regardless of the yet unknown outcome of the war, it looks like bondholders for a moment considered the conference's outcome to place a severe economic burden on Germany hindering post-war recovery and potentially affecting proper debt service. Allied trade discrimination would have very probably been an obstacle for Germany.[117] A downward blip of nearly five percent followed right on 23 June, very likely expressing bondholders' reaction to negative news from the Western Front where "[h]eavy German attacks [were] repulsed on both sides of the Meuse [and] [the] French regain[ed] ground […]."[118] Another upward blip

[114] Cf. Stevenson (2005: 258–259).
[115] Cf. Stevenson (2005: 84–85) and Strachan (2003: 196–197).
[116] Stevenson (2005: 143).
[117] Cf. Stevenson (2005: 143). Anyway, the rules that the Allied Powers agreed to implement on the occasion of the conference were, as such, never implemented. Though, Germany was facing severe trade restrictions in the interwar period.
[118] Cf. Gleichen (2000: 44, part II).

Table 30: Blips in the German 3% imperial loan

Year/Day	Estimated percent change in price	Proposed event	Major news headlines from Dutch newspapers (date of headline)
1916			
11 January	–19.2%	Conscription controversy in Britain	"The conscription question in England" (1 Jan; also 3–8 Jan)[1]
20 January	+4.4%	Austro-Hungarian campaign against Montenegro	"The surrender of Montenegro" (19 Jan)[2]
17 March	–12.3%	Admiral Tirpitz had resigned shortly before on March 15	"The resignation of von Tirpitz" (17 Jan); "The struggle at Verdun" (14 Jan; also 15–17 Jan)[3]
8 June	+23.9%	End of Battle of Jutland on 1 June; Lord Kitchener drowned on 5 June; German conquest of Fort Vaux near Verdun on 7 June	"The Sea Battle of Jutland" (3 Jun; also 5–6, and 8 Jun); "Mourning about Lord Kitchener" (7 Jun; also 8 Jun); "Fort Vaux taken by Germans" (8 Jun)[4]
22 June	–6.2%	Allied agreement on discriminatory economic policy after war	"The Paris economic conference"; "Russian breakthrough in the Bukovina" (both 21 Jun)[5]
23 June	–4.7%	Reaction to Battle of Verdun	"From the battlefields in East and West" (22 Jun)[6]
24 June	+9.5%	German reach "farthest point of advance" in the Battle of Verdun	"The struggle at Verdun" (24 Jun)[7]
1 July	–4.7%	Battle of the Somme begins with Allied offensive	"The offensive by the British"; "The struggle at Verdun" (both 30 Jun); "Russians in Volhynia and in the Bukovina" (1 Jul)[8]
20 July	+4.9%	Verdun and Somme; Jellicoe's report	"The struggle at the Somme"; "German critique on Jellicoe's report" (both 20 Jul)[9]
2 November	–3.9%	Reaction to Verdun and struggle in the east	"The struggle at Verdun"; "The frontline in Russia and Romania" (both 1 Nov)[10]
1917			
7 February	–4.0%	US-German diplomatic crisis	"Unrestricted submarine warfare"; "Standpoint of the US" (both 6 Feb; also 7 Feb)[11]
12 February	–6.1%	Further reaction to US-German diplomatic crisis	"Unrestricted submarine warfare" (10 Feb; also 12 Feb), "The mood in the US" (10 Feb)[12]

16 February	+7.0 %	Further reaction to US-German diplomatic crisis; Germany open to negotiate	"Unrestricted submarine warfare"; "Swiss response to the US and Germany" (15 Feb)[13]
22 March	–13.6 %	February Revolution in Russia (7–15 March); British offensives on the Western Front	"Revolution in Russia" (16 Mar; also 17, and 21–22 Mar); "War will be continued" (16 Mar); "Anti-German feelings in Russia" (17 Mar); "German retreat on the Western Front" (19 Mar)[14]
27 March	+4.1 %	?	"German retreat in the West"; "Germany and China" (both 26 Mar)[15]
24 April	–5.6 %	Battle of Arras (since 9 Apr); second Battle of the Aisne (since 16 Apr)	"British progress at Arras" (10 Apr; similar 11–16, and 24 Apr); "French triumph at the Aisne" (17 Apr; similar 18–24 Apr)[16]
8 May	+4.8 %	Further reaction to Russia	"Irregularities and demonstrations in Petrograd" (7 May)[17]
19 May	+4.6 %	Peace in sight?	"Strike in British mechanical engineering industry" (15 May); "Peace debate in the House of Commons" (18 May)[18]
22 May	–10.9 %	No peace with Russia; Italian offensive	"No separate peace" (21 May); "Italian offensive" (21 May; also 22 May)[19]
27 December	+7.5 %	Russia defeated; peace negotiations at Brest-Litowsk since 22 December	"Armistice concluded at Russian front"; "Peace negotiations begin" (17 Dec; similar 18–27 Dec)[20]
1918			
3 January	+7.3 %	Peace terms published	"Peace negotiations at Brest-Litowsk" (28 Dec; also 29 Dec–3 Jan)[21]
18 March	+6.4 %	Russia signs treaty; Romania accepts terms	"Peace treaty between Central Powers and Russia ratified" (18 Mar; similar previously)[22]
10 April	+6.0 %	German offensive opening the Second Battle of the Somme (since 21 March)	"The offensive at the Western Front has begun" (22 Mar); "The German attack (23 Mar; similar 24 Mar–2 Apr, 5–7 Apr)[23]
16 July	+5.5 %	German offensive opening the Second Battle of the Marne on 15 July	"The German attack on a 50 kilometer line" (16 Jul)[25]

Year/Day	Estimated percent change in price	Proposed event	Major news headlines from Dutch newspapers (date of headline)
1918 (cont.)			
18 July	–3.9 %	Allied Powers' begin counter-offensives on the Western front	"Counter-attacks by French and Americans" (17 Jul; also 18 Jul)[26]
19 September	–31.7 %	Allied Powers finally break through German lines at Amiens (8 August); further allied advances	"The Entente's attack at the Western Front"; "The Austrian peace note" (both 18 Sep); more battle news before[27]
20 September	–8.2 %	Reaction to Allied Powers' success on the Western Front	"The Entente's offensive in France" (19 Sep)[28]
7 October	+6.9 %	New government under Prinz Max von Baden offers ceasefire	"German Reich Chancellor offers peace to President Wilson" (6 Oct)[29]
9 October	+6.5 %	Reaction to German "peace offensive"	"Central Powers ask President Wilson for immediate armistice and peace negotiations" (7 Oct)[30]
19 October	+8.1 %	Second German note to and response by US president Wilson on 12/14 October	"President Wilson's response" (9 Oct; also 15 Oct); "German retreat" (12 Oct)[31]
21 October	+12.8 %	Further reaction to "peace offensive"	"Wilson's peace offer in 1917"; "Wilson's response to the Austro-Hungarian peace note" (20 Oct)[32]
22 October	–16.9 %	British advance in the West	"New British attack between" (21 Oct)[33]
23 October	+8.0 %	Further reaction to uprising	"Germany's response to Wilson" (22 Oct)[34]
24 October	+12.0 %	OHL demand cancellation of ceasefire negotiations and resumption of fighting	"The Allied Powers' impression of Germany's response" (23 Oct)[35]
26 October	–7.5 %	Austria-Hungary retreats	"General retreat of Austro-Hungarian troops" (25 Oct)[36]
31 October	–5.2 %	Germany signals ultimate surrender	"Germans confirm end of opposition" (30 Oct)[37]
7 November	–4.4 %	German army retreats	"Retreat of German troops from Aisne and Maas" (6 Nov)[38]
9 November	–9.1 %	Republic proclaimed; emperor Wilhelm II. resigns; revolutionary uprisings	"turmoil and revolutionary uprisings at various places" (8 Nov)[39]
11 November	+6.4 %	Armistice of Compiègne; new government	"New government installed"(10 Nov); "Armistice between Germany and Allied Powers concluded" (11 Nov)[40]

Sources: Chronologies: Büttner (2010: 742–744), German Historical Museum, 1917 Chronik, www.dhm.de/lemo/html/1917 (30 July 2013, 13:01), Idem, 1918 Chronik, www.dhm.de/lemo/html/1918 (30 July 2013, 12:56), Idem, 1919 Chronik, www.dhm.de/lemo/html/ 1919 (30 July 2013, 12:57), Gleichen (2000: Part II, Part III), Hirschfeld et al. (2009: 1014–1017), Mommsen (2002: 157–172), Tucker (2005: Vol. IV: S–Z: 1 308–1 317), vom Bruch/Hofmeister (2002: 495–497). Newspapers: cf. "Notes".

Notes: Percent change recovered using 100 * [exp(coefficient)–1]. Hereinafter, *Algemeen Handelsblad* abbreviated by "AH"; *de Telegraaf* by "DTe"; de Tijd by "DTi". [1] "De dienstpflichtquaestie in Engeland" (AH, No. 28 291, 28 293–29 298); [2] "De capitulatie van Montenegro" (AH, No. 28 309); [3] "De strijd bij Verdun" and "Het aftreden van von Tirpitz" (AH, No. 28 364–28 367); [4] "De zeeslag by Jutland", "Rouw over Lord Kitchener" and "Fort Vaux door de Duitschers genomen" (AH, No. 28 445–28 450); [5] "De economische conferentie te Parijs" and "De Russische doorbrak in de Boekowina" (AH, No. 28 463); [6] "Op de slagvelden in West en Oost" (AH, No. 28 464); [7] "De strijd bij Verdun" (AH, No. 24 666); [8] "Het Engelsche offensief", "De strijd voor Verdun", and "De Russen in Wolhynië en in de Boekowina" (AH, No. 28 472–28 473); [9] "De strijd aan de Somme" and "Duitsche kritiek op het rapport van Jellicoe" (AH, No. 28 492); [10] "De strijd bij Verdun" and "Aan de fronten in Rusland en Roemenië" (AH, No. 28 596); [11] "De verscherpte duikbootoorlog" and "De opvattingen in de Ver. Staten" (AH, No. 28 691); [12] "De verscherpte duikbootoorlog" and "De stemming in de Vereenigde Staten" (AH, No. 28 695–28 696); [13] "De verscherpte duikbootoorlog" and "Het Zwitsersche antwoord aan Amerika en Duitschland" (AH, No. 28 700); [14] "De revolutie in Rusland", "De oorlog wordt voortgezet", "Anti-Duitsche gevoelens in Rusland", and "De terugtocht der Duitschers aan het Westfront" (AH, No. 28 729–28 732); [15] "De Duitsche terugtocht in het Westen" and "Duitschland en China" (AH, No. 28 739; [16] "De Engelsche vooruitgang bij Atrecht" and "Fransche overwinning aan de Aisne" (AH, No. 28 752–28 767); [17] "Ongeregeldheden en betoogingen te Petrograd" (AH, No. 28 780); [18] "De staking in de Engelsche machinenijverheid" and "Een vredesdebat in het Engelsche Lagerhuis" (AH, No. 28 788, 28 791); [19] "Geen afzonderlijke vrede" and "Het Italiaansche offensief" (AH, No. 28 794–28 795); [20] "De wapenstilstand aan het Russische front gesloten" and "De vredesonderhandelingen beginnen" (AH, No. 29 003); [21] "De vredesonderhandelingen te Brest-Litowsk" (AH, No. 29 013–29 019); [22] "De vrede tusschen Rusland en de Centralen door de Sovjets geratificeerd" (AH, 29 093); [23] "Het offensief op het Westfront begonnen" and "Het Duitsche offensief" (AH, No. 29 097); [24] "Het Duitsche offensief" (AH, No. 29 170–29 171); [25] "Het Duitsche offensief op een front van 50 K.M, vanaf Château" (DTi, No. 21 695); [26] "Tegenaanvallen der Franschen en Amerikanen" (DTe, No. 10 174); [27] "Het Entente-offensief op het Westfront" and "De Ostenrijksche vredesnota" (AH, No. 29 275); [28] "Het Ententes offensief in Frankrijk" (AH, No. 29 276); [29] "De Duitsche rijkskanselier doet een vredesaanbod aan president Wilson" (AH, No. 29 293); [30] "De Centralen verzoeken president Wilson de sluiting van een onmiddelijken wapenstilstand en vredesonderhandelingen" (AH, No. 29 294); [31] "Het antwoord van president Wilson" and "De Duitsche terugtocht" (AH, No. 29 296, 29 299); [32] "Wilsons vredespogingen in 1917" and "Het antwoord van Wilson op de Oostenrijksch-Hongaarsche vredesnota" (AH, No. 29 307); [33] "Nieuwe Britsche aanvallen tusschen Kortrijk en Le Chateau" (AH, No. 29 308; [34] "Duitschlands antwoord aan Wilson" (AH, No. 29 309); [35] "De indruk in de geallieerde landen van het Duitsche antwoord" (AH, No. 29 310); [36] "Algemeene terugtocht van de Oostenrijksch-Hongaarsche troepen" (AH, No. 29 312); [37] "Een Duitsche erkenning van het einde van de Duitsche weerstandskracht" (AH, No. 29 317); [38] "Terugtocht van de Duitsche legers tusschen Aisne en Maas" (AH, No. 29 324); [39] "Oproer en revolutionaire bewegingen in verschillernde plaatsen" (AH, No. 29 326); [40] "Een nieuwe regeering gevormd" and "De Wapenstilstand tusschen Duitschland en de geallieereden geteekend" (AH, No. 29 328–29 329)

of 9.5 percent followed on 24 June, again likely due to happenings in the Verdun theater.

Further blips relate to the big Allied attack on German lines end of June (–4.7 percent on 1 July; and +4.9 on 20 July) unleashing the Battle of the Somme, the single most costly battle during the war in terms of the *body count*.[119] Regarding 20 July, we cannot exclude that bondholders reacted positively because German authorities vehemently disagreed with the report of Admiral Jellicoe, the Commander-in-Chief of the British Grand Fleet in the Battle of Jutland, advocating the view that is was actually Germany having lost it. A last 1916 blip occurred on 2 November, which again is most convincingly explained by negative news from both fronts.

Turning to 1917, the events that pressed bondholders in the first two months of 1917 were mainly related to the US-German diplomatic crisis triggered by Germany resuming unrestricted submarine warfare as an answer to the persisting Allied naval blockade and culminating in the US officially declaring war on Germany on 6 April. More specifically, statistically significant blips occurred (i) on 7 February – a drop in price of four percent, most likely interpretable as a reaction to the cancellation of US-German foreign relations on 3 February;[120] (ii) on 12 February – another drop in price of about six percent due to further news about general American discontent and pressure on neutral countries to join the Entente;[121] and (iii) on 16 February – this time a sudden upward spike in price of seven percent matching news on an attempt of the Swiss to mediate between the US and Germany leading bondholders to expect for a short while that US engagement in war may be avoided.

The blip some days later on 27 March cannot be link with any event. This time, the price change is positive (+4.1 percent). Looking at the newspapers, I do not see which event should have induced that positive – if short-term – reaction. There was news on German retreat at the Western Front and also on China willing to break up diplomatic contact with the German Empire. This, however, seems to be rather negative news. The downward blip (–5.6 percent) occurring on 24 April most likely related to battle news from the Western Front and Allied Powers' successes during the Battles of Arras and the Aisne. The three blips in May, in turn, linked up with the issue of German-Russian-relations. News about "irregularities and demonstrations in Petrograd" dating 7 May induced a short-

[119] Cf. Ferguson (1998: 292–298).

[120] Cf. Gleichen (2000: 171, part II). On US-German secret diplomacy, especially in 1918, cf. Schwabe (1971).

[121] According to Gleichen, rumors spread that James Gerard, US ambassador to Germany, was meanwhile (8 February) "being held hostage in Berlin and not allowed to communicate with USA". On 9 February, Gleichen notes that "German government admit having prevented Mr. Gerard communicating with USA, stating falsely that Count Bernstorff [German ambassador to the United States and Mexico; author's comment] has not been allowed communication with Germany. Mr. Gerard receives his passports"; Gleichen (2000: 173, part II).

term rise in price of 4.8 percent on the following day. Some vague signs between 12 and 19 May that peace may be a realistic option any time soon drove price up quickly by further 4.6 percent. However, further news stating that Russia was not willing to agree to a separate peace with Germany briefly depressed bondholders. This is reflected in a further downward spike bigger than the preceding two combined. The first blip in 1918 fits well into this issue of German-Russian relations, as it is most likely attributable to the publication of the peace terms after Russia had been defeated in the meantime.

The next blip on 10 April most likely reflects bondholders' reaction to the successful commencing of the spring offensive on the Western Front since 21 March instigating the Second Battle of the Somme. According to John Keegan, it was "on the evening of 21 March 1918, the British Expeditionary Force suffered its first true reverse in trench warfare that already lasted for three and a half years."[122] The following two blips on 16 and 18 July – in combination with the turning point detected on 6 June – can be seen as the prelude to the groundbreaking turning point on 19 September already discussed. The 5.5 percent temporary mark-up linked with 16 July corresponds to the opening of the Battle of the Marne which was the last of Germany's five spring/summer attacks; and the discount of 3.9 percent following only two days later matches the beginning of the Allies' counter-attacks.

Regarding the number of blips, a really turbulent time followed. Between 7 October and 11 November, when the Armistice of Compiègne was conducted, no fewer than 12 statistically significant blips occurred over essentially a time period of one month. The blip occurring on 7 October can be linked with the installation of the new German government under Max von Baden and, more specifically, with the government's peace offer to US President Wilson (+6.9 percent) foreshadowing a quick ending of the war. Three more positive blips followed suit on 9, 19, 21, and 23 October, which can be related to the peace correspondence between the US and Germany. Now that an immediate end of the war was imminent, bondholders appreciated Germany's attitude, presumably because they thought that authorities showing their good intentions now would pave the way for more favorable peace terms than originally expectable. Interestingly, while the peace correspondence with President Wilson in October 1918 caused some short-lived reactions on the side of bondholders, Wilson's reasonable "Fourteen Points" of early January 1918 had not induced a reaction whatsoever. Additionally, there is a large negative blip in-between, on 22 October (–16.9 percent), matching news on continued Allied attacks at the Western Front (e. g., Battle of the Selle since 17 October).[123] A further quite remarkable positive blip

[122] Keegan (2003: 556). This is my translation of the German original: *"Am Abend des 21. März 1918 hatte die BEF in dem nun schon dreieinhalb Jahre währenden Grabenkrieg ihre erste echte Niederlage erlitten."*

[123] Cf. Gleichen (2000: 118, part III).

of 12 percent dates 24 October, which may be linked with the OHL's (*Oberste Heeresleitung*) – more specifically, Erich Ludendorff's – call for resolute continuation of battle. On 26 October, he was dismissed due to fundamental disagreement with the political authorities – that is, with the *Reich* Chancellor and the Emperor – over the question of whether Germany should conclude an armistice or not.[124] News on his dismissal might have caused the immediate drop in price on 26 October by 7.5 percent. Yet, I think that the blip is better explainable by the news on the ultimate retreat of Austro-Hungarian troops, as this was the major headline on that day. Combining the blips on 24 and 26 October with blips on 31 October – Germany signals ultimate surrender (–5.2 percent) – and 7 November – the German army retreats (–4.4 percent) –, it seems reasonable to assume that bondholders had suspicions that Germany would resume hostilities since it had become clear after the peace correspondence with the Allies that peace terms would not be so favorable, at all. The second-to-last blip during the war occurred on 9 November matching news on the revolutionary turmoil in Germany with Wilhelm II abdicating his throne and the republic being proclaimed, followed by a modest reaction to the armistice on 11 November.

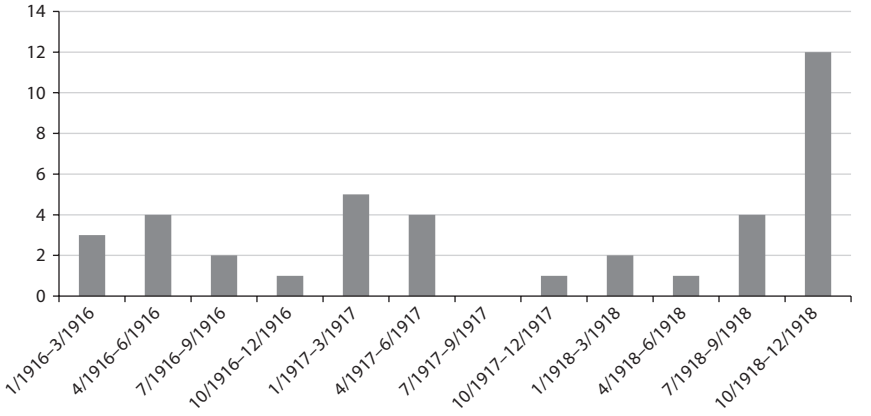
Figure 46 provides a summary of the blips analysis. Shown is the distribution of blips across three-months-periods; the distribution is very unequal, obviously. As to be expected in retrospect, blips cluster around the few months between July and November 1918, when the war entered its final stage. 12 blips alone fall into October and November, illustrating the rush and uncertainty among investors as to the final outcome. While we know in hindsight that the war ended formally (but not practically due to some continued fighting in sideshows) on 11 November, investors could have only guessed. But the volatility shows they were aware that these months were decisive, more decisive than any other months before. The two other clusters we can identify arguably relate to the first phase of the Battle of Verdun (January to June 1916) and the first half of 1917, when the United States formally entered on the Allied Powers' side. All these phases we might call phases of "increased awareness" and "increased uncertainty". Investors, so to say, re-evaluated the possibility that those months' happenings may break the stalemate characterizing the largest part of the war.

7.2. Agnostic turning points versus turning points "informed by historiography"

To what extent do the agnostic turning points detected by the structural break approach and the events hypothesized to have mattered based on timetable analysis align? The first observation we can make is that no turning point whatsoever can be linked to US President Wilson's Fourteen Points or the Armistice of

[124] Cf. Strachan (2003: 319) and Keegan (2003: 574). Ludendorff also disagreed with his own earlier position that he had taken in September for tactical reasons, namely that an armistice was overdue.

Figure 46: The distribution of blips over wartime



Sources: Author's own depiction based on Table 30.

Compiègne. While the total insignificance of the former for the capital market is striking, as the Fourteen Points had clear implications for territorial adjustments and disputes arising thereupon, the non-reaction to the armistice is not too surprising, because bondholders had, at that point in time, factored the end of the war into yields already; regarding Germany, for example, with 19 September 1918. The second observation we make when comparing both sets of dates is that the only *calendar* date popping up in both sets alike is 8 August 1918 when the Allies broke through the German lines at Amiens, at the beginning of the so-called Hundred Days Offensive. This date was detected as a break in the Italian yield series. Basically, it should not be surprising that the calendar dates have not been matched. For one, it just is a strong assumption that they would. And beyond that, news did certainly not travel instantaneously but took a while to be reported.[125] So, with a sense of pragmatism, we should not be looking for exact calendar date matches but for matches regarding the basic themes.

Table 31 is an attempt at such a "pragmatic" hypothesis test. In the column to the far left, the themes are displayed that are reflected by the events put down in Table 24. In the columns next to column one, a capital "X" denotes whether my analysis came up with a break in the respective country's series that is broadly subsumable under the ten themes. Consequently, a "/" indicates the case of no match. Additionally, the sign of the break is indicated by "+" and by "–", corresponding to an implied increase in perceived country risk or a decline in it. In the lower part of the table, two measures are given: one is the cumulated estimated absolute change in yield linked with the major themes (corresponding

[125] On the development of communication technology, cf. e. g. Field (1998).

Table 31: Summary on the hypothesis test

	Central Powers				Allied Powers					
Events according to timetable analysis	AUT	BUL	GER	TUR	ENG	FRA	ITA	ROM	RUS	SER
Verdun theater (1916)	–X	–X	–X	–X	/	–X	/	/	/	–X
Battle of Jutland (1916)	/	/	–X	/	/	/	/	/	/	/
Brusilov offensive (1916)	/	/	/	/	/	/	–X	/	/	/
Romania enters war (1916)	+X	/	/	/	–X	/	/	/	/	/
US involvement/Unrestricted submarine warfare (1916/1917)	+X	/	/	–X	+X	+X	/	/	+X	/
Peace with Russia (1917/1918)	–X	/	–X	/	+X	+X	+X	/	/	+X
Wilson's Fourteen Points (1918)	/	/	/	/	/	/	/	/	/	/
German spring offensive (1918)	+X	+X	+X	/	+X	+X	/	/	/	/
Allied final counterstrike (1918)	/	/	+X	/	–X	–X	–X	/	/	–X
Armistice of Compiègne (1918)	/	/	/	/	/	/	/	/	/	/
A. Cumulated estimated absolute change in yield linked with main events	4.82 %	4.10 %	3.53 %	0.20 %	1.55 %	2.60 %	8.25 %	0.00 %	1.50 %	5.65 %
B. Cumulated estimated absolute change in yield in total	10.00 %	8.90 %	7.80 %	2.60 %	2.20 %	3.80 %	14.70 %	1.00 %	8.10 %	13.20 %
Main events explained (A÷B)	48.20 %	46.10 %	45.20 %	7.70 %	70.40 %	68.40 %	56.10 %	0.00 %	18.50 %	42.80 %

Sources: Author's own depiction.
Notes: Event accounted for in the turning points analysis marked with an "X"; shift's direction denoted with "+" (perceived rise in country risk) and "–" (perceived decline in country risk). If a turning point refers to more than one event, the estimated shift in the mean yield is equally distributed over the number of events.

to column two in Table 24), and the other is the overall change in estimated yield. Note that for the purpose of cumulating the estimated changes in yield, I took the absolute values of the changes – that is, I ignored the sign. Take the figures on Austria as an example: If we cumulate all changes in mean yield having occurred in the Austrian 4 % based on their absolute values, we face a change of 10.0 percent. This is about 130 percent the initial yield of 24 August 1915. Furthermore, the part of this total absolute change in yield falling upon the major themes – we may say, the change caused by them – is 4.82. The decimal places originate in the fact that whenever I proposed two or more events to explain a break in Table 24, I simply distributed the change in yield linked with the break equally across the proposed events. A simple yet telling measure of the hypothesized main themes' significance in bondholders' eyes follows from dividing the latter by the former. In the Austrian case, the breaks partially or completely attributable to the main themes explain roughly half of the total absolute change in yield.

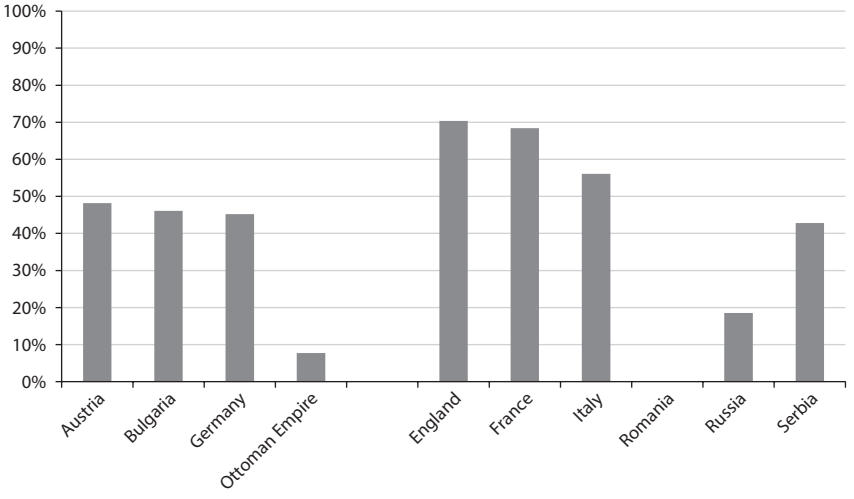
Figure 47 provides a helpful complement to Table 31. The upper bar chart (panel [a]) visualizes the share of hypothesized events in the cumulated yield shift that is given in the last row of Table 31. The chart given in panel (b) is to be understood as a decomposition of the share depicted in panel (a). It indicates the relative contribution of each hypothesized main theme to the cumulated mean shift.

So, besides the non-significance of two main themes (Wilson's Fourteen Points and the Armistice of Compiègne), we find that all other main themes popped up as turning points in investors' perception in one way or another. It is evident that the distribution of main themes across, but also within the two alliances is quite unequal. One might have expected that the same events would turn out to be important in bondholders' eyes regardless of the country, as long as the alliance as a whole was affected. That is obviously not what we find.

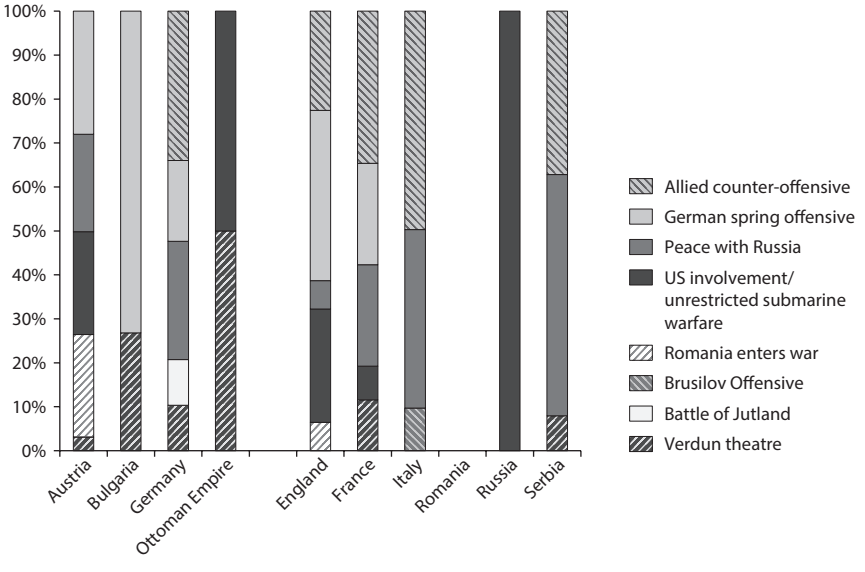
Regarding an event's significance, bondholders principally distinguished between significance for the alliance as a whole and for particular countries; their assessment is very asymmetric. The only main theme perceived by bondholders as having had really general significance for the whole alliance was the Verdun theater. In all four cases, we find that bondholders perceived the Central Powers' efforts to have an effect on the course of the war – directly (as regarding Germany), or indirectly (as the main ally forming the alliance's basis was affected). Regarding the Allied Powers, the main themes coming closest to such general "alliance significance" were the closing of the Eastern Front ("Peace with Russia") and the allied counterstrike beginning in late summer 1918, in retrospect known as The Hundred Days Offensive. Other main themes popping up as turning points relatively more often are the German spring offensive in the Central Powers' bonds and the effects of unrestricted submarine warfare, the issue causing the US to enter war eventually. In contrast, the Battle of Jutland or

Figure 47: Explanatory share of hypothesized events versus estimated turning points

(a) Share of hypothesized events in cumulated yield shift by country



(b) Share of hypothesized events in explained yield shifts by country



Sources: Author's own depiction.

the Brusilov Offensive did not matter too much for the market as a whole. It is worth noting that the main theme "Peace with Russia" is the theme popping up as a turning point in most cases – in six out of ten. What makes it special is that it is detected in all major powers' bonds except for the Russian bond itself.

Generally, the major powers' bonds except for Russia – the ones of Austria, Germany, England, and France – were, in bondholders' eyes, much more affected by the main themes than the minor powers. This certainly holds for the sheer absolute as well as relative incidence of the main themes having been detected as breakpoints. With the exception of Italy and Bulgaria, which are commonly counted as minor powers in the literature, the main themes contributed most to bondholders' risk assessment of the major powers. While the relative weight regarding the cumulated yield shift was about 50 percent in the Austrian, German, and also Bulgarian case, it was even about 70 percent in the cases of England and France; and 56 percent in the case of Italy. However, with an eye on Figure 47, panel (b), the main themes' relative share in causing the estimated mean yield quite varies. If the "Peace with Russia", "German spring offensive", and "Allied counteroffensive" themes popped up as turning points, their share was always at least around 20 percent (except for the perception of the "peace with Russia" among those bondholders that traded in the English 5 % war loan). This signals that these events moved bondholders most strongly.

So far, this has been the concise account on bondholders' perception of events that were taken as suggested by historiography to matter. It certainly suggests itself to ask why certain main themes did not pop up in this or that series. A simple, yet evasive, answer is that bondholders obviously did not attach too much significance to that event mattering (in form of a turning point!) for how the respective country fared over the course of the war (e. g., Battle of Jutland for England). I am evading answering this question, as there is really no limit to finding explanations for why they did not matter in bondholders' eyes. A second, related question we may ask is what to make of the events, or themes, that have been detected as turning points, but that *do not* match with the simple historical hypothesis tested here. The principally answer is that the historiography of World War One might have missed out on some – at least in bondholders' eyes – significant events. Whether that is a reasonable assessment depends on the place these events have in the historical literature. I will take up this aspect in the study's concluding chapter.

7.3. Simple sovereign bonds-based perception indices

To conclude this chapter's analysis, I want to establish continuous measures of bondholders' perception of each country and on the alliances as a whole. Such a measure, which is in my case a simple-form mash-up index[126], serves

[126] On the basic idea of mash-up indices and a discussion of their pros and cons, cf. e. g.

two purposes: Firstly, it offers a convenient and vivid summary of bondholders' perception of the belligerents' war effort; and, secondly, since it is a quantitative measure, it can principally serve as an explanatory variable in any parametric or non-parametric analysis focusing on a particular historical or social science aspect of World War One.

Figures 48 and 49 depict indices reflecting the timing, the direction, and the severity of the turning points detected in the analysis above. While Figure 48 plots country-specific perception indices, Figure 49 displays two aggregate, faction-specific indices – an unweighted (or, which is technically equal, an equal-weighted) and a weighted index. These indices offer a simple periodization of the war through the bondholders' lens. As with the original bonds, the indices are measured at daily frequency; and as the bonds' interest rates and, therefore, the observed yields principally fluctuate on different levels, it seemed appropriate to standardize the estimated time patterns based on mean yields. All bonds were, so to say, converted into bonds with a yield of 1.0 percent in the initial regime – that is, the stretch of time following the first wartime price observation and lasting until the first detected turning point (cf. the discussion of Table 24). For each country, this artificial bond decreased or increased at the respective turning points according to the growth rates of the estimated mean yield reported in Table 24 in column (3). These indices start on the same level and make a comparison of the timing and severity of the breaks much easier. The same absolute increase in the estimated mean yield, say by 1.0 percent (from 6.0 to 7.0 percent, or 10.0 to 11.0 percent), can be of very different severity regarding two bonds, depending on the level at which the change occurs. While this "problem" is likewise present in the indices, it is mitigated though such that shifts become more easily comparable in terms of their severity.

Turning to the faction indices, the unweighted indices are simply the arithmetic mean over the respective country series; that is, the series are equal-weighted. Note that the indices for the Allied Powers are computed both under inclusion and exclusion of Russia, as it formally dropped out end of 1917. I kept Romania, though, as its exclusion would not change the picture significantly. In order to account for the differing importance one might attach to the countries in reflecting how the alliance fared, I weighted the observations by the Composite Index of Material Capabilities (CINC) as proposed by the Correlates of War Project. Here, I refer the reader to Chapter IV of this study, where I explain this measure in more detail. Basically, the CINC measures the military strength of a country based on an array of different variables. The German Empire, for example, persistently exhibits the highest CINC in my sample of countries between

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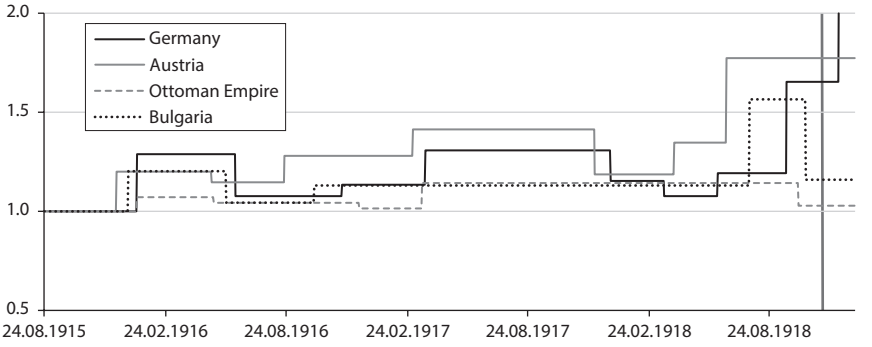
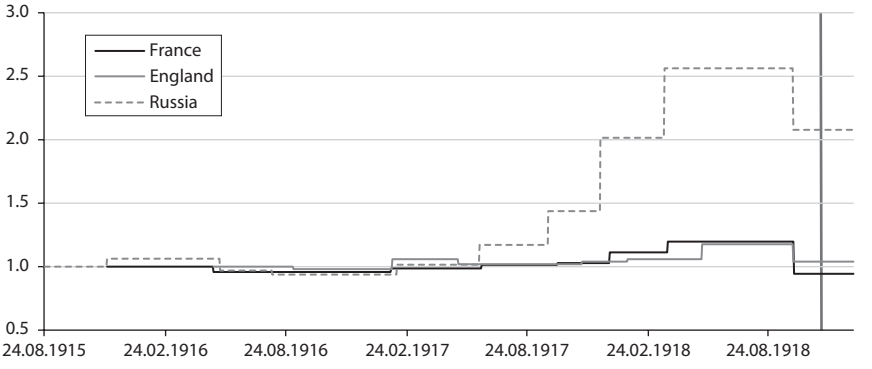
Dasgupta/Weale (1992) and Ravallion (2012). Well-known, more elaborate concepts in the social sciences include, among others, the Human Development Index, the Polity IV Index, the Composite Index of Material Capabilities, and the Freedom House index; cf. Singer (1979), Prados de la Escosura (2010, 2016), and Marshall et al. (2012).

Figure 48: A simple periodization attempt – single country risks

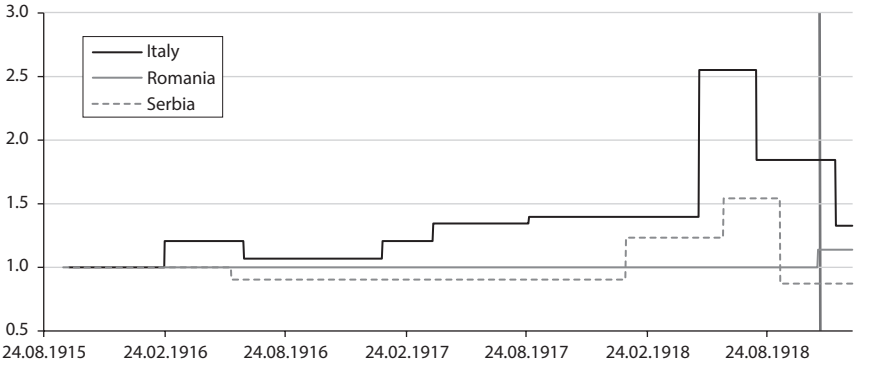
(a) Stylized country risk – Central Powers



(b) Stylized country risk – Major Allied Powers



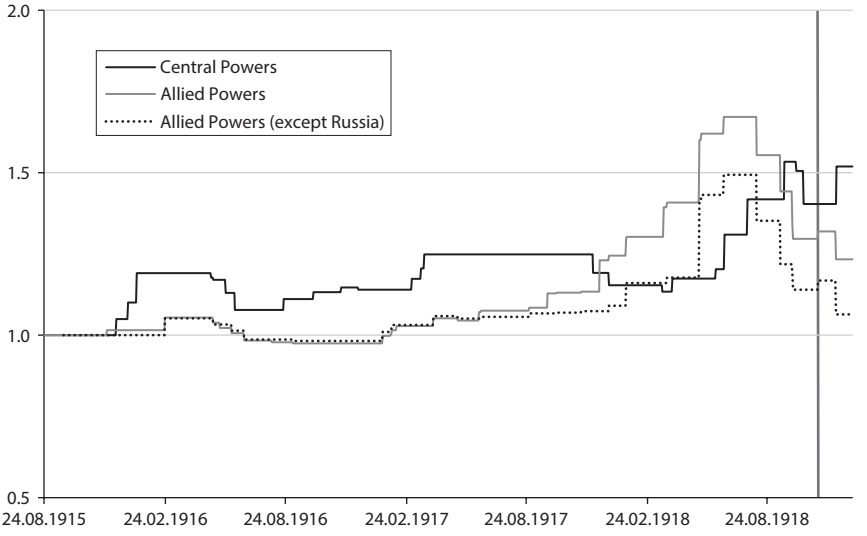
(c) Stylized country risk – Minor Allied Powers



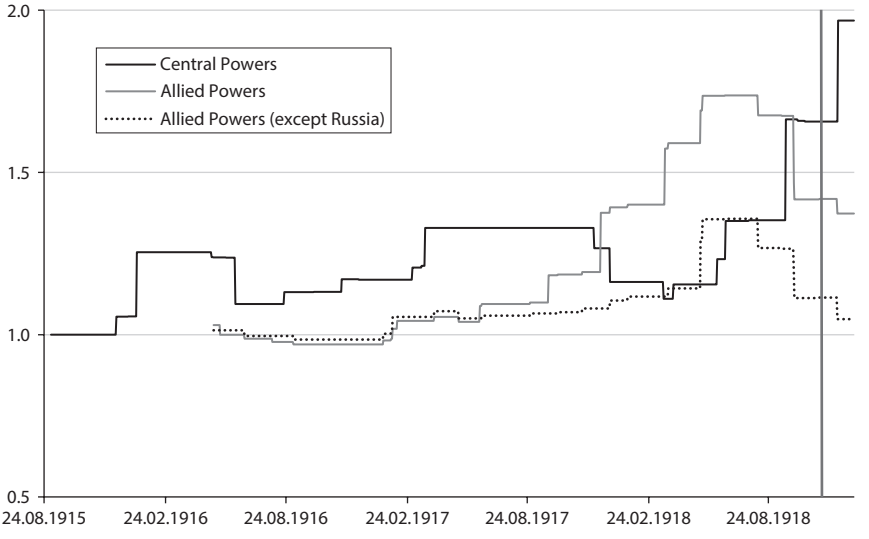
Sources: Author's own depiction.
Notes: The indices are based on the estimated growth rates of mean yields per regime; cf. Table 24.

Figure 49: A simple periodization attempt – faction indices

(a) Unweighted



(b) Weighted



Sources: Author's own depiction.
Notes: The Composite Index of National Capabilities (CINC) for 1915 is used to derive the weights; cf. Subchapter IV.2 for a discussion of the CINC.

1914 and 1918 (closely followed by the UK). This index appears to be a workable solution when it comes to weighting. In order not to confuse the picture with changes in the weighting structure, which would likely happen if I used annually varying CINCs, I decided to use 1915 weights throughout. Formally, each country's weight is its CINC value relative to the cumulated CINC value for the faction (as given in my sample).[127]

From the country-specific profiles depicted in Figure 48, it is evident that Italy and Russia exhibit the profiles with the largest risk increase due to the war. Comparing the unweighted and weighted faction indices, the aggregate country risk which the Central Powers, taken together, reflected was persistently above the risk of the Allied Powers until the end of November 1917.

When Russia is included in the indices, this turned after that point in time; aggregate Allied Powers' country risk increased. When Russia is excluded, however, aggregate Allied Powers' risk only temporarily exceeded the Central Powers' risk – between mid-May 1918 and early August 1918, the launching of the Allied counteroffensive (unweighted case) or, respectively, briefly in March 1918, and between mid-May and mid-June 1918 (weighted case). Insofar, on the aggregate, the indices reflect the Allied Powers' generally better odds of winning the war. This is a notable finding, because bondholders may not have had the same clear notion of the very unequally distributed resource base mentioned in the introductory chapter that historians have developed and that had, arguably, already determined the odds of winning *before* the war actually began.

[127] The weights in form of the country-specific CINC values for 1915 are: Austria: 0.062; Bulgaria: 0.001; Germany: 0.151; Ottoman Empire: 0.010; England: 0.150; France: 0.079; Italy: 0.034; Romania: 0.003; Russia: 0.123; and Serbia: 0.001; cf. Subchapter IV.2 for the source and discussion of the CINC.

IV. Perception of alliance credibility[1]

1. The problem

In this chapter, I will take a different view on how we can use bond prices to derive investors' opinion on the course of the war and their assessment of belligerents' war effort. While in the previous chapter I looked at structural breaks in the bond price series for *individual* players in order to make related statements, I will now look more closely at how we can link the bond price series to get a hold of investors' perception of the belligerents' *joint* performance as *alliances*. The basic question to be answered is: how did investors assess the credibility of the Central Powers and the Allied Powers under which many countries sided together over the course of the war?

As I have argued in the introduction to Chapter III, the war's outbreak seems to have generally come as a surprise to the capital markets – not only to London. Table 32 details this picture for the trading place of Amsterdam beyond the previous exercise. Reported is how the *entire* cross-section of bonds responded on average to the outbreak of the war. For this purpose, countries are sorted into different groups according to their status during the war. Given are the average current yields for five specific days including 27 July, the day before Austria-Hungary declared war on Serbia, and 28 July, the day on which war broke out and trading stopped at Amsterdam. In all groups except for the Central Powers, yields, on average, increased towards 27 July. The comparatively large average increase in the groups for African and South-American "allied bonds" is probably due to the greater financial instability of the respective countries than due to a specific war risk sensed by investors (unless, of course, one assumes greater dependence on access to international trade). The evidence on the "trigger group" is not surprising. The increase in basis points from 27 to 28 July almost corresponds to the increase over the first half of 1914. Investors sensed a greater risk for a local conflict. Note that the average yield in the group of the Central Powers (excluding Austria-Hungary) even decreased, and that the bonds of the European Allies only marginally increased from 27 to 28 July.

So, if any, there was another, rather limited, local conflict expected to arise in the Balkan involving Austria-Hungary and Serbia in the first place. The German

[1] Parts of an earlier version of this chapter are published in Jopp (2018a).

Table 32: Did the war come as a surprise to investors in Amsterdam?

	Group							
	Trigger	Central Powers	European Allies	European neutrals	Asian Allies	Africa	South American Allies	South American Neutrals
	Austria Bosnia-Herzegovina Hungary Serbia	*Bulgaria Germany Ottoman Empire*	*Belgium Italy Portugal Romania Russia*	*Denmark Dutch East Indies Finland Netherlands Norway Spain Surinam Sweden Switzerland*	*China Japan*	*Egypt Liberia*	*Brazil Cuba Nicaragua*	*Argentina Chile Colombia Dominican Rep. Mexico Uruguay Venezuela*
Average yield (growth)								
(1) Ø yield: 3 January 1914	4.93	4.96	4.72	4.02	5.01	4.18	5.35	6.59
(2) Ø yield: 18 April 1914	4.98	4.99	4.75	4.15	5.13	4.65	5.63	6.56
(3) Ø yield: 24 July 1914	4.93	4.96	4.72	4.02	5.01	4.18	5.35	6.59
(4) Ø yield: 27 July 1914	5.14	4.89	4.79	4.07	5.20	4.75	5.77	6.64
(5) Ø yield: 28 July 1914	5.32	4.84	4.82	4.07	5.21	–	–	6.66
(6) Absolute change in basis points	+0.21	–0.07	+0.07	+0.05	+0.19	+0.57	+0.42	+0.05
(7) Growth of average yield from (4) to (5)	+0.18	–0.05	+0.03	+/–0.00	+0.01		–	+0.02

Sources: Cf. Chapter II; author's own computations.
Notes: Current yield used. Many bonds did not note on 28 July 1914. In order not to suffer from attrition bias in the average yield for that day, the missing yields were extrapolated forward from 27 July under the assumption that they still served as a mental benchmark for investors. Averages are unweighted.

Empire, most interestingly, was not perceived as being dragged into that conflict. These investor assessments implicated by the evidence may surprise, as they do not match with our knowledge on the formal, contractual interconnections, or the interwovenness, of the major and also minor future belligerents in various alliances.

There, indeed, is vast political, economic, and historical research attempting to explain alliance formation and behavior in the run-up to and during World War One.[2] Alliance research laboring at the point of intersection between political science and economics has set out to generalize, in particular, on questions such as "why do/did countries choose to enter this or that alliance?"; "how are/were burdens shared within an alliance?"; "what is/was the optimal size of an alliance?"; "what are/were the effects of alliance formation on the international system?"; are periods of high levels of alliance formation generally followed by war or, respectively, is war generally preceded by alliance formation?".[3] Historical research has especially examined the complex web of diplomatic and military relations between the *de facto* alliance partners and their opponents as they, for example, showed up in the contemporary war aims discussions.[4]

Instead of directly examining alliance formation and behavior around the outbreak of and during World War One, I address a neglected dimension of the phenomenon in this chapter, namely *alliance perceptions* among the public, of which the military leaders usually demand commitment to the cause. To be more specific, against the background of the previous discussion and the use of bond prices, I want to answer the historical question of whether the Central and Allied Powers were perceived as credible alliances right at the time – that is, perceived as being two monolithic blocks that naturally arose from the tensions among the Great Powers in Europe over the preceding decades – or whether the public rather saw fully or partly "dis-integrated" allies. Judging on the grounds of country pairs and common history, many bilateral alliances had not been the most natural of all alliances after all – e. g., Bulgaria and the Ottoman Empire, as they both competed for control over the Balkan. If *perception* is an issue in the political and historical alliance literature, it is military leaders' perception of potential and actual allies as well as of potential and factual opponents; for

[2] Cf. e. g. Langer (1951), Gulick (1955), Rothstein (1968), Lee (1974), Singer (1979, 1980), Kennedy (1980), Snyder (1987, 1997), White (1995), Weitsman (2004), Bridge/Bullen (2005), Miller (2012), and Neilson (2014).

[3] Not every study necessarily addresses all questions. But, in total, the direction of impact of alliance research can be condensed into these interests; cf., most basically, Olson/Zeckhauser (1966), Ypersele de Strihou (1967), Bremer/Stuckey (1979), Siverson/King (1980), Levy (1981), Thies (1987), Conybeare/Sandler (1990), Conybeare (1992, 1994), Morrow (1993, 2006), Sandler (1993, 1999), Conybeare et al. (1994), Bennett/Stam (1996), Bennett (1997), Sandler/Hartley (2001), and Siroky (2012).

[4] Cf., for example, Fischer (1959, 1964), Fest (1978), Linke (1982), French (1986), Stevenson (1988), Michalka (1997), Stevenson (2005), Burhop (2016), and Soutou (2017).

example, as in Thomas J. Christensen's 1997 study, along the lines "perceived power of frontline potential ally in comparison with immediate rivals" and "perceived efficacy of offensive versus defensive military doctrines".[5]

Since public opinion is a wide field, examining perceptions as revealed by the nameless crowd that traded in the securities markets is supposed to be a workable strategy once more. In this chapter's analysis, I will focus on the yields of all war parties in my database except for the US, Belgium, and Liberia, due to data insufficiencies, and Brazil, Cuba, and Nicaragua, as they did not take part in fighting. My technical approach is broadly informed by commodity and financial market integration studies. I seek to determine the degree of *alliance integration*, yet among several pairs of countries, by applying cointegration analysis. In line with the reasoning put forward in Chapter III, I assume that bond yields of allies perceived as strongly *integrated* should be, statistically, cointegrated – that is, be in *long-term equilibrium*, while yields of countries not perceived as strongly integrated – that especially holds for opponents – should not show signs of positively correlated country risk. To that end, a *global test* searching for cointegration over the war period as a whole and a *sub-periods* test looking for potential breaks in the cointegration relationship such that we can distinguish periods of temporary cointegration from periods *with no* cointegration are performed.

Why should the bond yields of countries being members in the same alliance – whether this alliance was established formally or informally – be cointegrated at all? Testing for cointegration between time series is an elegant way to determine whether the time series show, to any significant amount, *co-movement*. My starting point here is that country risk must co-move if two countries are perceived as credible alliance partners. This is because what happens to the one partner in an alliance naturally has an impact on the other. With hindsight, given what is known on the course of World War One, it would certainly be reasonable to expect that at least neutral investors, not suffering from a patriotic bias,[6] were inconclusive on how divergent country risks may have been, as the major players entered into a long-lasting stalemate since the end of 1914. Hence, not knowing which faction would gain the upper hand eventually, country risk might well have become blurred in the eyes of investors – that is, the boundaries between the alliances would have vanished. My "real-time" approach seeks to determine whether investors' perceptions are in line with this hindsight judgment or at odds.

[5] Christensen (1997: 67–70).
[6] Cf., once again, Kang/Rockoff (2006) on patriotic bias.

2. Alliance formation before and during the war

Before delving deeper into the analysis of bond prices once again, an overview of the principle alliances that existed or were formed around the outbreak of World War One seems to be in order. This overview is kept brief, as the existing literature on this standard issue is already vast and does not need much more repetition.

2.1. The various alliances at a glance

The Central Powers' core was formed by the *Dual Alliance* of 1879 between the German Empire and Austria-Hungary; the Allied Powers' core by the *Triple Entente* of 1904/1907 between England, France, and Russia. The Dual Alliance was extended by Italy in 1882 and remained an alliance of three until Italy informally entered into World War One on the Allied Powers side in 1915. Originally, this arrangement fulfilled a basic security need for Germany and Austria-Hungary, as the partners committed themselves (i) to come to the other's rescue in case of an attack by Russia and (ii) to remain neutral in any other scenario.[7] Going a step further, the Dual Alliance was seen by Germany as an effective means to tie Austria-Hungary closer to itself, keeping it away from France and thereby keeping France isolated on the continent; and it was seen by Austria-Hungary as an insurance against any trouble arising from the Balkan. In alliance theory parlance, the Dual Alliance served the purpose of *capability-aggregation*.[8] The Triple Alliance's main feature was to make France's isolation perfect; all partners pledged help to one another in case a partner were attacked by France or faced an inescapable war with two or more Great Powers.[9] However, the treaty's foundation was decisively softened by Italy concluding additional arrangements with France (1900/1902) and Russia (1909)[10] as well as by the Austrian-Russian neutrality treaty of 1904.[11] Russia itself had taken part in the Alliance of the Three Emperors of 1881 and signed the follow-up arrangement holding from 1887 to 1890, the Reinsurance Treaty with Germany, centering on neutrality if one partner was involved in a great power conflict

[7] Cf. Conybeare/Sandler (1990: 1 197).

[8] Cf. e. g. Schroeder (1976: 242).

[9] Cf. Levy (1981: 585). He defines "Great Power status" as follows: "A Great Power is defined as a state which plays a major role in international politics with respect to security-related issues. Operational indicators of Great Power status include the following: possession of a high level of power capabilities; participation in international congresses and conferences; de facto identification as a Great Power by an international conference or organization; admission to a formal or informal organization of powers (such as the Concert of Europe); participation in Great power guarantees, territorial compensations, or partitions; and, generally, treatment as a relative equal by other Great Powers, in terms of protocol, alliances, and so on."

[10] Cf. Conybeare/Sandler (1990: 1 198).

[11] Cf. Schroeder (1976: 246).

(with the exceptions of a German-French and Russian-Austrian conflict). The Triple Entente formed with the Anglo-French treaty of 1904, which originated mainly in the wish to settle colonial disputes, and the Anglo-Russian treaty of 1907, settling differences that had arisen in the Asian theater. France and Russia already had an agreement dating back to 1893, concluded mainly as a reaction to the nonrenewal of the German-Russian neutrality agreement.[12]

This cursory overview has touched on arrangements among the Great Powers themselves. Taking the minor powers into account as well, the enumeration of pre-war alliances extends. These alliances might have held only for some time and, besides that, had often been formed between partners that later became opponents. There were also cases where alliance opponents later became alliance partners: among others, there were the German-Serbian (1881) and German-Romanian (1883) alliances; the Anglo-Japanese alliance of 1902 targeting Russia; and the Balkan League of 1912 that consisted of Bulgaria, Greece, and Serbia and that was directed against the Ottoman Empire.[13] Eventually, both major alliances were *informally* extended during the war by other countries just entering in on one side and thereby, broadly, signaling common interests with the core allies. The Dual alliance, for example, grew to four members when the Ottoman Empire in late 1914 and Bulgaria in late 1915 entered the scene.

Given the number of countries that were involved in World War One, it is not too far-fetched to speak of a global conflict consisting of multiple layers, where the Great Powers' conflict was only one layer, albeit the most visible and probably most important one. Smaller regional conflicts were fought under the veil of this large conflict, mostly to press home manifold territorial agendas. Following Oliver Janz (2014), this kind of motivation for entry equally holds, at least, for Italy, Romania, Bulgaria, Portugal, the Ottoman Empire, China, and Japan. Others such as most Latin American states – Brazil, most notably – wanted to secure their possibilities to carry on commerce via the sea – possibilities that were decisively threatened by the unrestricted submarine warfare which Germany had again resorted to since early 1917.[14]

Based on this brief account, it is tempting to ask whether contemporary investors saw through these multiple layers or, respectively, which connections between the various major and minor players they established implicitly.[15]

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[12] Cf. Conybeare/Sandler (1990: 1 198). For a discussion of alliances between 1815 and 1879, cf. Schroeder (1976: 231–242).

[13] Cf. Schroeder (1976: 243–248).

[14] Cf. Janz (2014: 152–153). On the war's global character, cf. Neiberg (2005) and Strachan (2010); and on the motives of the Latin American states to enter into the war, cf. especially Rinke (2014: 296).

[15] As has been mentioned earlier, we cannot exclude that market participants, at least, loosely exchanged thoughts and thereby might have influenced one another in making this or that buying or selling decision.

2.2. Measuring the alliances' strength

In Subchapter I.1, it has already been established that the Great Powers' potential to wage and sustain a great war was quite unequally distributed. Taking all important players into account (especially the US), the resource balance as of August 1914 was clearly in favor of the Allies (cf. Table 1). The variables applied to determine the resource balance in that little exercise have been GDP per capita, public debt, total population, and peacetime strength of land and naval forces. From the angle of resource availability, the Allied Powers' victory was certainly pre-determined.

The political science literature has proposed a more structured approach towards measuring the military potential of nations, in general, and of the Central and Allied Powers, in particular. This approach centers on *The Correlates of War Project*'s *Composite Index of National Capabilities* (CINC).[16] This multidimensional index has been created to operationalize the concept of "national power" – that is, a nation's potential to "exercise control over the behavior of another", "to punish or reward [another nation; the author]", and "to wage war or to sustain one it has been dragged into".[17] Per year, the CINC assembles and aggregates six indicators of a nation's material capabilities or, we might alternatively say, reaction potential.[18] The index consists of six indicators with two indicators each covering (a) the short-term perspective (military forces at immediate disposal), (b) the medium-term perspective (industrial capacity to produce war goods), and (c) the long-term perspective (demographic resources):

(a) *Military personnel* (total, but without reserves) and *military expenditures* (converted into pounds sterling before 1920; into US dollars thereafter);
(b) *Production of iron and steel* and *amount of fuel consumed* overall;
(c) *Urban population* and *total population*.[19]

Based on the CINC, the project's baseline assumption was tested that those nations that can rely on greater material capabilities generally are more war-prone than others. In his study Stuart A. Bremer (1980) argued that more capable nations have indeed fought more and heavier wars.[20]

Drawing on *The Correlates of War Project*'s database, Table 33 shows the 1913 and 1918 CINC distribution for the major belligerents along with dates of entry into war. In both years (as well as in-between) the German Empire ranked second in terms of material capabilities in the world after the US.[21] The

[16] Cf. the project's homepage at http://www.correlatesofwar.org/.
[17] Bremer (1980: 59).
[18] At the time of accessing the project's database, figures were available for the period 1816–2012.
[19] Bremer (1980: 60). For the aggregation procedure, cf. Bremer (1980: 63–66).
[20] Cf. Bremer (1980: 57–59, 79–82).
[21] Note, however, that France's and especially Britain's colonial empires are ignored here.

Table 33: Capabilities distribution for 1913 and 1918

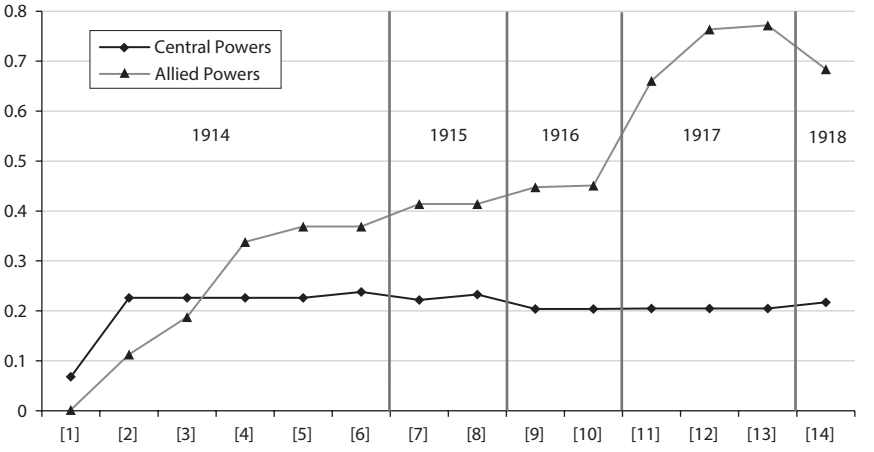
Country and alliance	Entry into war	CINC 1913	CINC 1918
Central Powers			
Austria	28/07/1914 [1]	.045	.032
Germany	01/08/1914 [2]	.143	.172
Ottoman Empire	05/11/1914 [6]	.017	.007
Bulgaria	09/10/1915 [8]	.016	.006
		.188 (Jul/Aug 1914)	*.204*
Allied Powers			
Serbia[a]	28/07/1914 [1]	.002	.002
Russia	01/08/1914 [2]	.116	.037
France	03/08/1914 [3]	.068	.088
United Kingdom	04/08/1914 [4]	.113	.143
Belgium	04/08/1914 [4]	.014	.005
Japan	23/08/1914 [5]	.033	.029
Italy	23/05/1915 [7]	.033	.033
Portugal	09/03/1916 [9]	.003	.002
Romania	27/08/1916 [10]	.004	.004
USA	06/04/1917 [11]	.220	.295
China	14/08/1917 [12]	.096	.086
Brazil	*26/10/1917 [13]*	*.010*	*.008*
		.346 (Jul/Aug 1914)	*.732*

Sources: CINC: http://www.correlatesofwar.org/COW2Data/Capabilities/NMC_5_0.zip; accessed: 7 August 2017; and Singer et al. (1972: 19–48). Dates of declarations of war taken from Gleichen (2000).
Notes: CINC abbreviates Composite Index of National Material Capabilities according to the Correlates of War Project. 1913: cumulative CINC for all countries that went to war in late July and in August 1914. The enumeration is not complete. [a] CINC is only available for Yugoslavia. Brazil is written in italics, as it will not be part in the empirical analysis below. "Entry into the war" either is the date of the first declaration of war against another country or the first declaration of war which the respective country received.

cumulated 1913 CINC values of 0.188 for the Central Powers and 0.346 for the Allied Powers are for all belligerents that would enter into the war up until end of August 1914. In terms of the CINC, we can argue even more convincingly than with reference to Table 1 that the German Empire and its alliance partners could only lose the war – even when excluding the United States from the picture.

However, as it stands, Table 33 does not convey a sound impression of the dynamics of the alliance formation process – that is, of the shifts in material capabilities over which an alliance could *formally* command due to other countries informally entering the alliance over the course of the war. Therefore, Figure 50 displays the evolution of both alliances' CINC values by entry event. Entry events are numbered one to thirteen (note the parentheses in column

Figure 50: The wartime evolution of the alliances' cumulated CINC



Sources: Author's own depiction.
Notes: Cf. Table 33 for the event dates.

two in Table 33); what is labelled entry event fourteen in Figure 50 is simply the cumulated CINC for 1918. All belligerents displayed in Table 33 were counted into the cumulated CINC with their annual values in the year they entered and stayed a war party until 1918 or until they were beaten. Note that it is Belgium (since 1915), Serbia (since 1916), Russia (in 1918), and Romania (in 1918) dropping out since they were beaten at some point in time before the actual end of the war. While the cumulated capabilities stayed constant for the Central Powers over the course of the war, those of the Allied Powers increased in several steps, most notably due to the immediate entry of the UK, and the entries of the US and China in 1917.

However convincing the picture of a backlog from the start might be regarding the Central Powers, such argumentation certainly introduces hindsight bias. This is because the picture – the information set, so to speak – for military leaders as well as the public at the time was very probably different. Besides, even if the victor could have only been the Allied Powers, there still is the length of war that has to be explained, given the unequal distribution of resources. Finally, the length of the war seems to have been highly dependent on the belligerents' abilities – separately and jointly, as an alliance – to transform economic potential in the broadest sense, over several steps, into factual military success. The bond-price approach enables us to assess public opinion on this "efficiency game", the outcome of which might actually be seen as less certain than one would be thinking at first glance.

3. Alliance credibility

The emerging (bilateral) alliances were a mixture of few long-term (or "permanent") alliances and many more "ad-hoc" alliances. Whether or not formed ad-hoc, some alliances may have become stronger alliances, while others may have been weaker alliances. There were also instances when players turned out to be kind of "swing allies", switching between existing alliances or negotiation partners at least once (e. g., Italy, Romania, and the Ottoman Empire).[22] Beyond that, many players – formally allies on one of the two commonly acknowledged sides – fought a couple of regional conflicts under the cover of the Great Powers' hegemonic struggles, following their very own territorial agenda. Against this background, the question of the public's real-time opinion on the credibility of the militarily, politically, and historically established alliances is proposed to be a welcomed addition to the usual angle from which credibility is assessed in the alliance literature, namely from the angle of how alliance partners and opponents see one another in terms of credibility.[23]

How are the terms "alliance" and "credibility" used here? With respect to the political science literature, there are two definitions that one may stick to when it comes to what an alliance is. In a narrower sense, an alliance may be understood as a "[…] treaty binding two or more states to come to each other's aid with armed force under circumstances specified in the *casus foederis* article of the treaty". The specificity of this definition is that a *written* treaty must exist. If it does, the alliance is to be called a "formal" alliance;[24] the alliances between the major powers established in the run-up to the war certainly match this criterion. However, most alliances we are dealing with in the context of World War One were formed ad-hoc and were not backed by written treaties. Thus, it seems appropriate to stick to the other, broader definition, which is that an alliance of two or more states simply reflects a "working partnership" between states that is backed by verbal, but not necessarily written, commitment or simply by conclusive action.[25] Apart from the pre-existing alliances among the Great Powers, partnerships were conclusively declared by just entering on one side and fighting against a player that committed itself this way to the other side.

[22] Cf. Levy (1981: 583) on the terms "ad-hoc" alliance and "permanent" alliance used as standard expressions in the balance of power theory. Ad-hoc alliances are said to "[have] formed for the specific purpose of counterbalancing a dangerous shift in relative power capabilities" and "[to be] necessary for checking any aggressive state" while "[p]ermanent alliances, […], are destabilizing precisely because they interfere with the flexibility of the international system to generate the ad hoc alliances necessary in order to maintain a stable equilibrium". Furthermore, on the categorization of alliances in terms of the dichotomy "close-distant", cf. Small (1979: 244).

[23] Cf. again Christensen (1997).

[24] Schroeder (1976: 227).

[25] Cf. Schroeder (1976: 227).

What is "credibility" or "credible alliance" supposed to mean here? In my view, an alliance was credible in investors' eyes if the partners were perceived as being compatible with one another. This may have depended, among other things, on the compatibility of each partner's declared war aims, on differences in size (e. g., territory, population) or, respectively, resource potential, or on a common pre-war history of good relations whatsoever. According to Miller (2012), for example, international relations studies may define the credibility of an ally as "[…] a state's willingness to follow through on its threats" and "[…] to be reliable allies".[26] The first aspect reflects what Miller describes as a state's ability to be a "resolute adversar[y]"; with the second aspect, he wants to go beyond this narrow view of credibility by showing that states – potential alliance partners – can have different reputations, just like firms in the economic sphere do. One reputational aspect going beyond may be that firms with a certain reputation will have better access to capital markets. Although, as Miller points out, it is not easy to compare firms and states or, respectively, alliances on this point, I will link up with this point in the discussion of my results to show that the way alliances are perceived by investors can have material bearings on the involved state's financing options. Furthermore, we can add Morrow's (1994) assessment that "[a]lliances could operate as signals of common interests among allies."[27] Regarding my case, a suitable summary of these definitional pieces is that alliances are credible if the capital market – i. e., the public – bought the signals of good relations and common interests. Insofar, credibility equates with the likelihood to accomplish the alliance's goals. An alliance perceived as more credible than another might be perceived more likely to dominate the conflict or, respectively, win the war. From a formal point of view, however, separating investor opinion into these basic notions is actually a problem that I do not try to solve here. But these considerations in combination should help us interpret the empirical evidence.

I draw on the literature on financial and commodity market integration in which cointegration analysis is commonly applied to determine the degree of integration of two (or more) *spatially* separated markets. Even if I am, formally, looking at only one marketplace, the different bonds may well be seen as establishing "sub-markets" for sovereign debt so that the "two or more markets-logic" of market integration studies still applies.[28] My baseline contention is that the sovereign yields of two countries should show signs of cointegration – that is, signs of a long-term (statistical) equilibrium – if the average investor regards them as close enough, compatible enough allies (that may even win the war together). In this case, I suppose, country risks attached to the alliance partners become somewhat blurred in investors' eyes. To what extent perceived country risks may

[26] Miller (2012: 4).
[27] Morrow (1994: 270–271).
[28] Cf. e. g. Choudhry (1996), Chan et al. (1997), Houpt/Rojo Cajigal (2010), Worthington et al. (2010), Federico (2012), and Brunt/Cannon (2014).

have become blurred depends on the status of the partners. If there was a major partner in terms of capabilities like the German Empire and a minor partner like Bulgaria, the minor partner would experience in that situation, in the eyes of investors, a credibility spillover. Depending on the war situation, this could have been a "credibility boost" – if the alliance, driven by the major player in the first place, were supposed to succeed – or a "credibility loss" in the opposite case. If the partners were equally capable, the existence and, respectively, the direction of a credibility spillover would not be as clear as in the case of a major power-minor power alliance. What sounds abstract here can have a factual, material bearing on the finances of countries' in alliance with one another.

In the following empirical part, the Central and Allied Powers are treated as if they each represented an aggregation of several *bilateral* alliances which is essentially what they were.[29] So, the focus will be on country pairs, meaning that it is a check for the existence of a cointegration relationship between exactly two countries at a time.[30]

The basic assumption of the simple "global" test of alliance credibility put forward first is that if two yield series were cointegrated, the cointegration relationship would hold over the entire war period. A cointegrating relationship of two series is a situation in which both series may deviate in the short term, but in the long term co-move or, respectively, converge. Usually, cointegration studies are augmented by an impulse-response analysis – that is, one looks into how the one series reacts to a sudden shock in the other series or, respectively, how it adjusts to that shock. I am not going to look into this because it is, in my view, just not necessary for answering the research question. My baseline hypotheses underlying the subsequent analysis are:

H0-A: The Central Powers formed a credible alliance – i. e., the yields of all countries that constituted the "Central Powers" are found to be *pairwise* cointegrated.

H0-B: The Allied Powers formed a credible alliance – i. e., the yields of all countries that constituted the "Allied Powers" are found to be *pairwise* cointegrated.

[29] Here I, broadly, follow Small (1979: 244).

[30] Instead of assessing cointegrating relationships pair by pair, I could apply a so-called *panel* cointegration approach where I would estimate the cointegrating relationships among all countries that formed an alliance simultaneously; cf. e. g. on panel cointegration Westerlund (2006). However, in my view, such an approach comes with interpretational difficulties in light of my actual goal – that is, to clearly identify if there was a cointegrating relationship between country A and country B. The logic behind the application of panel cointegration techniques exactly is not to study the relationship between the analyzed series pair by pair, but jointly, so that information on pairwise relationships is not part of the output. Therefore, such an approach could well tell us whether the Central Powers and the Allied Powers were *jointly* integrated or not. But this piece of information follows from the evidence of the more informative pairwise approach I apply, anyway.

H0-C: Opposing countries were viewed as *dis*integrated – i. e., the yields of opposing countries are not found to be cross-cointegrated.

H0-A and H0-B can be understood as necessary conditions for investors to have perceived monolithic blocks. H0-C, then, is the sufficient condition which has to hold to get unambiguous findings. Note that the hypotheses as a guide for the sub-periods test directly follow from the specific results of the global test. Therefore, I will not formulate them here but at the appropriate place, after having discussed those results.

4. Data selection

To examine public opinion on World War One alliances as formed among investors in more detail, I resort once more to a sample of representative[31] bonds from my database. Of the 38 different countries that saw their bonds – officially or unofficially – traded in Amsterdam, 20 had been a war party right from the beginning of the war or became a war party sometime over the course of the war. I include the representative bonds used in Chapter III extended for Portugal, Japan, and China into my analysis;[32] England and France enter again with their war bonds. For the sake of convenience and completion, Table 34 lists the full sample by date of entry into the war, with the given information already discussed earlier. Instead of using price series in the cointegration analysis, I focus again on current yields – that is, interest divided by day *t*'s price. As column four in Table 34 shows, the time until maturity was also sufficiently long for those bonds that were not included in the previous chapter's analysis where I discussed the significance of potential duration effects.

Note that I performed a baseline transformation of the yield series in that I subtracted the *market yield* from each yield series so that I am effectively starting from yield spreads. This is because (historical) market integration studies that are based on cointegration analysis are said to – potentially – suffer from one specific problem: Cointegration might be detected due to global (macroeconomic) factors affecting all markets to the same degree such that they are in equilibrium, although, otherwise, there might be no reason to believe that the markets really are economically integrated (because, for example, existing barriers-to-trade can be verified).[33] So, following the usual practice in the literature, this transformation necessarily has to be performed in order

[31] As for the use of representative bonds instead of country indices, the same reasoning applies as elaborated in Chapter III.

[32] Cf. Guoqi (2014) for a basic overview of how China fared during World War One; cf. Dickinson (2014) for Japan; and cf. Ribeiro de Meneses (2014) for Portugal.

[33] Cf. Federico (2012: 482).

Table 34: The dataset of representative bonds applied to assess alliance credibility

Country	Representative bond	LIQ	DUR	CUR
A. Central Powers				
Austria	4.0 % kroner perpetual 1892 (Jan/Jul)	.599	∞	*K*
Germany	3.0 % imperial 1890 (Apr/Oct)	.127	∞	*M*
Ottoman Empire	4.0 % Baghdad Railway 1st series 1904	.320	2001	*F*
Bulgaria	5.0 % tobacco 1902	.234	1953	*LF*
B. Allied Powers				
Serbia	4.0 % 1895 (500)	.245	1968	*F*
Russia	4.0 % Hope & Co 1885 (625r)	.649	1970	*R*
France	5.0 % war bond 1915	.207	n/a	*F*
England	5.0 % war bond (1915/1916?)	.163	n/a	*P*
Japan	5.0 % imperial 1908/09 (500/1 000)	.183	1964	*Y*
Italy	3.5 % 1862/81	.017	∞	*L*
Portugal	4.5 % tobacco 1890	.428	∞	*F*
Romania	4.0 % 1910 (2 500/5 000)	.009	1950	*F*
China	4.5 % 1898	.158	1944	*P*

Sources: Cf. Chapter II and Tables A.2 and A.3 in online Appendix 1.2.
Notes: In column two, the relevant subseries is identified in parentheses (either by size of pieces – e. g., 625 rubles in the case of Russia – or by coupon dates – e. g., in the German case, the one paying interest in April and October, in contrast to the other series paying interest in January and July). LIQ denotes a bond's liquidity during the war period; DUR its duration; and CUR its currency denomination (M = German mark; F = French franc; P = pound sterling; R = Russian ruble; K = Austrian kroner; LF = Bulgarian leva of francs; L = Italian lira; Y = Japanese yen).

to mitigate the potential distorting effect of global factors on the bond prices under study.[34]

In Chapters II and III, market indices based on prices and based on price returns have been introduced. For the purpose of this chapter's analysis, I add a simple daily market index based on the current yield notation. I computed two equal-weighted series which are depicted in Figure 51. One comprises the entire cross-section of officially traded bonds, and the other is based solely on the representative bonds of the countries which saw they debt traded in Amsterdam (cf. Table 15). The main difference between the two market yield proxies lies in the series' pattern in 1918 and 1919. In order to understand the gap, recall that the number of bonds per country is very unequally distributed (cf. Table 10).

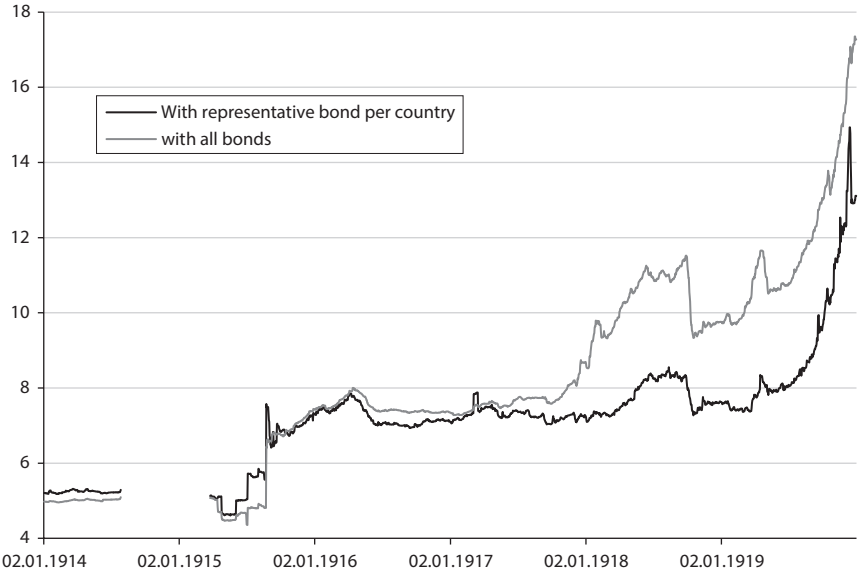
[34] On a practical level, this transformation is also the key to be able to perform both a structural break analysis and a cointegration analysis of my data. Recall that a structural break analysis like the one performed in Chapter III depends on statistical methods that require stationary series; in contrast, cointegration methods are created to be performed on non-stationary series. Thus, both methods seem to be mutually exclusive if it comes to applying them on one and the same series. Yet, my *theoretically informed* transformation of the data creates new series with new statistical properties and allows to take the two different, yet intertwined, angles that I put forward here.

Table 35: Summary statistics on sovereign bond yields (1914–1919)

Country and bond	Mean	Std. dev.	Min	Max	Observation period [dd/mm/yyyy]
A. Central Powers					
Austrian 4.0 %	12.86	11.17	4.66	97.56	01/01/1914–29/12/1919
German 3.0 %	6.92	4.35	3.90	31.58	01/01/1914–27/12/1919
Ottoman 4.0 %	7.17	1.77	5.19	40.00	01/01/1914–27/12/1919
Bulgarian 5.0 %	7.87	2.26	5.30	17.86	01/01/1914–16/12/1919
B. Allied Powers					
Serbian 4.0 %	8.67	2.30	5.16	20.00	01/01/1914–27/12/1919
Russian 4.0 %	9.89	4.84	4.73	29.63	01/01/1914–29/12/1919
French 5.0 %	7.22	0.70	6.22	12.58	27/11/1915–18/12/1919
English 5.0 %	5.39	0.31	4.96	6.37	16/05/1916–19/12/1919
Japanese 5.0 %	5.94	0.37	5.50	7.69	01/01/1914–29/12/1919
Italian 3.5 %	5.14	2.74	3.80	15.91	01/01/1914–14/05/1919
Portuguese 4.5 %	5.54	0.52	4.71	8.18	01/01/1914–29/12/1919
Romanian 4.0 %	6.04	1.76	4.78	13.33	01/01/1914–25/11/1919
Chinese 4.5 %	6.36	0.94	4.84	9.68	01/01/1914–29/12/1919

Sources: Author's own depiction.
Notes: Summary statistics refer to the raw yield series.

Figure 51: Simple market indices for Amsterdam based on current yields



Sources: Author's own depiction.
Notes: Yields are equal-weighted.

Table 36: Summary statistics on analyzed yields spreads

Country and bond	Mean	Std. dev.	Min	Max
A. Central Powers				
Austrian 4.0 %	5.53	10.17	–0.54	82.62
German 3.0 %	0.24	3.42	–2.40	18.67
Ottoman 4.0 %	0.13	2.19	–3.59	26.76
Bulgarian 5.0 %	0.86	1.18	–1.37	7.60
B. Allied Powers				
Serbian 4.0 %	1.50	1.67	–3.24	7.73
Russian 4.0 %	2.58	3.93	–1.52	16.71
French 5.0 %	–1.01	1.76	–6.09	1.63
English 5.0 %	–2.88	1.40	–8.68	–1.71
Japanese 5.0 %	–1.43	1.30	–8.76	0.45
Italian 3.5 %	0.03	2.08	–6.98	7.83
Portuguese 4.5 %	–1.82	1.09	–7.14	–0.14
Romanian 4.0 %	–0.03	0.65	–2.18	3.11
Chinese 4.5 %	–0.82	1.12	–7.43	1.31

Sources: Author's own computations.
Notes: Yield spreads computed on the basis of interpolated yield series.

Of the 37 sovereign issuers, 22 were European countries accounting for roughly three quarters of all bond series traded. Taking another angle on the data, about half of all traded series were Brazilian, Dutch, and Russian issues alone. It is especially the Russian bonds' prices', or yields', behavior that visibly drives the "all bonds market yield" in the last two years; Russia's country risk increased due to its defeat by the Central Powers at the end of 1917 and due the Bolshevik repudiation of all Tsarist bonds in February 1918.[35] In my view, the "all bonds" version is not the best reflection of the general market development because it attaches too much weight to the risk pattern of Russian bonds and, generally, to the bonds of those sovereign issuers that account for a relatively large proportion of traded bonds. Thus, I corrected sample yields by the "representative bonds market yield".[36]

Finally, Figures 52 and 53 depict the time pattern of the derived spreads over the war period and separated by alliance. Note that the spreads can be positive and/or negative. Tables 35 and 36 add descriptive statistics on the representative bonds and the spreads.

[35] Cf. Oosterlinck/Landon-Lane (2006) and Oosterlinck (2016).

[36] Since the methods used below require series that cannot have gaps, I again interpolated the gaps by filling in the last available official price. The economic logic behind is that the last official price implicitly still holds over non-trading phases as a mental benchmark.

Figure 52: Yield spreads of the Central Powers' bonds over the war period

(a) Austria

(b) Bulgaria

(c) Germany

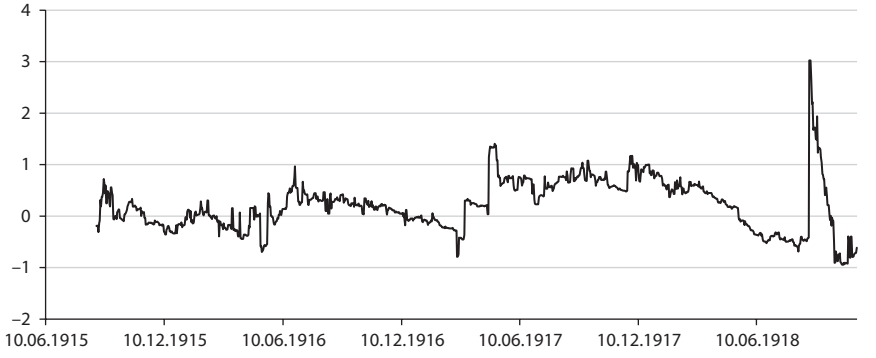
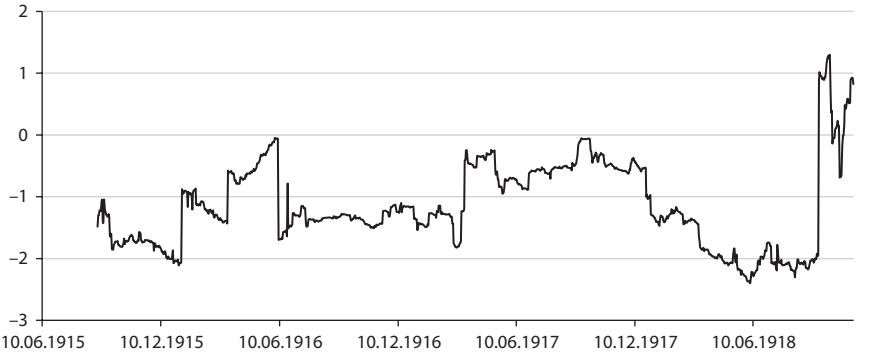


Figure 52 (continued)

(d) Ottoman Empire



Sources: Cf. Table 34.

Figure 53: Yield spreads of the Allied Powers' bonds over the war period

(a) China

(b) England

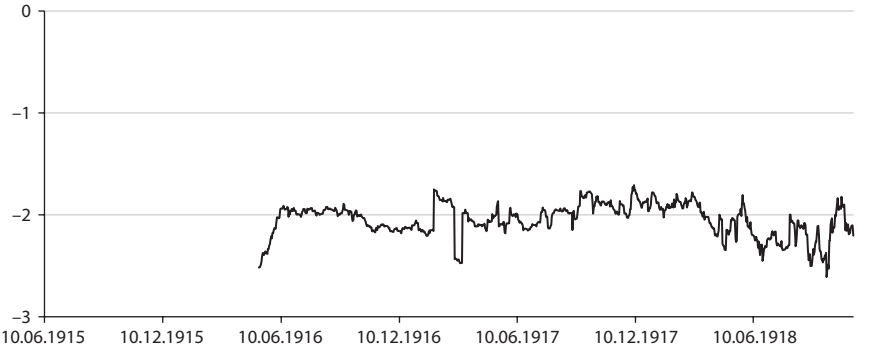
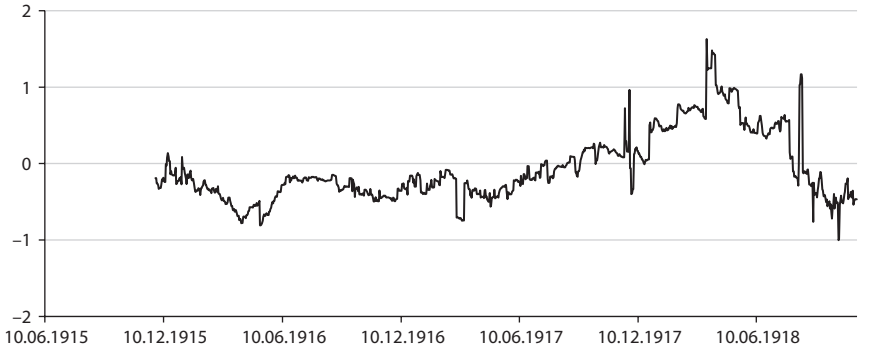
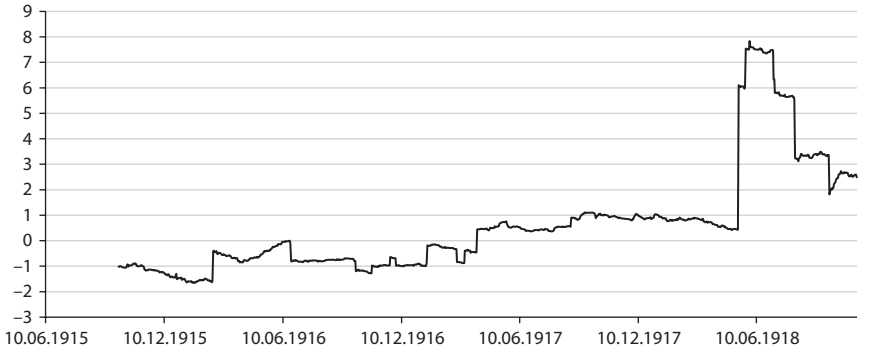


Figure 53 (continued)

(c) France



(d) Italy



(e) Japan

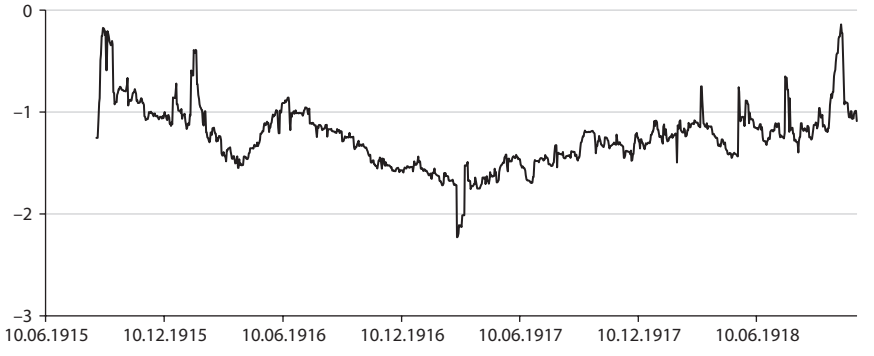
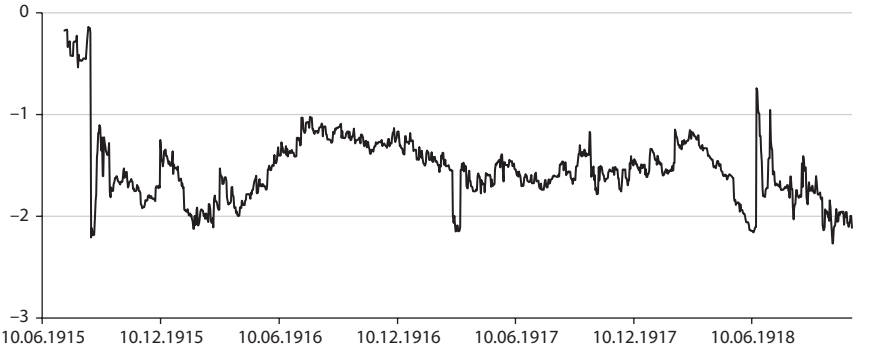
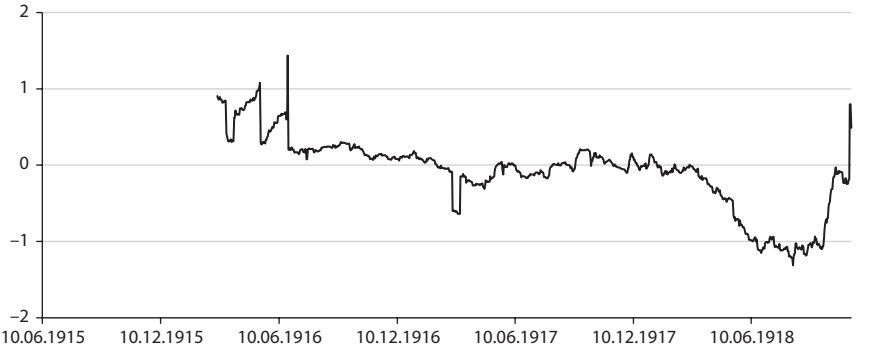


Figure 53 (continued)

(f) Portugal



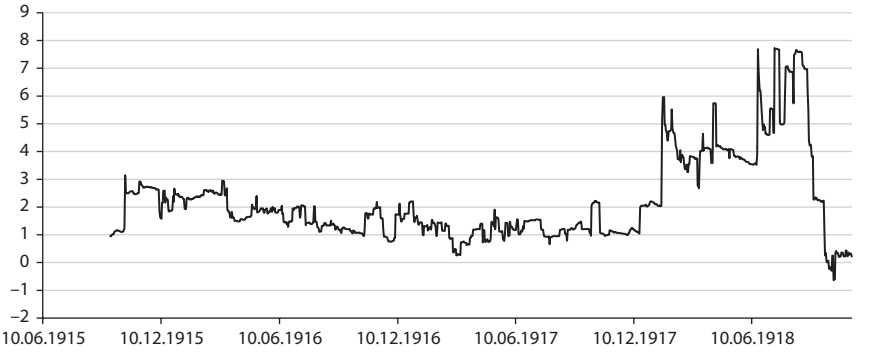
(g) Romania



(h) Russia

Figure 53 (continued)

(i) Serbia



Sources: Author's own depiction.

5. Empirical findings on a "global" test

5.1. Starting from a simple approximation of co-movement – correlation coefficients

Let us start the empirical part with a descriptive analysis of co-movement of bond prices or, respectively, yields. For this purpose, I take a look at the coefficient of correlation as an easy-to-implement, standard tool used in empirical research to assess co-movement of time series.[37] The coefficient of correlation ranges between –1.0 and +1.0 and measures the strength of the *linear* relationship between two time series; a high positive (negative) correlation coefficient signals that high positive values in the one series are paralleled by high positive values in the other or, respectively, that both series move in the same (opposite) direction. According to Feinstein (2002), a correlation coefficient of around +/–0.7 signals a strong relationship which, however, must not be understood as telling us anything about causality.[38]

Table 37 reports on this measure. In the upper part, it displays descriptive statistics based on the pairwise coefficients of correlation calculated for subsets of the Central and Allied Powers, and also calculated across the alliances' boundaries. Additionally given are the *p*-values of *t*-tests on equal means in the adjacent time periods. Depicted in the lower part are some selected pairwise correlations among the major powers.[39]

[37] Cf. e. g. Volosovych (2011, 2013), Federico (2012: 481–482), Waldenström (2014: 25), and Stuart (2017).

[38] Cf. Feinstein/Thomas (2002: 82–83).

[39] Table A.11 in the online Appendix reports pairwise correlations for all bonds in the sample used here, yet for the raw yields.

Table 37: Correlation of yield series among main belligerents

	Country pairs included	Pre-war period	War period	Post-war period
Among Central Powers	6			
Mean (standard deviation)		+0.41 (0.22)	+0.20 (0.16)	+0.49 (0.29)
Difference in mean to previous period (*p*-value of *t*-test on equality of means)			$p = 0.130$	$p = 0.041$
Minimum		+0.14	+0.02	+0.02
Maximum		+0.72	+0.51	+0.92
Among Allied Powers	36			
Mean (standard deviation)		+0.27 (0.28)	+0.11 (0.40)	+0.28 (0.62)
Difference in mean to previous period (*p*-value of *t*-test on equality of means)			$p = 0.071$	$p = 0.168$
Minimum		–0.19	–0.78	–0.73
Maximum		+0.82	+0.77	+0.99
Across factions	32			
Mean (standard deviation)		+0.37 (0.21)	–0.03 (0.27)	–0.36 (0.54)
Difference in mean to previous period (*p*-value of *t*-test on equality of means)			$p = 0.000$	$p = 0.002$
Minimum		–0.31	–0.65	–0.99
Maximum		+0.71	+0.84	+0.99
Selected pairwise correlations				
Germany-Austria-Hungary		+0.31*	+0.18*	+0.92*
England-France		n/a	+0.24*	+0.86*
England-Russia		n/a	–0.19*	–0.68*
France-Russia		n/a	+0.73*	–0.44*
Germany-England		n/a	+0.13*	–0.91*
Germany-France		n/a	–0.42*	–0.75*
Germany-Russia		+0.14*	–0.30*	+0.71*

Sources: Author's own computations.
Notes: Pearson's correlation coefficients are computed on the basis of the yield series that is corrected for the market yield. "n/a" is "not available". * denotes significance on the ten-percent level or better.

The Central Powers' spreads show, on average, strikingly low positive zero-order correlation[40] during the war compared to the post-war and also to the pre-war period. The average correlation among the Allied Powers' core during the war was even lower in each and every period. Computing the average pairwise correlation across opponents reveals a marginally negative correlation in the war period which, at least regarding the sign, does not come unexpectedly. In the final run-up to the war, when economic and political relations were formally still intact, average cross-alliance correlation was still modestly positive with +0.37. Moreover, it also does not come as a surprise that immediately after the war, when it was clear which player was the victor and which one was the vanquished, average correlation among the opponents was visibly negative; country risks were rapidly diverging for the two groups (i. e., due to post-war inflation and regime changes, above all). Thus, to conclude, based on simple coefficients of correlation, we might not suspect that there are too many significant pairwise cointegrating relationships to be found for the alliance cores.

5.2. Do we find cointegrating relationships?

Let us now turn to the global test based on examining country pairs for potential co-integration relationships over the war period as a whole – that formally is, 9 February 1915 (when the Amsterdam stock exchange re-opened for trade) and 11 November 1918 (the Armistice of Compiègne). For reasons of illustration, I also check for cointegration from 1 January to 28 July 1914 and 12 November 1918 to 31 December 1919.[41] To that end, I will go through three steps:

Step 1: To begin with, all yield spread series are tested for the presence of a unit root since potentially cointegrated series must be of the same order of integration, and at least of order one (i. e., series have to be non-stationary); stationary series drop out. This test allows us to determine which country pairs' series can potentially be integrated and which countries were definitely perceived to not be in alliance.

Step 2: I perform Johansen Trace and Maximum Eigenvalue tests for cointegration – two standard preliminary tests of whether a cointegrating relationship can reasonably be expected to exist between the two series; all country pairs for which both tests *unanimously* reject a potential cointegrating relationship (implied by a cointegration rank of zero) drop out at this stage, too.

Step 3: Finally, for all remaining pairs, I estimate two Johansen Vector Error Correction (VEC) models – one with an unrestricted constant and one with

[40] The term "zero-order correlation" implies that it is not controlled for additional variables in calculating the pairwise correlations. In my case, there is no reason to include such additional variables.

[41] To extend the post-war period further does not seem to be helpful since disguised inflation set in for some countries such as for Germany.

an unrestricted trend.[42] To determine whether a cointegrating relationship between two yield series exists, I perform two *t*-tests on the slope parameters of the cointegrating vector. Note that the cointegrating vector contains one slope coefficient for each series (plus a constant and possibly a trend coefficient). In order to determine the one coefficient, the other has to be normalized to one. Both normalizations are performed, and a valid cointegrating relationship is assumed to exist *only* if the freely chosen coefficients *both* are statistically significant on the ten-percent level or better.[43]

Regarding the first step, I checked for the presence of a unit root in the yield spread series by applying the Dickey-Fuller Generalized Least Squares (DFGLS) test. This test is said to have the advantage of having greater power over the commonly used Augmented Dickey Fuller and Philipps-Perron tests. The test has the null (hypothesis) of a random walk. Alternatively, the series may be stationary around a linear time trend or around a (zero or nonzero) mean. The test is performed on specifications with between one and *k* lags.[44] Table 38 reports the test statistics for the pre-war, war, and post-war periods along with the level of significance and the optimal truncation lag according to Ng and Perron's (1995) sequential *t* in parentheses.[45] As has been mentioned before, technically, applying cointegration analysis requires series to be integrated of the same order and at least of order one. As Table 38 shows, for a number of series, though, we can reject the null in favor of either trend or mean stationarity, or both, at the ten-percent level or better. But re-computing the DFGLS test with the differenced series allows consistently rejecting the presence of a second unit root. Hence, the series are either I(1) or I(0), that is, contain a single unit root or none at all.[46] In order for a series (or, in fact, a country) to make it into step two, I(1) is required.

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[42] Cf. Johansen (1988, 1991).

[43] Here, I follow the recommendation by Hjalmarsson/Österholm (2007) to perform both normalizations.

[44] Cf. Elliott et al. (1996) for the technical details on the DFGLS test; and cf. Ng/Perron (2000) for details on lag selection. By default, the software I used – Stata – supplies three lag selection criteria as part of the results on the DFGLS test, namely the MAIC, the Schwartz information criterion (SIC), and the Ng-Perron sequential *t*. There seems to be no clear-cut rule for when to use the one or the other criterion. According to Liew (2004), for example, the AIC performs relatively best for a sample size of between 120 and 240 observations if the aim is to minimize the probability of underestimating the true lag length of the process. However, since the sample sizes are usually larger for the war and post-war periods, I decided to follow the suggestions of Ng and Perron to use their sequential *t* (for reasons of consistency also for the pre-war period where sample size is in the range mentioned by Liew); cf. Ng/Perron (2000) and Liew (2004: 5).

[45] Cf. Ng/Perron (1995) for the technical details.

[46] For Austria, we can reject the presence of a second unit root in the pre-war period only on the ten-percent significance level.

Table 38: Step one – DFGLS unit root test on representative bonds' yield spread

Country and bond	Pre-war period		War period		Post-war period	
	H1: Stationary around trend	H1: Stationary around mean	H1: Stationary around trend	H1: Stationary around mean	H1: Stationary around trend	H1: Stationary around mean
A. Central Powers						
Austrian 4.0 %	–0.35 (12)	1.37 (12)	–2.51 (18)	0.21 (18)	–0.84 (17)	2.24 (14)
Bulgarian 5.0 %	–1.84 (3)	–1.79 (3)	–3.70*** (22)	–1.89* (22)	–3.59*** (1)[a]	–1.14 (11)
German 3.0 %	–1.24 (10)	–0.79 (10)	–2.27 (21)	–1.64 (21)	–0.50 (1)[a]	1.63 (1)[a]
Ottoman 4.0 %	–1.83 (11)	–0.61 (11)	–3.30** (13)	–2.87*** (13)	–3.38** (11)	–3.16*** (11)
B. Allied Powers						
Chinese 4.5 %	–2.45** (1)[a]	–2.39** (1)[a]	–3.66*** (16)	–1.13 (11)	–1.06 (17)	1.66 (17)
English 5.0 %	n/a	n/a	–1.74 (14)	–1.00 (14)	–0.84 (17)	1.45 (17)
French 5.0 %	n/a	n/a	–1.53 (17)	–1.49 (17)	–2.56* (11)	–1.28 (11)
Italian 3.5 %	–2.05 (2)	–1.99 (2)	–2.83* (11)	–1.30 (11)	–1.37 (17)	1.65 (17)
Japanese 5.0 %	–1.69 (8)	–0.54 (12)	–3.26** (20)	–3.26*** (20)	–0.57 (17)	2.27 (17)
Portuguese 4.5 %	–1.40 (14)	–1.30 (14)	–1.29 (21)	0.08 (21)	–1.40 (17)	1.05 (17)
Romanian 4.0 %	–1.36 (13)	–1.06 (13)	–1.26 (12)	–0.75 (12)	–3.40** (17)	–3.22*** (17)
Russian 4.0 %	–1.56 (5)	0.16 (5)	–1.57 (19)	–0.41 (19)	–2.76* (8)	–1.22 (8)
Serbian 4.0 %	–0.71 (13)	0.13 (13)	–2.34 (17)	–1.90 (17)	–3.55*** (13)	–3.69*** (13)

Sources: Author's own computations.
Notes: ***, **, * denote significance on the one-, five-, and ten-percent levels. Optimal truncation lags according to the Ng-Perron sequential *t* in parentheses. "n/a" is "not available". [a] According to the Ng-Perron sequential *t*, the optimal lag order is zero; however, given is the test statistic for lag order one.

Which countries drop out at this stage? Which bilateral alliances did definitely not exist in the eyes of the capital market? Basically, (i) China in the immediate pre-war period, (ii) Bulgaria, the Ottoman Empire, and Japan in the war period itself, and (iii) the Ottoman Empire, Romania, and Serbia in the post-war period cannot be associated with being pairwise allied with any belligerent. Whether or not China and Italy were in the war period, and Bulgaria, France, and Russia were in the post-war period, depends on the model. So far, globally, a monolithic block named Central Powers was apparently not perceived as such by investors. But a monolithic block of *European* Allies could still have been perceived as such *in* the war.[47]

In the following, I am not going to present the intermediate results after applying Johansen's Trace and Maximum Eigenvalue tests – that is, delve deeper into step two. Instead, I leave the presentation and discussion of this necessary intermediate step to the online Appendix and focus on the end results – that is, existing pairwise cointegration relationships given that the cointegrating vectors' slope coefficients have been subjected to an additional hypothesis test as outlined above.

Table 39 summarizes my estimations on cointegrating relationships among the belligerents from a global perspective. For twelve different subsamples of country pairs, the possible and the identified number of significant cointegrating relationships is reported, along with an identification of the pairs in parentheses. Take subsample (1), the Central Powers, first. Of six possible cointegrating relationships, we find exactly one such relationship in both the war and post-war periods, and that is for the German-Austrian yield pair. This, of course, was to be expected. Perhaps it is much more surprising that German and Austrian yields were not cointegrated in the final run-up to the war. Carefully interpreted, investors seem to have perceived them as – at least, temporarily – being not too close a partner for one another. This finding matches nicely with the exercise in the introduction to this chapter where prices of the "trigger group" and the "Central Powers group" had even moved in opposite directions just before the stock exchange was closed. So, what was politically, but even more *de facto* militarily, an alliance of four, appears to have been, in "capital market terms", definitely an alliance of two.

Turning to the countries that are de facto counted as Allied Powers, we find that French and English yields as well as French and Russian yields were cointegrated over the war period, but not English and Russian yields. This is a remarkable finding since – under the technical conditions of my approach – the very core of the Allied Powers appears to have been none in investors' eyes. It

[47] For illustrative purposes, Table A.12 in the online Appendix reports unit root test results for when merging the war and post-war periods into one period. The picture slightly changes in that, first and foremost, the Ottoman Empire, Romania, and Serbia could not have been "integrated" with any other country. However, I favor splitting the period 1915–1919.

Table 39: Summary results on Johansen tests for cointegration

Countries/Alliances [possible no. of cointegrating vectors per period]	Number of significant cointegrating vectors by sub-period		
	Pre-war period	War period	Post-war period
Within Central Powers			
(1) AUT, BUL, GER, TUR [6]	2 (GER/BUL; TUR/BUL)	1 (AUT/GER)	1 (AUT/GER)
Within Allied Powers			
(2) ENG, FRA, RUS [3]	n/a	2 (FRA/ENG; FRA/RUS)	0
(3) ENG and CHN, ITA, JAP, POR, ROM, SER [6]	n/a	3 (ENG/ITA; ENG/ROM; ENG/SER)	0
(4) FRA and CHN, ITA, JAP, POR, ROM, SER [6]	n/a	1 (FRA/SER)	1 (FRA/ITA)
(5) RUS and CHN, ITA, JAP, POR, ROM, SER [6]	1 (RUS/SER)	1 (RUS/CHN)	0
(6) CHN, ITA, JAP, POR, ROM, SER [15]	0	3 (CHN/ITA; CHN/POR; CHN/ROM)	1 (CHN/ITA)
Between factions			
(7) AUT, BUL, GER, TUR vs. RUS [4]	0	1 (GER/RUS)	0
(8) AUT, BUL, GER, TUR vs. ENG, FRA [8]	n/a	5 (AUT/FRA; AUT/ENG; GER/FRA; GER/ENG; BUL/ENG)	2 (GER/FRA; BUL/FRA)
(9) AUT vs. CHN, ITA, JAP, POR, ROM, SER [6]	1 (AUT/SER)	0	1 (AUT/POR)
(10) GER vs. CHN, ITA, JAP, POR, ROM, SER [6]	0	2 (GER/ROM; GER/SER)	2 (GER/POR; GER/JAP)
(11) TUR vs. CHN, ITA, JAP, POR, ROM, SER [6]	0	0	0
(12) BUL vs. CHN, ITA, JAP, POR, ROM, SER [6]	0	0	0

Sources: Author's own computations; cf. the online Appendix.
Notes: Country pairs are in square brackets. The results of Trace and Maximum Eigenvalue tests determined for which country pairs I would estimate Johansen VECMs. Models were estimated with either unrestricted constant or unrestricted trend. Superior model selected according to the AIC. Note that "n/a" is "not available".

is also striking to find no cointegration for all three pairs in the intermediate post-war period; at least, the existence of such a relationship between France and England as victors was to be expected. Moreover, subsamples (3) to (6) add another nine significant cointegrating relationships out of thirty-three possible ones. A monolithic block certainly looks different.

As argued above, a necessary condition for two or more countries to be truly perceived as an alliance seems to be that these countries are not perceived as *cross-allied* with opponents at the same time. So, technically, we should be able to reject cointegration between opposed countries' yields. Yet subsamples (7) to (12) indicate that this condition is not fulfilled. Of thirty-six possible cases of no cointegration, we find no less than nine significant relationships for the war period, but only one for the pre-war and five for the post-war period. This might not be problematic if only pairs of minor players showed cointegration. But, in fact, cointegration has been detected for almost all Great Power pairs – if we counted Austria(-Hungary), England/UK, France, Germany and Russia as such. The only combination missing is Austria-Russia. There might be a trivial reason explaining this result. It could, for example, be that my way to dampen the distorting effects of exogenous shocks affecting all yields simultaneously does not properly work. But if this were the case, we might also expect the incidence of cointegrating relationships to be higher among the "Great Power-opposed Minor Power" pairs than it actually is. With reservation, we may conclude that, in the eyes of investors, the boundaries of the two alliances' cores became indistinct, dubious. Except for Bulgaria, the non-alliance relations between the Great Powers and the opposed Minor Powers were perceived as being considerably clearer.[48]

Based on the findings in the main part, the three simple hypotheses established above can be answered as follows: The Central Powers, indeed, did not form a credible alliance in the sense that all country pairs were separately perceived to reflect credible alliances; that is, for investors at Amsterdam, a monolithic block named Central Powers did arguably not exist (H0-A). This assessment equally holds for the perception of the Allied Powers (H0-B). Up to here, the findings are well in line with the notion that World War One was a

[48] One might claim that it is too restrictive to pre-eliminate country pairs right away with the unit root, Trace, and Maximum Eigenvalue test results. From a technical point of view, there seems to be room for arguing that the only valid test of the existence of a significant cointegrating relationship is the hypothesis test on the *estimated* cointegrating vector – irrespective of what the pre-tests say. I refer here to the statistical literature on the problem of *near-integrated* time series which is, in fact, a problem of "almost (no)" or "near" unit roots; cf. e. g. Phillips (1988), Cavanagh et al. (1995), Elliott (1998), and Hjalmarsson/Österholm (2007). Given the partly indeterminate results of the DFGLS test, it might be reasonable to consider the yield pairs dropped in steps one and two as potentially near-integrated. However, as in my view "near-integration" is in some way a highly elusive concept, I stick to the results of my structured approach and do not engage in altering the assumptions.

global conflict made of multiple layers. There was the hegemonic struggle of the Great Powers establishing the frame and, arguably, attracting most attention then as now. And there were the various struggles intended to push through territorial and trade agendas under the cover of the core conflict. Investors seemingly got a sense of how diverse and incompatible the agendas had been in numerous cases. However, it is somewhat surprising that there are pairs of opponents – especially among the Great Powers – that show cointegrated yields *although* they are not supposed to (H0-C).

What are we to make of these ambiguous findings? How can we explain the seemingly cross-integrated alliance cores? One substantive explanation might be that this is simply an expression of investors acknowledging the deep-rooting pre-war financial interrelationships between the Great Powers that a war would not quickly unmake.[49] In fact, the war negatively impacted on these interrelationships through the restrictions of the capital market and, possibly, goods markets immediately imposed by the belligerents (e. g., abandonment of the gold standard by suspending convertibility, restricting the trade of opponents' securities at the principal stock exchanges) and the following trade disruptions (e. g., the naval blockade by Britain, Germany's unrestricted submarine warfare).[50] However, not so easy to destroy, we may argue, were any financial relationships based on cross-holdings of sovereign debt.[51]

We should probably distinguish between a *de facto* disintegration of capital markets due to no, or very limited, arbitrage opportunities left and what may be called "mental disintegration". So, what we have here, then, might be called a *mental measure* of capital market (dis)integration as opposed to a *material measure* (effective restrictions on arbitrage between two trading places) that would tell of immediate disintegration over the war. It would be interesting to see whether we made a similar observation when analyzing other principal trading places (at times of war) in the fashion put forward here.

Another suggestion I want to put forward here is that this finding might express investors' awareness of the *trench (warfare) trap*. It is commonly acknowledged among historians that the switch to trench warfare in grand style prolonged the war, raised costs, and essentially built in stone the stalemate that took belligerents a while to overcome. Investors – the professionals perhaps to a larger extent than the amateurs – assumingly had a feeling for costs and for how increasing costs due to a prolonged war would affect the finances of the great players – that is, default probabilities. However, under the temporary *veil of not*

[49] On financial market integration in the First Age of Globalization, cf. Neal (1986), Bordo/Rockoff (1996), Goetzmann et al. (2001), Estevadeordal et al. (2003), Findlay/O'Rourke (2003), Obstfeld/Taylor (2003), and Volosovych (2011, 2013).

[50] Cf. Schwabe (1915), Henning (1992), Kiehling (1998), Michie (1999), Silber (2005), and Bernal et al. (2010).

[51] Cf. e. g. Turner (1996).

knowing regarding the question as to which alliance was going to win the war investors saw the major belligerents mutually entrapped so that, financially seen, perceived country risks did not decisively diverge from one another in the long run. A pairwise cross-cointegrated alliance core then is kind of the statistical expression of the "trench equilibrium" in which opposing forces just compensate each other. Whatever term one may use to describe the situation – "stalemate" or maybe "gridlock" –, it was a stable situation in essence, and that is what characterizes equilibrium. Investors seem to have perceived this.

Is there a way to improve on this picture of investors' alliance perceptions at the time? I think yes, and I propose a "sub-periods" test in the following chapter as an adequate extension. This test will allow for intermittent *non-cointegration* between two alliance partners, thus will explore the possibility of *unstable* public alliance perceptions, softening the limiting assumption of the global test.

6. Empirical findings on a "sub-periods" test

6.1. Correlation coefficients once more

To motivate the notion that alliance perception may well have been *unstable* over time rather than *fixed* – that it may well have broken and two, or maybe more, "alliance perception regimes" per country pair exist in the data – I turn to the coefficient of correlation again, a descriptive tool to measure co-movement of two series. However, this time, we have to assess *moving* correlations as an extension of the way correlation was measured in the preceding subchapter.[52] A moving correlation is nothing other than the coefficient of correlation for two series computed for a constant window of so-and-so many days, D (in the case of daily data, of course), where D is considerably smaller than the total number of observations, T, available on each series. There is no rule as to the length of the window. It should just not be too small or too large. This window is moved over the series day by day such that we end up with as many computed coefficients of correlation as we have full windows.

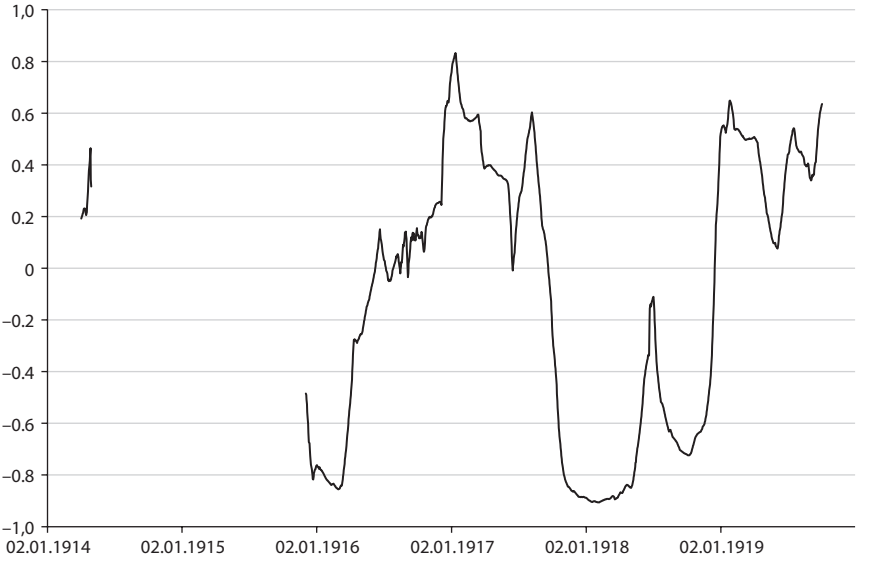
Figure 54 gives a first impression of what a moving correlation may look like. Depicted are the centered six-month and one-year moving correlations between the German and the Russian yield spread. Window length is, precisely, 181 and 365 days; and the first window is 3 January to 2 July 1914 and 2 September 1915 to 30 August 1916, respectively, with the corresponding coefficient of correlation depicted for 3 April and 2 March, the windows' center.

Firstly, as a technical matter, it is evident that the larger the window, the more the moving-correlation-series is smoothed. Analogously, if window length was shortened to less than six months, there would likely be more spikes or,

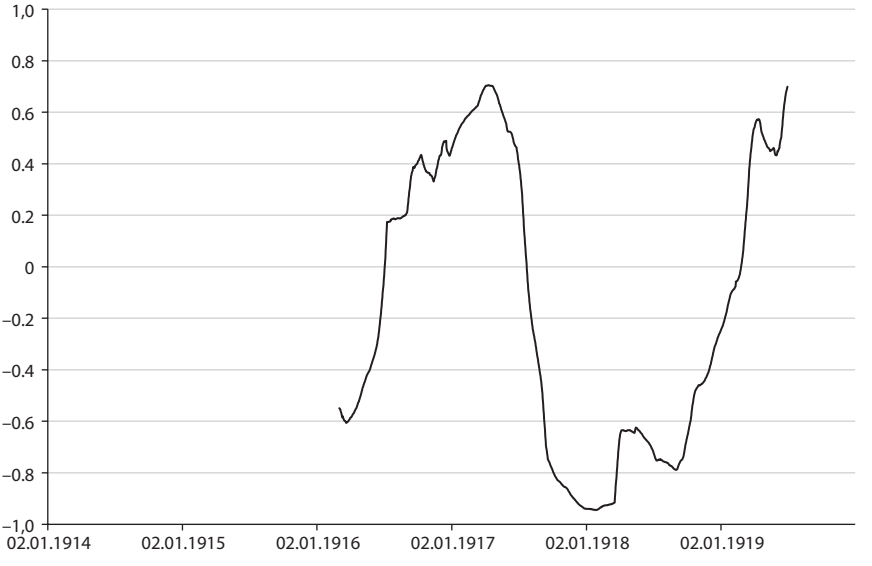
[52] Cf. Waldenström (2014: 25) for an application on Swedish bond and stock market series.

Figure 54: Moving correlation between the German 3 % and the Russian 4 %

(a) Six-month moving correlations

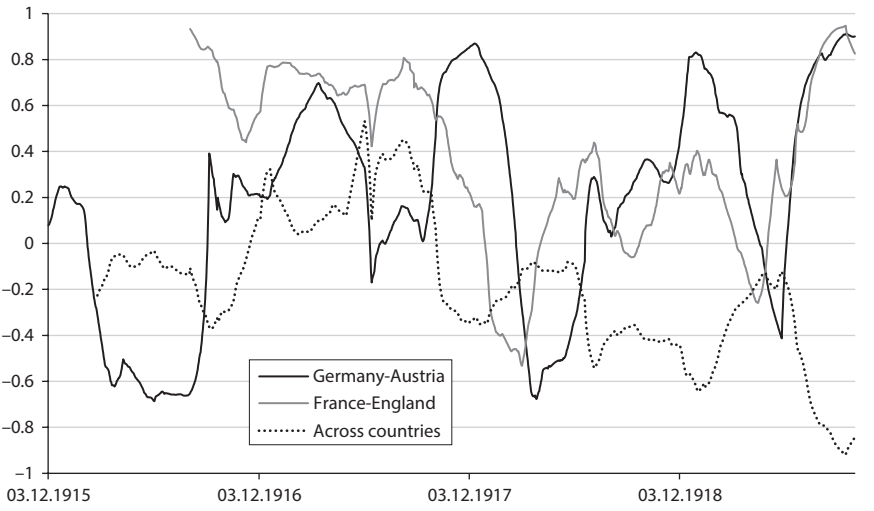


(b) One-year moving correlations



Sources: Author's own computations.

Figure 55: Additional pairwise moving correlations

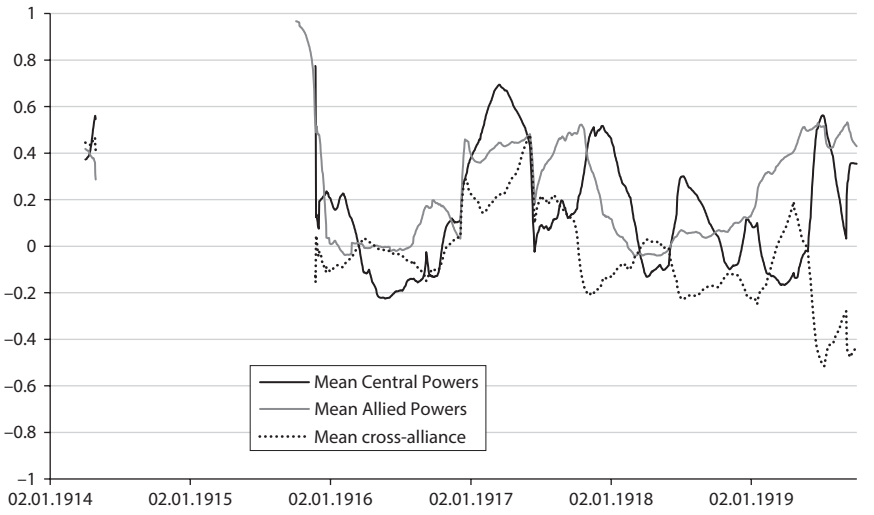


Sources: Author's own computations.

respectively, ups and downs. Secondly, regarding substance, we can gather from Figure 54 that there were two distinct phases of negative correlation between the German and the Russian series, namely, the part of the war period before mid-, or end of, June 1916 (depending on window length) and the sub-period between the end of July, or end of September, 1917 (again depending on window-length) and the end of 1918 (or beyond). In other words, for a bit more than a year, both series show positive co-movement.

Figure 55 extends the view on *wartime* co-movement among the pairs Germany-Austria, France-England, and the cross-correlation for the four opponent pairs (Germany-France, Germany-England, Austria-France, and Austria-England). Interestingly, while the German Empire and Austria have turned out to be a globally integrated alliance in the previous subchapter, they no longer appear to when looking at on moving correlations. There were phases of distinct, intermittent negative correlation, such as the period between mid-March 1916 and mid-August 1916 or March to May 1918, the point in time when Germany launched its spring offensive. Regarding the pair France-England, we likewise observe a phase of more distinct opposed movement, namely the months around January 1918, into which the defeat of Russia and the beginning of the peace talks at Brest-Litovsk fall. Finally, cross-alliance correlation was unexpectedly positive between end of 1916 and early October 1917, which may be – with all due caution – be interpreted as the actual "stalemate equilibrium" as seen through investors' eyes.

Figure 56: Moving correlations including all country pairs



Sources: Author's own depiction.

Finally, Figure 56 draws the "grand picture" by depicting the *average* of the centered six-months moving correlations among all country pairs within the Central Powers, within the Allied Powers, and across opponents. Without going into detail, the graphs reveal that there were, on average, distinct phases of co-movement among allies as well as distinct phases of divergent movement. As expected, divergent movement (negative correlation) was more prevalent in cross-alliance relationships.

6.2. Was perceived credibility unstable?

Given the moving correlations' implications, publicly perceived alliance credibility, or incredibility, was obviously not stable over time – in contrast to the basic assumption of the global view. Perception seems to have been subject to breaks separating phases of perceived credibility from phases of perceived incredibility. Here, this approach has a clear link with the structural break analysis performed in Chapter III, as these breaks are endogenously identified by the series, so to say.

There is indeed technical literature supporting the meaningfulness of the idea of an alternating pattern of temporary cointegration and temporary non-cointegration.[53] The test I am going to perform in this section principally allows for variation in investors' perception in some boundaries defined by technical

[53] Cf. e. g. Davidson/Monticini (2010).

matters. More specifically, the test is designed as to endogenously identify breaks between periods of cointegration and periods of no cointegration. Indeed, there are approaches in the literature that focus on determining structural breaks in the parameters of a cointegration relationship. However, it is imperative to note that the basic assumption of those approaches is that cointegration holds over the entire study period, whichever period it is; there may be breaks in the short- and long-term parameters of the cointegrating relationship, but no fundamental change like I suspect to find in my data.[54] Thus, I test for something different with a somewhat *ad-hoc* "rolling cointegration test".

The global test came up with the puzzling observation that the Great Powers' yields were cointegrated with one another, implying, in particular, cointegration between opponents' yields. So, in the following, the sub-periods test is applied only to this group of five countries – Austria, England, France, Germany, and Russia. Basically, my test centers on estimating the Johansen Trace and the Augmented Engle-Granger (AEG) pre-tests on cointegration for windows of 360 days length moved in *seven-day* steps.[55] Take the German 3 % and the Austrian 4 % as examples. Trade in the German 3 % was resumed some days after trade in the Austrian one had kicked in again. So, the first 360-day window for which the cointegrating rank determined by the Trace test and the AEG statistic were recorded is 7 September 1915 to 31 August 1916. The next estimation window was 14 September 1915 to 7 September 1916, and so on.[56] Note that I stored the cointegrating rank and the AEG statistic for two baseline models of the cointegrating equation – one assuming that the cointegrating vector is stationary around a mean (model with constant) and the other assuming it is stationary around a linear time trend (model with trend). Figure 57 exemplarily depicts the recorded series for the pair Germany-Austria and the model with constant.[57] The dashed line in the upper part reports the rank determined by the trace test (either one or zero). The solid line reports the AEG test statistic. The dotted horizontal lines represent the one-, five-, and ten-percent critical values for the AEG test.

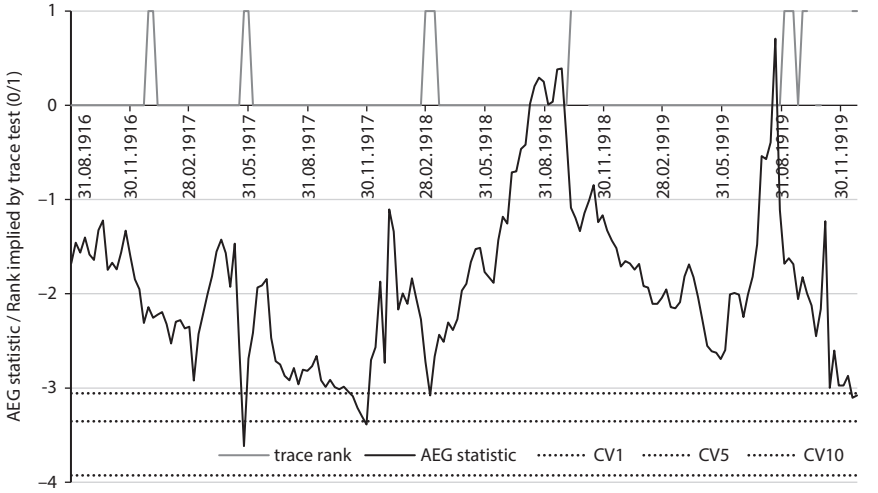
[54] Cf. Gregory/Hansen (1996a, 1996b), Arai/Kurozumi (2007), Kejriwal (2008), Kejriwal/Perron (2008), Hatemi-J (2008), and Maki (2012).

[55] In my opinion, a window length of at least 360 days is appropriate, given that a cointegrating relationship implicates a long-term equilibrium between two yield series. I do not show sensitivity analyses performed on smaller or larger windows. But the picture seems to critically depend on window length chosen. The AEG test according to Engle/Granger (1987) was performed in Stata with the add-in developed by Schaffer (2010).

[56] To be precise, for each pair I began rolling estimation with the window from 9 February 1915 to 3 February 1916. In the Germany-Austria case, the first window for which I have full observations for both series is the window beginning on 7 September 1916. However, trade in the German 3 % occurred for the first time during the war on 3 September. So, formally, we have lost four yield observations at the beginning.

[57] I spare showing the other figures; they are available upon request.

Figure 57: Exemplary rolling trace and AEG tests for the country pair Germany-Austria



Sources: Author's own computations.
Notes: The rolling window's length is 360 days. Every seventh rolling window was estimated.

In a next step, I specified the windows for which the tests detected a potential cointegration relationship. Regarding the Trace test, a rank of one was determined, for example, for the windows from 4 January 1916 to 28 December 1916 and from 11 January 1916 to 4 January 1917, as reflected in the first "spike" in the dashed line. Regarding the AEG test, every window was selected for which the test statistic exceeded the ten-percent critical value; for example, the window from 30 May 1916 to 24 May 1917 which is the first downward spike in the solid line passing the first dotted line. Adjacent windows were merged into a larger window. Larger windows determined this way could have overlapped. If possible, I also determined larger windows of no cointegration according to the pretests' results. For either type of window selected this way, I estimated a Johansen VEC model with an unrestricted constant and performed a hypothesis test on the cointegrating vector as outlined above and in the online Appendix. In the end, I was able to come up with larger windows within which a cointegrating relationship may hold, or may not hold.

For every country pair and separately for the two tests, Tables 40 and 41 report the respective phases along with a judgment on the existence of a cointegrating relationship ("YES/NO") based on the model with a constant. For all phases for which I could not find cointegrated yields based on the model with constant, I additionally estimated the VEC model with an unrestricted trend and

Table 40: Rolling cointegration test – within-core alliance view

	Were the spreads cointegrated in the particular phase?			
Rolling …	GER/AUT	FRA/ENG	FRA/RUS	ENG/RUS
A) Trace test				
Phase 1	YES: 03/09/1915–14/03/1918	YES: 09/05/1916–07/03/1918	NO: 30/11/1915–27/03/1916 [trend: no]	NO: 09/05/1916–14/06/1917 [trend: no]
Phase 2	NO: 15/03/1918–09/09/1918 [trend: yes]	NO: 08/03/1918–19/08/1918 [trend: no]	YES: 28/03/1916–18/09/1919	YES: 18/07/1916–29/08/1918
Phase 3	YES: 10/09/1918–31/12/1919	YES: 14/08/1919–31/12/1919	NO: 19/09/1919–31/12/1919 [trend: no]	NO: 26/02/1918–27/03/1919 [trend: yes]
Phase 4	–	–	–	YES: 26/11/1918–31/12/1919
B) AEG test				
Phase 1	NO: 03/09/1915–29/051916 [trend: yes]	YES: 09/05/1919–20/12/1917	NO: 30/11/1915–10/01/1916 [trend: no]	NO: 09/05/1916–03/04/1919 [trend: no]
Phase 2	YES: 30/05/1916–07/03/1918	NO: 21/12/1917–15/07/1918 [trend: no]	YES: 11/01/1916–04/01/1917	YES: 04/04/1919–31/12/1919
Phase 3	NO: 08/03/1918–23/12/1918 [trend: no]	YES: 16/07/1918–31/12/1919	NO: 05/01/1917–19/08/1918 [trend: yes]	–
Phase 4	YES: 24/12/1918–31/12/1919	–	YES: 20/08/1918–14/08/1919	–
Phase 5	–	–	NO: 15/08/1919–31/12/1919 [trend: yes]	–

Sources: Author's own computations.
Notes: The basic model is a Johansen vector error correction model with an unrestricted constant. Robustness of periods with no cointegration under that model regime are checked for cointegration assuming an unrestricted trend instead of a constant only (judgment in square brackets). Selection of sub-periods is based on the AEG test on the ten-percent level or better. Assumed level of significance for the underlying hypothesis test on the cointegrating vector is five percent or better.

Table 41: Rolling cointegration tests – across-core alliances view

	Were the spreads cointegrated in the particular phase?		
Rolling …	GER/FRA	GER/ENG	GER/RUS
A1) Trace test			
Phase 1	YES: 30/11/1915–12/06/1916	NO: 09/05/1916–12/06/1916 [trend: no]	YES: 07/09/1915–31/12/1919
Phase 2	NO: 13/06/1916–12/03/1917 [trend: no]	NO: 13/06/1916–25/11/1918 [trend: yes]	–
Phase 3	YES: 13/03/1917–07/03/1918	YES: 26/11/1918–31/12/1919	–
Phase 4	NO: 08/03/1918–29/07/1918 [trend: yes]	–	–
Phase 5	YES: 30/07/1918–31/12/1919	–	–
B1) AEG test			
Phase 1	YES: 30/11/1915–27/03/1916	NO: 09/05/1916–02/04/1917 [trend: no]	YES: 07/09/1915–03/06/1918
Phase 2	NO: 28/03/1916–16/08/1917 [trend: yes]	NO: 03/04/1917–18/04/1918 [trend: yes]	NO: 04/06/1918–29/05/1919 [trend: yes]
Phase 3	YES: 17/08/1917–31/12/1919	YES: 19/04/1918–31/12/1919	YES: 30/05/1919–31/12/1919
	AUS/FRA	AUS/ENG	AUS/RUS
A2) Trace test			
Phase 1	NO: 30/11/1915–08/05/1916 [trend: no]	NO: 09/05/1916–07/03/1918 [trend: yes]	YES: 24/08/1915–08/05/1916
Phase 2	NO: 09/05/1916–14/06/1917 [trend: yes]	YES: 16/02/1918–31/12/1919	NO: 09/05/1916–10/05/1917 [trend: no]

	Were the spreads cointegrated in the particular phase?		
Rolling …	GER/FRA	GER/ENG	GER/RUS
Phase 3	NO: 15/06/1917–15/10/1917 [trend: no]	–	NO: 11/05/1917–16/09/1918 [trend: yes]
Phase 4	YES: 16/10/1917–31/12/1919	–	YES: 17/09/1918–31/12/1919
B2) AEG test			
Phase 1	NO: 30/11/1915–22/03/1917 [trend: no]	NO: 09/05/1916–24/09/1917 [trend: yes]	YES: 24/08/1915–06/03/1916
Phase 2	YES: 23/03/1917–31/12/1919	YES: 25/09/1917–31/12/1919	NO: 07/03/1916–14/06/1917 [trend: no]
Phase 3	–	–	YES: 15/06/1917–31/12/1919

Sources: Author's own computations.
Notes: The basic model is a Johansen vector error correction model with an unrestricted constant. Robustness of periods with no cointegration under that model regime checked for cointegration assuming an unrestricted trend instead or a constant only (judgment in square brackets). Selection of sub-periods based on the AEG test on the ten-percent level or better. Assumed level of significance for the underlying hypothesis test on the cointegrating vector is five percent or better.

performed the obligatory hypothesis test on the cointegrating vector – that is, the double normalization restriction (judgment in square brackets).[58]

Table 42 provides a summary of the intermediate evidence presented in Tables 40 and 41 by reporting, for each country-pair, the sub-period(s) with no cointegration according to the two tests. Since I do not want to run the risk of over-interpretation, which is always an issue when choosing a quantitative-historical approach, I decided to look upon the smallest common denominator of both tests – namely the overlap of those periods. So, as an *absolute bottom line* I can deconstruct the "global picture" drawn in the previous subchapter in the following way: Evidence based on the sub-periods test proposes that Germany and Austria went through a phase of perceived alliance *dis*integration from

[58] The implication here is that phases of cointegration could well exhibit structural breaks in the parameters.

Table 42: Summary on rolling cointegration – was the core permanently integrated?

	Sub-period with no cointegration*	Rolling test (Trace/AEG)	Overlap (Trace/AEG)
(1) Germany/Austria	08/03/1918– 23/12/1918 (a)	AEG	–
(2) France/England	08/03/1918– 19/08/1918 (a) 21/12/1917– 15/07/1918 (a)	Trace AEG	03/03/1918– 15/07/1918
(3) France/Russia	30/11/1915– 27/03/1916 (a) 19/09/1919– 31/12/1919 (a) 30/11/1915– 10/01/1916 (a)	Trace Trace AEG	30/11/1915– 10/01/1916
(4) England/Russia	09/05/1916– 14/06/1917 (a) 09/05/1916– 03/04/1919 (a)	Trace AEG	09/05/1916– 14/06/1917
(5) Germany/France	13/06/1916– 12/03/1917 (b)	Trace	–
(6) Germany/England	09/05/1916– 12/06/1916 (b) 09/05/1916– 02/04/1917 (b)	Trace AEG	09/05/1916– 12/06/1916
(7) Germany/Russia	–	–	–
(8) Austria/France	30/11/1915– 08/05/1916 (b) 15/06/1917– 15/10/1917 (b) 30/11/1915– 22/03/1917 (b)	Trace Trace AEG	30/11/1915– 08/051916
(9) Austria/England	–	–	–
(10) Austria/Russia	09/05/1916– 10/05/1917 (b) 07/03/1916– 14/06/1917 (b)	Trace AEG	09/05/1916– 14/06/1917

* (a) no alliance perceived or, respectively, (b) no trench warfare trap perceived
Sources: Author's own computations.

March 1918 to about December 1918. This assessment is based on the results from the AEG test. In investors' eyes, what might have caused the breaks? We can speculate, but the timing certainly matches the large – and, as we know with hindsight, the last – offensive of the Central Powers in spring and early summer. An obvious interpretation is that investors perceived Austria(-Hungary) as already being on the edge of its possibilities, as having exploited its resource potential (or its capacities) in the broadest sense, while Germany still had potential to turn the odds. Consequently, the spring offensive was perceived as a German action in the first place, and not action that should be ascribed to the bilateral alliance. However, in investors' eyes, Germany and Austria(-Hungary) certainly lost the war together. Interestingly enough, both players were perceived as reintegrated again in defeat.

In the same manner, we can go through the other pairs. Exemplarily, take pair (2). France and England were perceived as being disintegrated as allies from March 1918 to July 1918. This pretty well matches the German spring offensive, implicating that investors perceived the German final attempt to win the war as an attempt that could really turn the tables in favor of the Central Powers. However, when the Allied Powers managed to instigate their massive counteroffensives in the summer, investors quickly re-established France and England being in alliance.

Regarding pairs (5) to (10) – the pairs of opponents – the test suggests that (i) German and Russian as well as Austrian and English yields were permanently cointegrated; that (ii) Germany and France were perceived disintegrated since around the end of the First Battle of Verdun and the US sustainably entering the scene; that (iii) Germany and England were temporarily perceived disintegrated in the last phase of the First Battle of Verdun, potentially implying that investors thought Germany would be victorious and thus, maybe, would escape the "trench warfare trap"; that (iv) Austria and France were essentially perceived disintegrated from November 1915 to May 1916; and that (v) Austrian and Russian yields show no cointegration between May 1916 and June 1917. Given the evidence on intermittent non-cointegration derived from a simple test, the permanently integrated core of the Great Powers we found above, somewhat making us forget the boundaries between the two major alliances, was not so permanently integrated, at all, it seems.

7. Discussion

In this concluding subchapter, I briefly focus on two questions following from the evidence: Firstly, globally viewed, is there a possibility to condense the evidence into a measure of the perceived degree of alliance integration? Secondly, is there a way of measuring the perceived nature of the underlying bilateral al-

liances as to which partner was perceived the leading player? Or were alliance partners perceived as equals?

7.1. Measuring the degree of alliance integration

Turning to the first question, Table 43 offers estimates of the perceived degree of alliance integration. I consider an unweighted and a weighted measure. Given the nature of the global test's statistical evidence – namely to be provided with the *number of* statistically significant cointegrating relationships per alliance over wartime – the two measures cannot give more than a crude notion of the matter.

Let us begin with the unweighted measure. Therefore, note that Table 43 reports the number of integrated country pairs by major alliance and within by the countries' power status – that is, subsets (1) to (3) and (5) to (7). Moreover, given is the total number by major alliance. The table reports the perceived degree of alliance integration by power status subset – as if the alliance consisted only of countries within the subset – as well as for the entire alliance. The unweighted degree of integration of the Central Powers is 1/6, so 17 percent as, essentially, only Germany and Austria were perceived to be in bilateral alliance. In contrast, for the Allied Powers, we can compute the degree to 28 percent, if Russia is included, and 22 percent when excluded.

However, as has already been pointed out in the discussion on the structural break-based perception indices in Subchapter III.7, there were certainly massive qualitative differences between the countries as to their material capabilities. So, it seems reasonable to look for a way of weighting the bilateral alliance's importance for the superstructure. I therefore implemented simple weights, w, for each country pair, p, based on the pre-war CINC distribution of 1914 among the subset of countries studied here. For each pair, I computed the sum of the two country's 1914 CINC values. I then divided the cumulative sum across all pairwise summed CINC values by a pair's sum to get the weight. The weight for the pair "Germany-Austria", for example, is 31.2 percent, and all three pairs including Germany have a cumulated weight of 77 percent.

This way, we arrive at perceived degrees of alliance perception that somehow take into account how important a bilateral alliance was for the overarching alliance and its war effort.[59] What we see is that the weighting increases the perceived degree of alliance integration to the aforementioned 31 percent for the Central Powers and to 40 (42) percent regarding the Allied Powers (excluding

[59] This procedure is all but perfect. The significance, or non-significance, of bilateral alliances or of single countries for the war effort of the whole alliance may well be determined in a different way. Take Bulgaria, for example: Its material capabilities as measured by the CINC were extremely low. But the fact alone that Bulgaria entered the war led to Germany and Austria being directly geographically connected to the Ottoman Empire. This kind of geopolitical importance that is born out of the moment is, of course, not measured by the CINC and thus not measured by my weights.

Table 43: Perceived alliance integration during wartime as per the "global test"

Faction	# of integrated pairs	Expectation	Degree of alliance integration: Unweighted	Degree of alliance integration: Weighted
A) Central Powers				
(1) Major power–major power	1	1	100 %	100 %
(2) Major power–minor power	0	4	0 %	0 %
(3) Minor power–minor power	0	1	0 %	0 %
(4) Overall	*1*	*6*	*17 %*	*31 %*
B) Allied Powers				
(5) Major power–major power	2 (1)	3 (1)	67 % (100 %)	61 % (100 %)
(6) Major power–minor power	5 (4)	18 (12)	28 % (33 %)	36 % (34 %)
(7) Minor power–minor power	3 (0)	15 (10)	27 % (0 %)	53 % (0 %)
(8) Overall (Asia excluded)	*10 (5)*	*36 (23)*	*28 % (22 %)*	*40 % (42 %)*

Sources: Author's own computations.
Notes: The degree of alliance integration in rows (1) to (3) and (5) to (7) is computed as if the respective pairwise alliances formed the Central Powers or the Allied Powers. In other words, it is not the cumulated weight of the respective pairwise alliances in (4) and (8). The figures in parentheses in columns two to five refer to the case when Russia is excluded.

Russia). Still, both alliances were certainly not perceived as monolithic blocks. Apparently, the capital market saw through the complex web of different layers of alliances.

7.2. What can Granger-causality tell?

Two series being cointegrated just means that, firstly, they are each nonstationary series and that, secondly, both series are in long-term equilibrium. So, basically, both series may be drifting away from each other in the short term. But in the long term, they move together. In the previous analysis, I made use of that notion to implement the concept of "perceived alliance integration". A *credible* bilateral alliance – that is the assumption of my reasoning – should exhibit a common trend in the form of the cointegrating vector.

However, we can go one step beyond determining *that* two countries' yield spread series were in equilibrium. There is a statistical concept related to cointegration that may help us to also get an idea of whether one alliance partner was to be perceived, so to say, to dominate the alliance or whether both were perceived as equals. We may be inclined to ask in which direction the credibility runs that let the bilateral alliance as a whole look credible. The tool I am referring to is the concept of Granger-causality, after the statistician Clive Granger.[60] Following

[60] Cf. Granger (1969, 1980).

Table 44: Which alliance partner Granger-caused the other in the war-period?

Central Power – Central Power (1)	Allied Power – Allied Power (2)
Germany → Austria (**)	France → England (*)
	France ← Russia (***)
	England → Italy (*)
	England → Romania (**)
	England ← Serbia (*)
	France ← Serbia (**)
	Russia ← China (***)
	Italy ← China (***)
	Portugal ← China (**)
	Romania → China (**)

Sources: Author's own computations.
Notes: ***, **, * denote significance on the one-, five-, and ten-percent levels. In case of bidirectional Granger-causality, the lower significance level is given.

this concept, a series *X* can be considered to Granger-cause another series *Y* if the future course of that series *Y* can be predicted based on past observations of *X*. This is certainly a purely statistical concept of causality which, however, has proven helpful in qualifying the relationships between economic time series. Note that Granger originally formulated the concept for the analysis of predictive causality among stationary time series. But the concept can also be applied to nonstationary series. Without going into technical detail, I use Toda and Yamamoto's (1995) procedure to test for Granger-causality.[61] Note that the specific theoretical link between cointegration and Granger-causality is that if two series are cointegrated, *there has to be* unidirectional, or even bi-directional, granger-causality. Insofar I am not going to test for whether granger-causality is present or not, but in which direction it runs.

Table 44 summarizes the results separately by Central Powers' pairs and Allied Powers' pairs. The arrow indicates in which direction Granger-causality runs – that is, which series Granger-causes which or whether both series cause one another simultaneously. As was to be expected, causality ran from Germany to Austria. Regarding the Allied Powers, causality is in all cases unidirectional, too. While the French series Granger-causes the English, it is the Russian series that Granger-causes the French. We might see in this a market judgment that

[61] Cf., basically, Toda/Yamamoto (1995), but also Sims/Stock (1990), Toda/Phillips (1993), Rambaldi/Doran (1996), and Chigira/Taku (2003) for more theoretical background. Burhop (2006) uses the tests of Sims/Stock (1990) and Toda/Yamamoto (1995) to investigate whether banks caused the industrialization in Germany. Morys (2016), who studies the international gold standard, provides another economic historical application of the concept of Granger-causality.

the stand of France on the Western Front was dependent on Russia keeping up the Eastern Front. As the global test does not allow for the fact that Russia dropped out in the meantime, this finding seems to make sense. Apart from that, it matches very nicely with the fact that French investors held a considerable amount of Russian debt. Insofar, the direction of causality runs counter the direction of the original credit flow.[62] Regarding Serbia, this argument applies, too. While the direction of causality regarding the pair Russia-China is understandable, the causality running to or from the Chinese series is principally hard to explain. Finally, we find that England may be seen as lending credibility to Italy and Romania and, thus, as dominating these bilateral alliances, unsurprisingly.

[62] Cf., for example, Oosterlink/Landon-Lane (2006), Bernal et al. (2010), and Oosterlinck (2016).

V. Conclusions

"Public opinion is a variable and changing thing."[63] This is the first part of the passage I have quoted from Ebba Dahlin's (1933) early study of public opinion. As a matter of fact, it is the very first sentence of her study. If we seriously embark on the idea that sovereign bond prices, probably better than any other type of security, can convey public opinion on how a state fares, the evidence presented in this study indeed supports Dahlin's view. The core analysis was based on detecting *turning points* in investors' opinion on the belligerents' war effort. The concept of turning points is certainly a rather strict concept of measuring perception. This has to do with the assumption that perception is reflected in *breaks* in the bond price series. After all, a bond price series that does not break at any point is useless. Yet, the analysis has yielded no less than 58 turning points. These breaks mark fundamental changes in bondholders' expectations and jointly draw a picture of how dynamic bondholders perceived the war to be. From a bird's eye view, World War One may well be divided into three major regimes – the pre-stalemate phase when the path that would determine much of the war's total length emerged, the stalemate phase itself emerging in early to mid-1915, when the belligerents got locked in the "trench warfare trap", and the phase in which they transitioned from the old equilibrium to a new one. However, the turning points analysis shows that *perceived* probabilities of victory or, respectively, of defeat, implicit in sovereign bond prices, changed quite lively in the stalemate phase. From a methodological point of view, being able to observe perception in a fashion comparable to what has been done in this study cannot be underestimated for its value for research. I once more quote Ebba Dahlin:

> The material for the study of public opinion does not adequately reflect strata in a nation. Historically speaking, the less literate as well as the radical groups secure much less space than they deserve. Newspapers often express the views of the editor or of a small circle of readers; debates in legislative houses express the highly vocal party leaders; group publications reflect the views and intentions of specific organizations. However, evidence secured from actual events reveals a great deal, […].[64]

Investors were certainly neither representative of the "less literate" nor of the "radical groups". But observing them has a clear advantage over many a source:

[63] Dahlin (1971 [1933]: 9).
[64] Dahlin (1971 [1933]: 11).

they did not want to be heard; they did not want to spread their opinion; they did not want to persuade others of their opinion; they just traded. Surely, they traded for the motive of gaining wealth. But that is exactly what makes their perception so valuable. False expectations led to money losses. This, at least, means that investors would have tried to assess the situation rationally, level-headed. If they traded, they certainly sensed something important was going on. Insofar, observing turning points in sovereign bond prices may be understood as what Dahlin names "evidence secured from actual events". Or, to quote from Kristen Willard et al's (1996) ground-breaking turning points study:

> Participants in financial markets may not, of course, be "typical" of their contemporaries. But why should the opinions of thousands of people, distilled in market prices and expressed at the risk of their own personal fortunes, be viewed as any less representative than those manifested in the literary sources more commonly used by historians?[65]

That said, is analyzing bond price series for latent public perception only a worthwhile undertaking if one puts the focus on structural breaks? Beyond that it reflects an attempt at *interdisciplinary* public opinion research, the analysis performed on alliance perception has shown that there actually is more than one approach possible to filter out bondholders' perception. Without doubt, the cointegration approach to alliance perception stretches the notion of what bond prices may say about bondholders' perception to the maximum. While the structural break approach has some intuitive appeal, as it is easier to imagine how investors, at a particular point in time, adjust their expectations fundamentally, the cointegration approach somewhat breaks away from the individuals behind it. Yet, I am suggesting that this approach helps to broaden our understanding of World War One, too.

1. Turning points summary

The performed turning points analysis has been designed to be *agnostic*, thereby taking up a recent trend in economic history towards such design. Principally, this kind of design does not need input from historical accounts as to which events might be worth checking for abnormal price reactions that would indicate the events' significance in market participants' eyes. Rather, major events are determined endogenously, letting the price series – or, in fact, letting the investors – identify which events mattered and which did not.

From the perspective of the turning points approach, the history of the belligerents' war effort, as perceived by the Amsterdam bond market, is to be written as "Through World War One in a couple of turning points". This is certainly a provocative view. Maybe this is even an ignorant view, as much more is to be

[65] Willard et al. (1996: 1 017).

reported on World War One, obviously. This is indicated by the vast amount of literature produced on World War One, especially over the last three decades. It is definitely a reductionist view which, however, inevitably comes with the method.

For everyone who needs an even more intuitive notion of how turning points in sovereign bond prices are best interpreted in this light, I point to a common figure of speech: Turning points have, in my view, an interpretation similar to the "last drop causing the barrel to overflow". This interpretation fits quite nicely with the fact that actually a good number of turning points in a bond's prices happened after a stretch of time of no trade (and, thus, no prices). As I have argued, everything that happened in that stretch of time – sometimes a week or two, sometimes months – principally is to be taken into account. I have also argued that the turning point occurring at the end of such a stretch of time may be understood as a *cumulated* reaction, but was nonetheless triggered by an event close to the calendar date of the breakpoint. There must have been that "drop"; and I provided ideas on theses drops. To use the same metaphor, the happenings in between, so to say, filled the barrel with water until the tipping point was reached. In my view, we may attach this function to what I have introduced, according to parts of the literature, as "blips" in the discussion in Subchapter III.7. I discussed them exemplarily for the German Empire. That is certainly a worthwhile discussion to be extended to all analyzed bonds. However, this was not the primary scope of my analysis as I embarked on examining long-lasting adjustments in perception – or, on the "last drops", so to say. In fact, it is not standard practice in historical turning points research, which has, first and foremost, been focusing on the American Civil War and World War Two, to delve deeper into detecting "significant single day events", at all.[66]

Turning to the breakpoints summary, in short, 58 turning points in ten sovereign yield series have been identified by my approach. 25 of these have been identified in the Central Powers' bonds' prices and they distribute as follows: seven in the Austrian 4 %; five in the Bulgarian 5 %; eight in the German 3 %; and five in the Ottoman 4 %. 33 turning points have been detected in the Allied Powers' bonds' prices: seven each in the English 5 %; the French 5 %, the Italian 3.5 %, and the Russian 5 %; four in the Serbian 4 %; and one in the Romanian 4 %. The turning points in the Italian and Romanian series have to be taken with all due caution, as these bonds are prime examples of extremely thinly traded bonds. Yet, they represent the relatively most liquid issues for each country.

A vital part of the analysis, complementary to the breakpoints analysis, was checking for the plausibility of the breaks by accounting for economic "hard facts". Separate regressions on each series along with two time series-cross-section regressions reveal, firstly, that all but two breakpoints (one in the Austrian

[66] The study by Brown/Burdekin (2002) is one of the few studies simultaneously investigating such significant single-day events and events with a long-term effect in the form of turning points.

4 % and one in the Ottoman 4 %) indeed turn out to be robust and, secondly, that the set of explanatory variables performs quite differently in explaining yields. This may be interpreted with all due caution as showing that the bonds in question were not all part of the average investor's portfolio at once at the time. Market liquidity, in conjunction with the interest rate, turns out to be the variable which performs comparatively best in explaining variation in yields. Portfolio effects could not be substantiated to have generally mattered. Foreign and domestic inflation does not explain variation in the separate series at all, which might be due to measurement insufficiencies. Though, reviewing the time series cross-section models, variation in yields can be explained by exchange rates in at least one of two models.

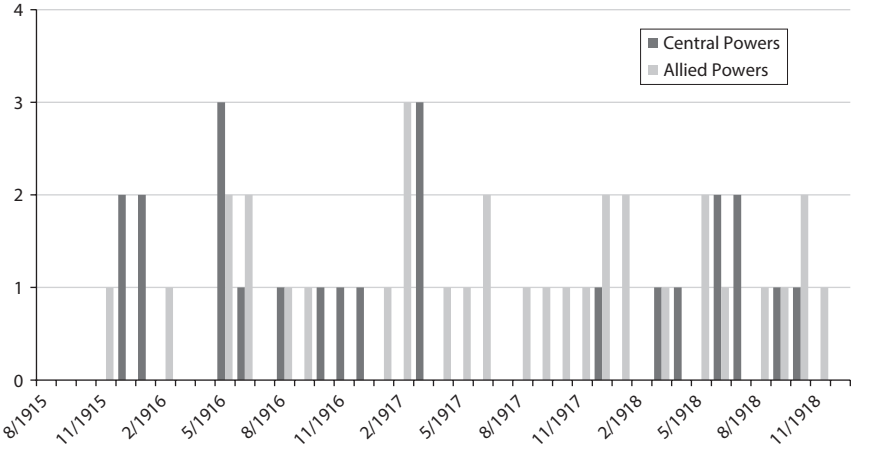
A straightforward historical hypothesis was suggested stating which ten events should most likely turn out as significant breaks in sovereign yields according to historians' judgment – among others, the entry of the USA into the war, Wilson's Fourteen Points, or the peace treaty of Brest-Litovsk. Evidence is quite mixed, though. Approximately half of the detected turning points actually relate to these major topics. The three events (or, in fact, sequences of events) most consistently implied as major turning points were the (i) the First Battle of Verdun and especially June 1916 (detected in six of ten series), (ii) the Central Powers' spring offensive since late March 1918 (detected in five series), and (iii) the Allied Powers' answer since late summer 1918, ultimately bringing war to a head (also detected in five series). They match well with the historical hypothesis put forward to organize thoughts.

Putting both parts of the structural break analysis together, a noteworthy implication arises for our understanding of sovereign debt valuation during wartime. The major breaks were all due to military, maybe diplomatic, news. But it seems, so far, that financial "hard facts", coming in the form of news reports or "only" in the form of not further commented statistical material (the one-month interest rate on day *x*, for example), cannot convincingly explain the fundamental re-evaluations of the belligerents' country risk that took place from time to time. This certainly holds under the assumption that the average investor informed himself mainly on the basis of broader-scope newspapers, with the *Algemeen Handelsblad* leading the way. Besides, evidence indicates that both the role of market liquidity during wartime and also the bonds' individual liquidity history deserve more attention in future research.

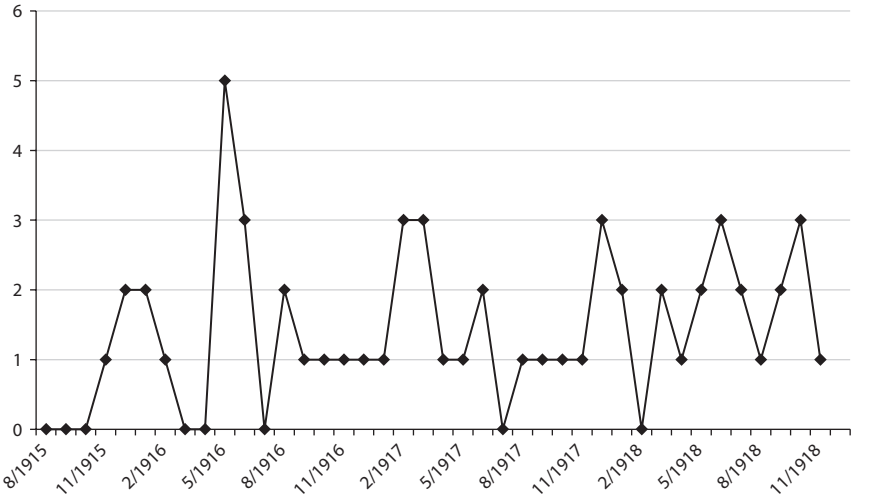
Figure 58 is an attempt at summarizing the turning points evidence in a way that shows how investors perceived the war's dynamic. The figure is solely based on the number of turning points and shows their timing by month – panels (a) and (b) – as well as by three-month periods – panels (c) and (d). While panels (a) and (c) present the simple number separately by faction, panels (b) and (d) provide an aggregate view. The pattern describing the Central Powers' war effort is somewhat clearer than the one for the Allied Powers. While the turning

Figure 58: Structural break summary

(a) Cumulated number of breaks in Central and Allied Powers' bonds per month



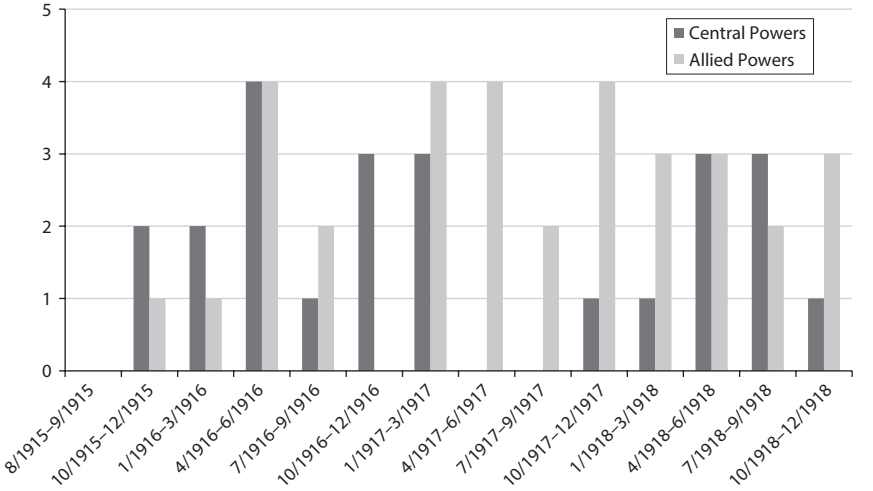
(b) Total number of breaks per month



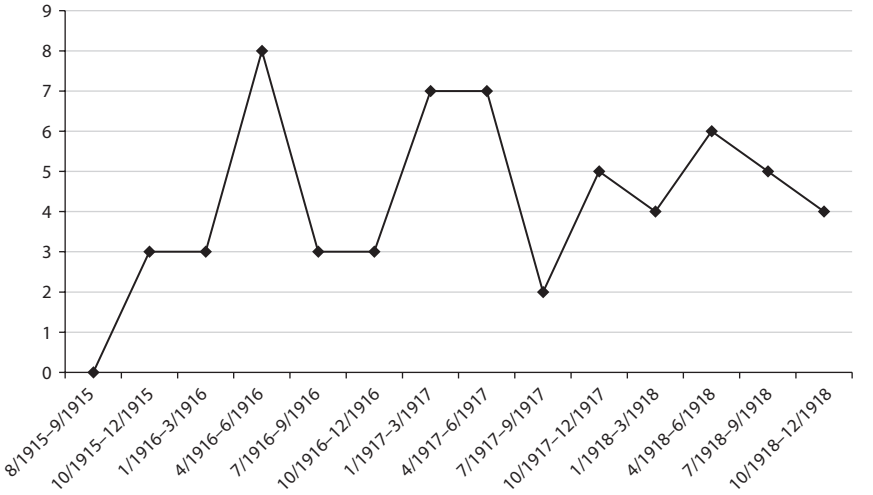
points in the Central Powers' series cluster in the periods from December 1915 to March 1917 and from December 1917 to October 1918, and thus exhibit a period between April 1917 and September 1917 of no perceived dynamic, the turning points in the Allied Powers' series somewhat distribute more evenly over the months under observation. Certainly, this is a very simple exercise to summarize the perceived dynamic, especially over the long stretch of gridlock

Figure 58 (continued)

(c) Cumulated number of breaks in Central and Allied Powers' bonds per three-month period



(d) Total number of breaks per three-month period



Sources: Based on the findings in Chapter III.

generally pointed to by historians – from 1915/1916 to December 1917 or, respectively, March 1918.

However, there are clear technical limits to condensing the turning points evidence into *aggregate* measures of bondholders' perception. This is because the analysis was intentionally kept on a level that ensures that the evidence would offer, beyond mere *statistical* plausibility, *historically* plausible interpretations – that is, interpretations that are comprehensible for non-specialists.[67] But this is essentially what the turning points analysis delivers: the *timing* of events perceived as important by contemporary bondholders; and the severity of the events as discussed in detail in Chapter III. So, there are clear technical limits for how aggregate perception or, as we may stretch the issue verbally to: "mood curves", can be depicted.

2. Have historians missed out on major events?

I want to take up a point here that I have spared in the discussion of the structural break evidence in Chapter III.7. A question following naturally from the agnostic structural break approach to public opinion is: have historians missed out on major events? Basically, the significance historians attach to an event (or a sequence of events) retrospectively – knowing how the story ended –, may well differ from the significance contemporaries were attaching to the event. The benefit of hindsight allows forming scholarly opinion on an event's role in a whole chain of events; a chain that contemporaries were not easily able to observe or construct in real-time. In the same vein, contemporaries may have seen relationships between events – a kind of causality maybe – that has not turned out to be anywhere near important after all, when knowing how the story ended. However, being able to reconstruct what drove past observers to think of an event in a particular way, and to act on their thoughts, is an achievement in itself – no matter whether today we know that they were wrong. The ambivalence of historians' hindsight, what it means for the research process, is an oft-debated topic. It is certainly not news when I establish the basic scientific problem here. But, what is news is that my approach offers new insights into the possible extent of such bias regarding the historiography of World War One. My study certainly makes a small step towards evaluating this issue with a source that has, as I have stressed several times, extremely nice properties and has not yet been exploited by researchers anywhere near to the extent I have. The turning points evidence discussed in Subchapter III.5 is an invitation for everyone, historian or otherwise, to rethink which events mattered to contemporaries of World War One –

[67] Cf. Jopp/Spoerer (2017: 38) on statistical versus historical plausibility; this is a key issue in the long-standing debate among historians on the surplus value and fallacies of a quantitative approach towards history.

especially when it comes to contemporaries' assessment of a belligerent's or an alliance's *ex ante* probability of victory or defeat. It is an invitation to discuss this approach's and the derived evidence's validity beyond my own assessment.

Regarding the question as to whether historians have missed out on important events, I will pick up only one example here. That is the example of the structural break in the German 3 % on 11 January 1916. I argued that this break – a massive break in investors' perception of the German Empire's *ex ante* probability of being victorious in the end – is attached to the coming of compulsory military service in England. Based on the fact that this issue was quite present in the *Algemeen Handelsblad* for days, producing major headlines, I am convinced that investors reacted to that event, anticipated its formal passing in British Parliament, and reckoned with German country risk to increase massively, as Britain would be able to conscript a significant number of troops beyond the voluntary forces existing at that moment in time.

I have underlined my own assessment with David Stevenson's (2005) assessment. It is not by chance that I referred to him. As to my impression, Stevenson's account of the "conscription controversy" is relatively voluminous compared to what we find on conscription and the Military Service Act's fate in other major works which are intended to provide the big picture on World War One.[68] In Hew Strachan's (2003) study, for example, we do find the topic "conscription" reported in the index, and also the name of Prime Minister "Asquith" as the conscription's principal proponent. However, we do not find the parliamentary debate and the passing of the act reported or discussed, let alone pointed out as a significant event. The same observation we can make regarding other important studies.[69] One reason why the "conscription controversy" is not, as it seems, a standard part of a big picture is that it failed in the end, as Stevenson (2005) points out. But given that many events are discussed although we know that they had no decisive effect on the war and may not even have generated public concern, this discrepancy at least warrants some closer examination. So, my list of turning points is also an invitation for specialists to cross-check for potentially missed-out events.

3. Alliance perception summary

A way of going beyond the agnostic structural break analysis has been suggested by the analysis in Chapter IV. The historical question posed at the beginning of the analysis certainly is in and of itself relevant, as historians as well as social scientists have long been interested in questions of alliance formation and al-

[68] Cf. Stevenson (2005: 198–206).

[69] Cf. e. g. Hardach (1977), Ferguson (1998: 198–199), Keegan (2003), Neiberg (2005), and Sondhaus (2011).

liance behavior. Yet, a neglected aspect seems to have been how contemporaries specifically perceived the alliances that formed on the occasion of World War One and specifically the *joint* effort of the alliance partners. No contemporary of World War One – investor or otherwise – could escape the basic knowledge that there were two major alliances in the first place – the Central and the Allied Powers; the superstructure, as I have been saying. It was the contemporary use of language in the newspapers. Yet, not so easy to grasp in real-time, we may assume, were the different layers which World War One was made of. This view is especially put forward by historians taking the "global approach" to World War One, taking more of a bird's eye view on it than historians specialized in the history of a particular participating country do. Historian Hew Strachan (2010), for example, strongly argues for the global character of the war that can, however, be deconstructed into various local conflicts fought under the superstructure established by the great European hegemonic powers. Those conflicts had little to do with the Great Powers' aims; and the fact alone that all major European Powers saw public war aims discussions over a considerable time of the war shows that they were not even sure about their own aims when entering the war. Strachan puts it nicely when saying that "[b]elligerence was a passport to the peace negotiations, which seemed likely to create a new world order."[70]

That "global-local view", we should be saying more fittingly, is a rather recent nuance added to the traditional view on World War One.[71] Following Strachan, the war's global character is much reflected in financial matters or, more precisely, in countries all around the world having been financially quite deeply interwoven with one another. All financial strands somehow sprang from Britain or, respectively, led there, as it was *the* international financial center of the world as of July 1914; in the words of Strachan once more: "Britain's entry to the war in 1914 therefore meant that finance and trade were affected globally, whether a state was belligerent or not, and Britain's economic warfare only underlined this point."[72]

Against the background of this recent nuance added to the literature on World War One, it somehow suggests itself to ask for whether contemporaries actually saw through these multiple layers of – partly diverging, partly well-paired – interests; and a reasonable unit of observation, that is this study's proposition, is the bilateral alliance, formed by written treaty or just by conclusive action, as countries wanted to secure themselves the "passport" to geopolitical and economic bliss.

Basically, it was assumed that the yields of two belligerents' bonds – a major power-major power, major power-minor power, or minor power-minor power

[70] Strachan (2010: 11).

[71] Cf., basically, Strachan (2010), but also Neiberg (2005), Sondhaus (2011), and Janz (2014).

[72] Strachan (2010: 7).

pair – would exhibit a long-term equilibrium relationship if perceived by bondholders to form a credible match. To this end, a framework has been established to test for cointegrating relationships pair by pair. Hence, analytically, I treated the two major alliances as the sum of the bilateral alliances forming under their roof. Based on the evidence, both the Central and Allied Powers must not be understood as alliances consistent in themselves. There were much less credible alliances than one might have been inclined to expect. Investors at Amsterdam – and here I am possibly reaching the limits of how bond prices as a real-time opinion poll can be reasonably interpreted – did not see monolithic blocks. This evidence is well in line with the "global-local view" mentioned above and underlines the significance of this nuance to the literature. Investors somehow saw through the multiple layers forming World War One. Investors seemingly got a sense of how diverse and incompatible the agendas in many cases had been. This comes all but naturally when considering how long it took historians to point that out.

However, the analysis yielded somehow ambiguous findings because specifically the major alliances' cores – consisting of the Great Powers – turned out to be cross-integrated, violating a vital assumption of my approach. Two explanations have been put forward: Firstly, investors acknowledged the deep-rooting pre-war financial interrelationships between the Great Powers that World War One would not be able to unmake quickly; here, interwovenness by cross-lending or, respectively, cross-borrowing is the key to an understanding. Secondly, investors were well aware especially of the Great Powers exerting most of the war effort to have been mutually entrapped in *trench warfare*. Here, the key to an understanding certainly is the investors' greater sensibility for the costs – especially the long-term costs – of that style of warfare. Investors did, indeed, adjust their expectations on *single belligerents'* odds of winning or losing. But under the temporary *veil of not knowing* which side, exactly, would win the war, the major belligerents' bonds were "entrapped" in a longer-term equilibrium, essentially meaning that country risks became somehow indistinct for a considerable stretch of time.

A question following from this view is whether the way alliances were perceived by investors bore any material effects. Basically, we can ask how the investors' perception impacted their willingness to buy, hold, or sell government debt. It seems reasonable to distinguish two situations from one another: the trading of debt on the secondary market – that is, of debt that had already been issued; and the underwriting of debt in the primary market – that is, the place to launch future debt issues. There certainly is a connection between the two markets; probably even more than one connection. But the connection I want to point to is this: The risk that the market attached to the belligerents' issued debt certainly had an effect on the belligerents' option to launch new debt in the short as well as in the longer term. This simple reasoning is nicely illus-

trated by the fact that war loans everywhere were issued with a considerable mark-up on the interest rate. While, for example, the German Empire could well borrow for three percent in peacetime, the war loans had to be equipped with an interest rate of at least five percent in order to be attractive enough.[73] To bring in the alliance perspective: One may think of a credibility or "alliance" discount or, respectively, mark-up not unlike that associated with mutually guaranteed debt recently discussed as a means to overcome the European sovereign debt crisis.[74] A highly indebted country that has to borrow at relatively high interest rates (due to its higher default risk) might benefit from a common issue with an average interest rate lower than the interest rate at which the country were to borrow on its own. The less fiscally credible country would then benefit in terms of borrowing costs from what might be called a credibility spillover. More credible sovereign issuers lend part of their credibility to that country. In our context, it is imaginable that a smaller power that is perceived to be part of a credible alliance with a major power would benefit (or as well suffer because an alliance as defined here meant "entrapment" in an equilibrium relationship with the other country's bond), as a side effect, just in these terms if the alliance was perceived to win (or lose). By definition, a small power is militarily less capable than a major power.[75] Thus, the spillover worked through the smaller power being associated with the military capabilities of the major power, on which the smaller power may then, indirectly, capitalize. Given the presented evidence, there is the theoretical chance that such spillovers might be found on the Allied Powers' side, in subsamples (3) to (5) (cf. Table 39). However, practically testing for the presence of a credibility discount in the context of World War One seems to be problematic because government legislation shut down the primary market for foreign government debt at the principal trading places in Europe. What we needed to know – namely whether, for example, Romania was able to launch new debt at lower cost in London (after controlling for other factors) once it was perceived to be in a credible alliance with Britain – we cannot observe due to wartime regulations. We may also take secondary market prices of that smaller power's bond(s) as containing such a credibility discount (or mark-up), besides other mark-ups such as the one that investors demand for holding a less liquid security or the general default premium. However, testing this contention requires, in my view, a more elaborate model of bond pricing that goes beyond this study's intention. The point is that we have difficulty to practically assess positive or negative financial credibility spillovers induced by being in alliance in the context of World War One. But this does not mean that

[73] At some point, surely, did suspending trade at the stock exchanges and launching war loan advertisement campaigns impact on the loans' "attractiveness", too.

[74] Cf. for a historical focus Ferguson (2005), Postel-Vinay (2014), Steinbach (2015), and Esteves/Tunçer (2016a, 2016b).

[75] Cf. Rothstein (1968: 29) for a definition of "small power".

it would be impossible to assess this notion in the context of other conflicts or wars providing the right institutional setting for this purpose. Insofar, my study calls for more research in this direction.

4. Outlook

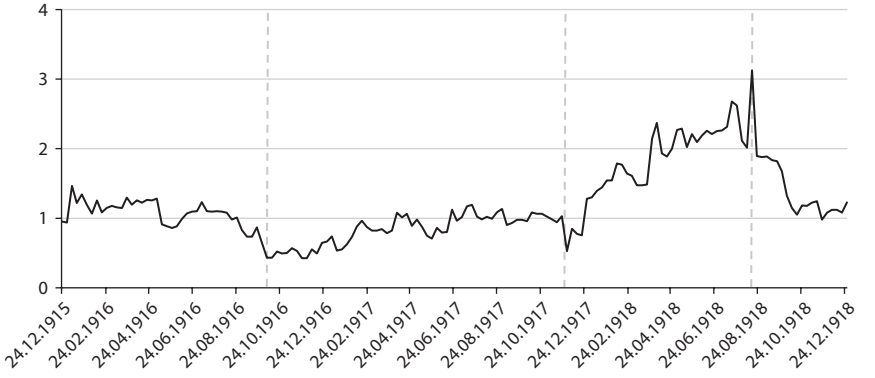
In order to be able to perform both types of analyses on World War One that I put forward in this study, I had to create a database of sovereign bond prices at *daily* frequency. To the best of my knowledge, we do not have such a high-frequency database for any one securities sub-market for the time of World War One as yet – not to this extent and certainly not for Amsterdam.[76] Insofar, gathering the cross-section of Amsterdam sovereign bond prices became a natural goal of my research. The creation and discussion of this extensive database represents one further genuine contribution to the literature, offering researchers new possibilities of studying World War One matters of public perception. To name just one example: The database allows delving deeper into the topic of bond market liquidity during wartime. Especially when a researcher is interested in the economics of *thinly* traded securities, my database offers rich data. As it has been shown in Chapter II, many bonds were actually not very liquid but were traded extremely thinly.

To provide an outlook on how research on bond markets' perception of World War One can be extended beyond this study and the few related studies discussed in the main body, consider Figure 59. Depicted is the current yield spread between Amsterdam, London, and Paris for three selected sovereign bonds at weekly frequency. To be precise, plotted are the spreads of Amsterdam yields over London and Paris yields for the French 5 % war bond, the Russian 5 % of 1906, and the German 3 % Imperial loan. Recall that the French 5 % and the Russian 5 % of 1906 have been analyzed by David S. Adams (2015) and by Kim Oosterlinck and John S. Landon-Lane (2006) over an essential part of the war. To the best of my knowledge, these two bonds are the only ones analyzed in the literature at daily frequency and as traded *during* World War One. I added the German 3 % for comparative reasons, too, drawing on my extended database. The comparative development of these bonds as cross-traded at the three major European trading places has been discussed in Chapters II and III. However, depicting the yield spreads instead of depicting the series separately illustrates much more clearly how World War One affected the capital markets. Take the French 5 % as an example: It certainly meets the observer's eye that, firstly, the Amsterdam risk assessment was more pessimistic throughout the war, as

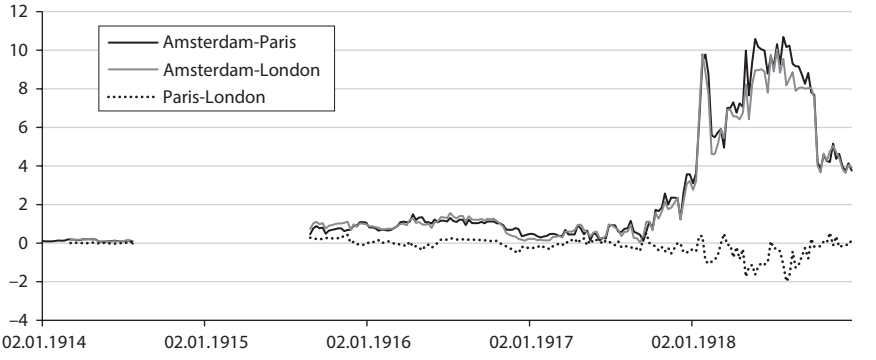
[76] As mentioned in the main text, the Moore-database covering twelve stock exchanges (including Amsterdam) and all securities traded at these places is at monthly frequency. This leads to considerably less observations on Amsterdam than my database can provide. It, surely, largely depends on the research question which data frequency is preferable or sufficient.

Figure 59: Marketplaces in wartime – spreads between Amsterdam, London, and Paris

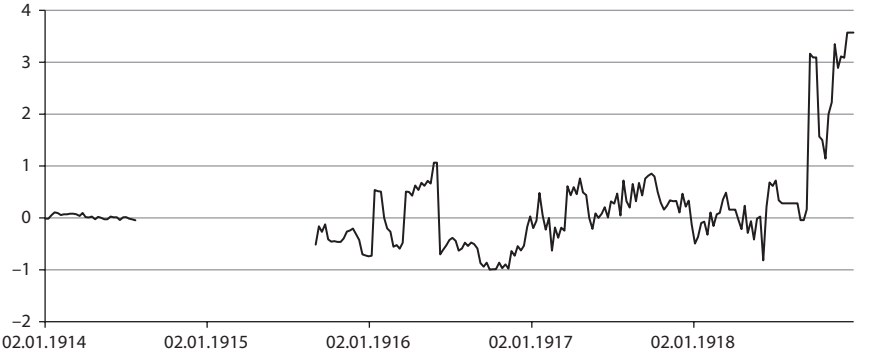
(a) Amsterdam-London current yield spread of the 5 % French war bond



(b) Current yield spread of the Russian 5 % of 1906



(c) Amsterdam-London current yield spread of the German 3 % imperial loan



Sources: On the French war bond, cf. the discussion of Figure 34 in Subchapter III.5.3.
Notes: The spread is the Amsterdam yield minus the London yield.

Amsterdam yields were larger than London yields; and that, secondly, we can distinguish four regimes regarding the bond's pattern, indicated by the dotted vertical lines. Now, the fact that the spread is so large – regarding the French 5 %, but also regarding the Russian 5 % and German 3 % when compared to 1914 – reflects, at least, three influences: firstly, the influence of capital market and especially securities market controls implemented internationally with the outbreak of the war making arbitrage largely impossible; secondly, the effect of miscellaneous distortions of price formation that were at work beyond the distortions introduced by lacking arbitrage opportunities; and, thirdly, this is the factor that I want to highlight, the prevalence of basically different opinions among investors in Amsterdam, London, and Paris.

The differential assessment of the risk inherent in the Russian 5 % due to the Bolshevik's repudiation of all Tsarist debt is, for example, pretty evident. Amsterdam yields exploded relative to London and Paris yields. On the one hand, we may suspect in line with Oscar Bernal et al. (2010) that this difference may be rooted in different regional bail-out expectations, very likely due to distortions in the flow of information. But, on the other hand, a temporary spread of 10.0 percent may suggest some other effect being at work. Or, for that matter, take especially the pattern in the French 5 % after November 1917 (the second dotted line). It seems as if investors in Amsterdam assessed the risk for France resulting from the closing of the Eastern Front much more pessimistically than did London investors. In the patterns occurring in the first two regimes, we may be inclined to see, at least to some extent, convergence in opinion (regime one up until October 1916; the time when French troops began to regain ground in the Verdun theater) followed by a "modest" divergence of opinion (regime two) developing into sharp divergence in the third regime. In the same vein, the pattern of the German 3 % yield spread also offers the possibility for speculating on different investor attitudes.

It is beyond the scope of this study to evaluate cross-traded bonds in detail, including all economic and opinion-wise influences that are supposedly reflected in the spreads' pattern. But it should have become clear that Amsterdam serves as the "neutral" benchmark when assessing differential opinions especially under the header of "belligerence". But besides the war status of the populations, it may well have been that basic differences in information availability governed those (potential) differences in opinion. My extensive Amsterdam database offers opportunities to investigate this in more depth.

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