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Abstract

This study uses prices for the German 3 percent imperial loan issued in several tranches since 1890 and still traded during World War I to measure capital market players' real-time perceptions of the prospects for Germany as the war proceeded. Price data are gathered from the Amsterdam market for government bonds; the Netherlands remained neutral throughout war. Focusing on the window from August 24th 1915 to August 11th 1919, ten (twelve) turning points are identified in a baseline (extended) model. Each implies a significant adjustment of lenders' confidence in Germany being able, or willing, to service its debts in the future. Two turning points stand out. In early January 1916, the price plummeted by 14.3 percent between the first and eleventh of the month, which was most likely due to the Military Service Act discussed in the British parliament. On September 19th 1918, the price dropped by 17.5 percent compared to the last available price quote from the end of July. This coincides with the Allied Powers' revival on all fronts since the summer, leading to the ultimate collapse of the German lines.

JEL classification: C22, G14, H63, N01, N24, N44

Keywords: Amsterdam, Bonds, Capital market, Confidence, Expectations, Germany, Sovereign debt, Structural breaks, World War I

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1 Introduction

With the outbreak of World War I in late July 1914, the European system of alliances, established some decades earlier and since then put to several tests, witnessed the ultimate escalation of latent hostilities. Regardless of whether or not war had come as a surprise, it provoked ambiguous feelings on all sides, ranging from sheer enthusiasm to the greatest anxiety. One topic that is much debated in the historical literature on WWI is the seemingly widespread phenomenon of *war fever* in the initial phase, among the German population, as well as within the Central and Allied Powers. Beyond the *spirit of 1914* phenomenon in particular, the literature also debates the more general question as to what extent confidence in the principle belligerents' ability to win the war changed as time passed and the *short war assumption* turned out to be an illusion (Tuchman 1964; Kruse 1991; Verhey 1991; Joll 1992, pp. 199-233; Rohkrämer 1997; Ferguson 1998, pp. 174-211; Gregory 2003). The historical picture that emerges in this context depends on the type of historical source evaluated and the class of population addressed (Daniel 1993; Krumeich 1993; Schichtel 1993; Fries 1995; Silbey 2005).[1] As yet, it seems that not much effort has been made to quantitatively measure which single war or political event that occurred as a prelude to or during WWI had, or had not, a noticeable effect on confidence. Indeed, this is almost impossible to measure for any country's population as a whole. However, it might be possible for social subgroups. The intention of this article is to assess this possibility using the example of the German Empire's economy during the war and seeing through the lens of the capital markets.

More specifically, this study aims to answer the question of how the performance and the prospects of a belligerent Germany were perceived on neutral grounds, by a particular group of capital-market players – namely, holders of sovereign debt.[2] Their real-time perceptions are measured using prices for the *German 3 percent imperial loan* (issued between 1890 and 1903)

[1] Sources may, among other things, include newspapers, poetry, individual records such as letters and diaries, or official publications by the authorities; classes of population may be rural or urban, intellectuals, workers, ordinary soldiers, or military elite.

[2] The term *neutral* demands some substantiation. The Netherlands certainly adopted a neutral political and military position during WWI, towards both the Allied and the Central Powers, and managed to maintain neutrality throughout war. This is not to say that the Netherlands was not (highly) economically dependent on either Germany or England, or both. The literature on the economic history of the Dutch economy certainly points out the traditionally strong (pre-war) economic ties to England and, in particular, Germany. However, what matters for this approach is only whether Amsterdam's capital market was regulated similarly to Germany's and Britain's – perhaps due to direct demands of either of both – or not. As to my understanding of the literature, there is no reason to assume that prices formed in Amsterdam did not constitute market prices fulfilling basic desirable information functions. On Dutch economic history, e.g. see van Zanden (1998), Frey (2000), De Jong (2005), Klemann (2009), and Euwe (2010).

as formed at the Amsterdam Stock Exchange during WWI. The approach's basic idea is to let bond prices identify the war-related and political events that induced bondholders to adjust their expectations about the length of the war, about the war's cost to the German Empire, and about the costs they might incur if the German government took the option of defaulting on its debts. Thus, I look at major structural breaks in the bond price, usually addressed in the relevant literature as *turning points*.[3] For reasons of data availability, this investigation is limited to the last three years of the war. Using Amsterdam data, we necessarily miss the first year of war – a year in which, arguably, several military successes led to some euphoria among the Central Powers (e.g., advancement on the Eastern Front). This year does not appear in the data because the Amsterdam Stock Exchange was temporarily closed from the end of July 1914 until February 9th 1915, when trade in the various securities was gradually resumed; after the outbreak of the war, the German 3 percent imperial loan's price was not recorded again until August 24th 1915. Thus, the baseline sample covers the period from late August 1915 to November 11th 1918, the date of the Armistice of Compiègne; an extended sample runs until 11th August 1919, so that the initial post-war period can also be screened for potential turning points.[4]

There is a long-standing interest in analyzing time-series of bond prices as reflecting condensed historical information on capital market players' perceptions of different sorts of events – war, political events, and economic ones. Perhaps one of the earliest attempts is Pierre-Joseph Proudhon's *Manuel du Spéculateur à la Bourse* (1857), in which the well-known liberal socialist and opponent of Marx relates events around the reign of Napoléon Bonaparte to price changes of the 5 percent French bond (Senft 2009, pp. 18-19).[5] Meanwhile, the economic-historical literature on detecting turning points in capital market data has grown considerably, especially with regard to the American Civil War (e.g., Willard, Guinnane and Rosen 1996; Brown and Burdekin 2000; Weidenmier 2000; Weidenmier and Oosterlinck 2007) and WWII (e.g., Frey and Kucher 2000; Brown and Burdekin 2002; Oosterlinck 2003; Frey and Waldenström 2004; Walden-

[3] Alternatively, one might supply a pre-defined set of *significant events*, selected according to historians' evaluation, to examine precisely whether those events show up in the price series as obvious downward or upward spikes, or as structural breaks.

[4] Note that the end date of this study is chosen for three reasons: First, the influence of undisguised inflation on lenders' perception still might not have been too strong; second, some potentially important post-war events related to the peace process are included—for example, the ratification of the Treaty of Versailles in late June 1919; and, third, for technical reasons, to avoid a unit root in the price series (which occurred if the sample was extended to December 31st 1919.

[5] E.g., the Napoleonic Wars, Napoléon's exile on the island of Elba, his unsuccessful return to power, and his final exile.

ström and Frey 2008).[6] Besides highly unstable periods of war, recent publications also focus on periods of relative peace and events such as political unification (e.g., Collet 2013) and political regime turnover (e.g., Ferguson and Voth 2008). Compared to this body of literature, capital market data on the WWI period, though not completely neglected, are quite understudied when it comes to the measurement of perceptions. Regarding both methodology and substance, three studies must be mentioned: First, using data from the Swiss currency market, Hall (2004) decomposes exchange rate movements regarding the Allied Powers (Great Britain, France, and Italy) and Central Powers (Germany and Austro-Hungary) 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. 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. In the second study, Ferguson (2006) conducts an event analysis based on yields of the great European players' bonds for the period 1848 to 1914. In particular, he focuses on the question of whether WWI was generally seen as a high-probability event on the London capital market long before its outbreak. While pre-war crisis events caused some fluctuations in yields, a full-scale war was considered rather low-probability up until very shortly before WWI actually broke out. Finally, for the period 1915 to 1919, Oosterlinck and Landon-Lane (2006) search for structural breaks in the price evolution of a representative Tsarist bond traded at Paris to evaluate how French bondholders perceived the Bolshevik repudiation of all Tsarist bonds in early 1918 and related events thereafter.

In all, ten (twelve) turning points in the German 3 percent imperial loan's price are isolated in a baseline (extended) model, each implying a significant longer-term adjustment of lenders' confidence in Germany's ability, or willingness, to service its debts in the future. Of all the identified turning points, two stand out because they represent the two most dramatic, long-term decreases in price throughout the war. One major structural break occurred in early January 1916, when the price of the German 3 percent imperial loan plummeted by 14.3 percent between the first and eleventh of the month. Indeed, this drop coincides with some negative news from the front, but especially with the Military Service Act discussed in Britain at the time; the capital market seems to have anticipated the final passage of the act in late January, which introduced conscription, thus allowing for extra resource mobilization by the Allied Powers. The second major structural break occurred on September 19th 1918, when the price dropped by 17.5 percent

[6] Further studies in the context of political instability and, perhaps, war-like conditions include Burdekin and Lahey (2008), Sicotte, Vizcarra and Wandschneider (2010), Christodoulaki, Cho and Fryzlewicz (2012), and Collet (2013).

compared to the last available price quote from the end of July. This is most likely explained by the Allied Powers' summer offensive – especially at the Western Front – leading to the ultimate collapse of the German lines.

The article proceeds as follows. A brief discussion of a straightforward pricing model for bonds follows in Section II. This enables us to impose some substance on the data with regard to the question of how observable changes in bond prices might be interpreted. In Section III, the data on Amsterdam prices are introduced and some background information on the bond in question is presented; daily prices were collected from the *(Uittreksel uit de) Officieele Prijscourant der Vereeniging voor den Effectenhandel* (in particular, the part on *Staatsleeningen*) – the extensive extracts of the stock exchange price listings of securities as published in major Dutch newspapers. Section IV is dedicated, first, to a brief visual comparison of Berlin and London prices for German sovereign debt with Amsterdam prices and, second, to the turning-points analysis, relying on some straightforward time-series econometrics and two models (a baseline and an extended one). Section V concludes.

2 War, capital markets and bond prices

This section presents a straightforward pricing model that imposes some substance on what the economic and historical *subtext* of changes in bond prices might be. 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.[7] 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 *t*, so that it has a clear maturity *T* – e.g., thirty years after the initial issue. The price may be written as

$$(1) \quad P_0 = \sum_{t=0}^{t=T} \frac{(c*N)*(1-\beta^c)}{(1+r)^t} + \frac{N*(1-\beta^N)}{(1+r)^T} \quad , t = 0, ..., T,$$

[7] 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, see Choudry (2010), pp. 18-19, and Martellini, Priaulet and Priaulet (2003), pp. 41-45.

where c denotes the coupon rate, N denotes the nominal value redeemed at maturity, and, consequently, c times N is the coupon payment due at regular intervals. To make the time-displaced payment streams comparable, the discount rate r is applied.[8] 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 depends on the future state of government finances, as well as political factors, which, in turn, are usually highly affected by the fact that a country has actively participated in war. The outcome of the war, especially, 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 to take pressure off government finances or, if vanquished, would, instead, be forced to pay. Therefore, it appears reasonable to incorporate probabilities 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 about) a country's ability or willingness to settle debts may be reflected in these probabilities of default. Thus, a decline 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.[9]

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 (Campbell and Ammer 1991, p. 6; Cutler, Poterba and Summers 1989, pp. 4-12; Shleifer 2000, p. 1-8): (i) changes in the subjective discount rates triggering a change in the average discount rate over all bondholders; there is no reason to believe that economic agents discount payments occurring in different periods equally; (ii) changes in the bondholders' inflation expectation; one may assume that a country will service its debts, but that the value of interest payments and principal will decline 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

[8] 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 for the 3 percent imperial loan, equation (1) would need to be adjusted. However, the basic implications remain the same.

[9] Note that this simple model to organize thoughts tells nothing about how precisely bondholders' expectations are formed.

inflation in the long term; and (iii), since the efficient market hypothesis has been overruled as adequately describing how capital markets work, positive or negative accidental shocks. 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.

For our purposes, it suffices to think of the inflation expectation, or the inflationary potential of monetary policy, as being captured by the probabilities of default; inflation risk and default risk are certainly highly correlated. 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 have 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 on the money market that they could earn if they had not invested their money in bonds. In the remainder of the article, I will not formally disentangle the changes in bond prices over time according to these factors. 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.

3 Data

3.1 Sources

This paper analyzes price quotes of the German 3 percent imperial loan (henceforth, *the 3 percent imperial*) traded during WWI. The subsequent subsection reports some historical background on the loan itself. In what follows, it suffices to bear in mind (i) that the three- percent imperial constituted internal debt; (ii) that coupon payments were made in marks, not in gold; (iii) that payments connected with the loan were not guaranteed by a special type of revenue stream (e.g., customs duties); and (iv) that if one of the *Reich*'s bonds was traded outside the German Empire, it was the 3 percent imperial. I collected prices on it by hand from the official price list of the Amsterdam Stock Exchange, as published in several Dutch newspapers – the *(Uittreksel uit de) Officieele Prijscourant der Vereeniging voor den Effectenhandel te Amsterdam*. In all, I screened nine newspapers to compile daily quotations covering the period January 1st 1913 to December 31st 1919: The *Algemeen Handelsblad* (or *Nieuwe Amsterdamsche Courant*), was the major source, providing the most-extensive extracts; furthermore *Het Cen-*

trum, *De Tijd: Godsdienstig-Staatkundig Dagblad*, *Het Nieuws van den Dag*, and the *Nieuwe Rotterdamsche Courant* were the most important additional sources; and the *Leeuwarder Courant*, the *Nieuwsblad van het Noorden*, the *Rotterdamsch Nieuwsblad*, and *De Telegraaf* were sources of minor importance. All these newspapers were published daily, some with two issues per day (e.g., the *Algemeen Handelsblad*).[10] It was necessary to consult at least these nine newspapers for two reasons: First, there are gaps in the stock of accessible issues of my main source, the *Algemeen Handelsblad*; to fill gaps in coverage to the extent possible, I had to consult the others (which may also have contained gaps). Second, 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, for example, a price for the 3 percent imperial for day *x* was not recoverable from the *Algemeen Handelsblad*, but was from *Het Centrum*, or vice versa. So, broadening the source base was imperative to obtain as many quotations as possible.

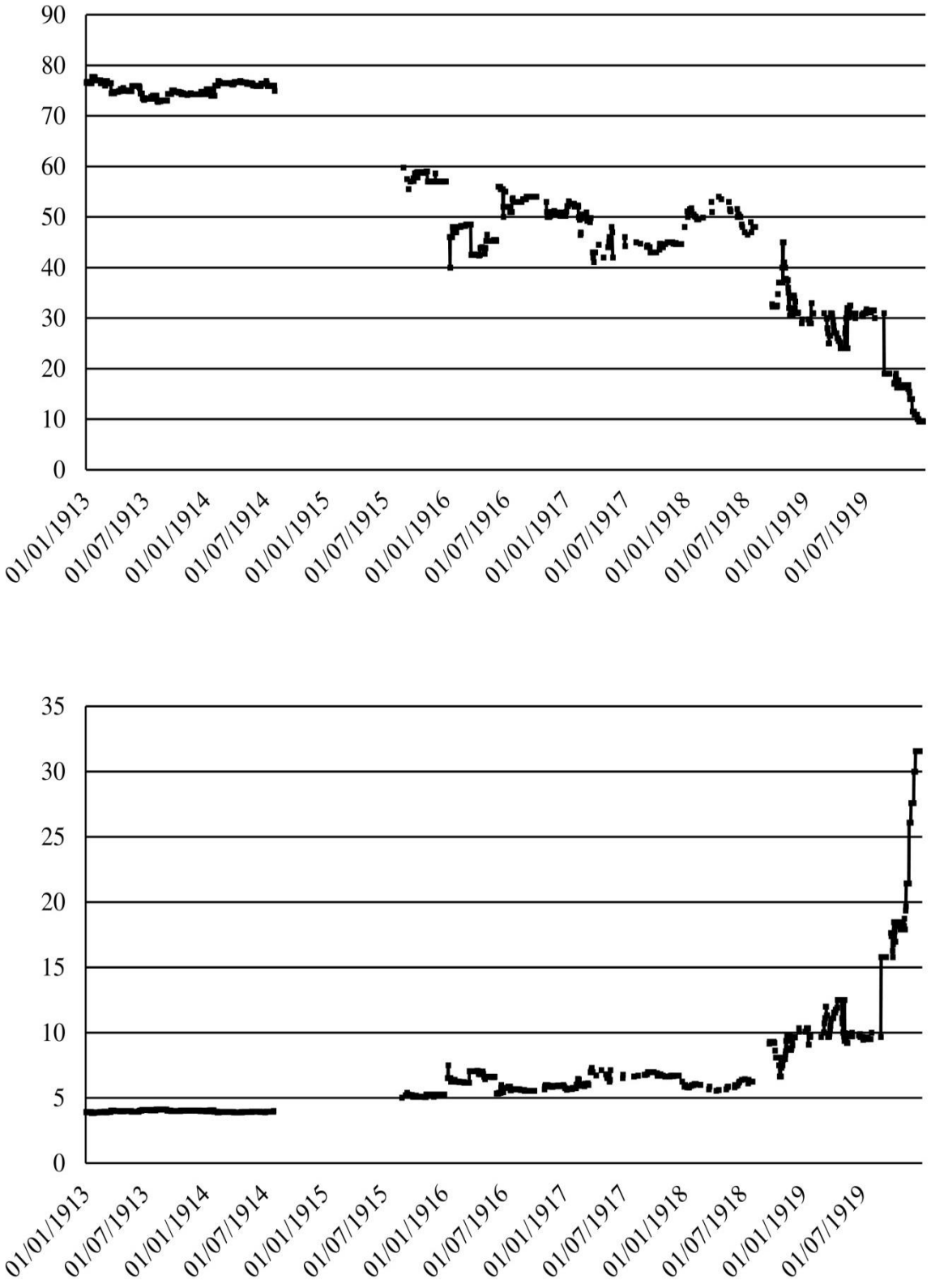
The *Officieele Prijscourant* reported three different prices, sometimes four, per security – namely, the *L.K*, *H.K*, *V.K*, and, depending on the newspaper one looks at, *S.K.*, so abbreviated without further explanation. According to Brenninkmeyer (1920, p. 136), who provides an institutional overview 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, the mid-price of the previous day (*vorige koers*) – i.e., the average over the lowest and highest quotes – and the closing price of the actual day (*sloetkoers*). Thus, for example, the official price list for July 29th 1914 – the last official statement before the stock exchange closed until February 9th 1915 (Euwe 2010, pp. 222-223) – reported the mean price of July 28th. In the following, I use the reported mean prices.[11] Since two series of the 3 percent imperial were issued and separately traded (see the following subsection) that differed in coupon dates, I combined them into one series. Figure 1 plots the price in percent of par value (upper graph) and the current yield (lower graph). Additional summary statistics are reported in Table 1.[12]

[10] The *Koninklijke Bibliotheek* (*National Library of the Netherlands*) provides a great many digital copies of them via its internet site; cf. *www.kb.nl/en/home*; use the search mask *historical newspapers*, and type, for example, *prijscourant*.

[11] Principally, 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 the 3 percent imperial; this also holds for the majority of the remaining bonds.

[12] In addition to the 3 percent imperial, two Prussian bonds were traded. However, I did not consider them here for the following reasons: the 3 percent consols' time pattern looks quite similar to that of the 3 percent imperial; and for the 3.5 percent consols – formally also issued in two series – there are too few observations available.

Figure 1: The German 3 percent imperial loan as traded in Amsterdam – nominal price in percent of par (upper plot) and current yield (lower plot), daily basis, 1913-1919



Notes: The stock exchange closed between the end of July 1914 and early February 1915. Trade in government bonds first resumed for domestic issues. German bonds were not traded again before late August 1915. Here, the two 3 percent imperial series were combined. The current yield is approximated as [annual interest payment/$price_t$].
Sources: Algemeen Handelsblad; De Tijd: Godsdienstig-Staatkundig Dagblad; Het Centrum; Het Nieuws van den Dag; Nieuwe Rotterdamsche Courant; Leeuwarder Courant; Nieuwsblad van het Noorden; Rotterdamsch Nieuwsblad; De Telegraaf (each: various issues between 1/1/1913 and 31/12/1919).

Table 1: Summary statistics

	Price in percent of par		Current yield	
	All years	War	All years	War
Observations	1,036	456	1,036	456
Mean	57.0	50.0	7.0	6.2
Standard deviation	18.3	5.6	4.3	0.8
Skewness	-0.56	-0.48	3.3	1.2
Kurtosis	0.62	0.15	13.7	3.0
Minimum	9.5	32.0	3.8	5.0
Maximum	77.7	59.7	31.6	9.4

Notes: War period is August 1st 1914 to November 11th 1918.

As becomes obvious from Figure 1, there are numerous days – apart from Sundays and holidays, of course – for which I could not collect a price even after consulting the whole set of newspapers. I interpret the missing values as implying that no transactions regarding the particular bond took place the day, week, or even month. I will come back to the observable time pattern and a closer visual inspection below, after having introduced some alternative price quotes on London and Berlin that are useful as a reference.

3.2 Background information on the German 3 percent imperial loan

Since 1890, the loan had been offered in two series with different coupon payment dates; interest was paid semi-annually on the first of April and October (first series) or on the second of January and first July (second series). As of 1914, pay offices were located in Berlin, Brussels, Antwerp, Basel, London, and Amsterdam. Prices were quoted in Berlin, Brussels, London, and Amsterdam, implying that these had become the bond's principal trading places. Taking both series together, the first issue, on October 9th 1890, amounted to a nominal value of 170 million marks at an issue price of 87 percent of par. There were further issues in 1891 (February 20th: 200 million), 1892 (February 9th: 160 million), 1893 (April 11th: 160 million), 1894 (April 24th: 160 million), 1899 (February 9th: 75 million), 1901 (April 3rd: 300 million), 1902 (January 22nd: 115

million), and 1903 (April 17th: 290 million); at the onset of WWI, pieces worth about 1.64 billion marks nominal were still in circulation (Heinemann, Tischert and Weber 1918, pp. 39-40). According to a note in the *Stock Exchange Official Intelligence*, a small percentage of the total nominal principal outstanding was supposed to be redeemed each year (Skinner 1916, pp. 62-63; Skinner 1917, p. 65). Since (i) there was no final redemption date specified, (ii) redemption actually occurred only sporadically, and (iii) bondholders had no right to demand repayment, we might classify the 3 percent imperial as a perpetual (or *unredeemable*) bond, with the German Empire, as the bond issuer, having been equipped with a call option. In fact, provided that they were not chosen for redemption due to the Empire's call option, bondholders could recover (part of) the principal in two ways: sell on the regular market or obtain an inscription in the imperial debt register established in 1891 (The Secretary of the Share and Loan Department 1914, p. 109). As of late 1914 – thus, after issuance of the first war loan – the 3 percent imperial still represented about 17.5 percent of outstanding *Reich* debt (Heinemann, Tischert and Weber 1918, p. 37).[13] Since all German loans were apparently issued under domestic jurisdiction, even if partly held by foreign creditors, they did constitute internal debts.[14] Furthermore, I could find no evidence that payments were guaranteed in a special way, by a specific underlying stream of income to the government (certain taxes and customs duties) or by the promise of servicing of debts in gold.[15] Finally, interest payments seem not to have been suspended at the beginning of, or sometime during, WWI – unless, of course, payments had flowed into enemy countries.[16] This

[13] Of 9,428,900,000 marks, 3,448,038,500 marks were linked with the 5 percent obligations issued as part of the first war loan, 1,137,807,400 marks with the 4 percent imperial loan, 1,983,251,400 marks with the 3.5 percent imperial loan, 1,000,000,000 marks with 5 percent treasury bills, and another 220,000,000 marks with 4 percent treasury bills. Note, however, that the biggest issues coming from Germany prior to WWI actually were the Prussian 3.5 percent consols, of which a nominal amount of more than six billion marks had once been issued and was still outstanding when war broke out.

[14] For a definition of internal and external debt, see Reinhart and Rogoff (2011), p. 55.

[15] Suspending convertibility into gold was one of the first monetary measures belligerent countries took after hostilities began; so, too, did the *Reichsbank.* A guarantee of payments in gold would have become obsolete anyway; see James (2002), p. 160.

[16] Both politicians and the financial press discussed whether a debt deferral regarding redemption and service of interest payments was not an appropriate answer to put pressure on finances caused by the war economy and to the Allied Powers' postponement of payments, especially to foreign creditors. For example, take a small contribution to the journal *Die Bank: Monatshefte für Finanz- und Bankwesen* (author unknown, 1994, pp. 806-809) in the second half of 1914 entitled "*Die Notwendigkeit eines Kriegsmoratoriums*" (The necessity of a war moratorium). The author pointed out that there were two opposing factions: one favoring a universal moratorium for public and private debt, and the other advocating the commitment to proper servicing of debts. The government belonged to the latter. After the outbreak of war, the author conceded, there may have been decisions to establish a moratorium in individual cases, and with respect to private liabilities, but not in general, and particularly not with regard to government debts. A second example of how the contemporary discussion of the issue was framed comes from the *Reichstag*, dated April 23th 1918. In his speech, undersecretary of the exchequer Siegfried Graf von Roedern, took up the claim

assessment is compatible with what we know, or do not know, from Lotz (1927) and Roesler (1967), in which I could not locate information on a general suspension.

4 What do bond prices reveal about bondholders' confidence in Germany's ability to win the war?

4.1 There is more than just one view: Amsterdam prices compared to London and Berlin prices for German sovereign debt

For comparison, to get at least a glimpse of how German debt was priced in the domestic market and in the market in a major enemy's country, I gathered additional monthly data covering London and Berlin. London prices are official, perhaps regulated closing prices from the last day of the respective month. Berlin prices for the war period are available only for the *4 percent*, not the 3 percent, imperial loan (Kronenberger 1920, pp. 23-24); prices are either closing prices, as in the case of London (1913-1917; 1919), or closing prices referring to the first day of a month (1918). Principally, knowing the prices, we may assess whether or not German debt was priced symmetrically at the three trading places. Figure 2 offers a perspective from inside the Central and Allied Powers. In order to facilitate a visual comparison, I converted the daily series on Amsterdam plotted in Figure 1 into a monthly series by assigning each month the latest available price quote.

For the period of war itself, Berlin prices refer to transactions on the *grey market* – which took about until the second half of 1914 to form – and which shows that a want of liquidity in parts of the population made its presence felt, even with official trading channels no longer available.[17] According to Klebba (1920), trade in the grey market was quite lively at the beginning of 1915 and continued to be throughout war.[18] However, the volume of unofficial trade is

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that the *Reich*'s debt service should be suspended for the remainder of the war and argued that one should stick to servicing debts properly and to still financing interest with war taxes.

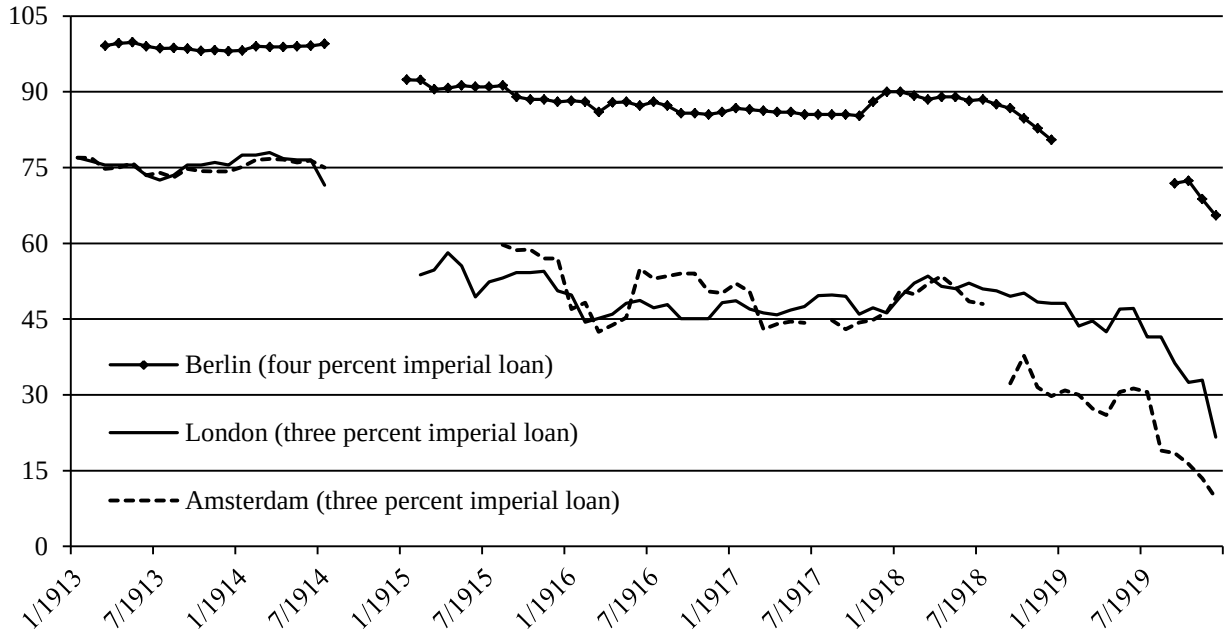
[17] To avoid even harsher drops in securities prices, all major, and even most minor, trading places were shut down even before the sequence of declarations of war in the first days of August occurred and, at least, until late 1914 (Stucki 1924, p. 26). The Berlin Stock Exchange was closed between July 31st 1914 and September 1st 1919. Trading in bonds restarted only after its official re-opening in 1919.

[18] It took place on the streets, in cafés, and even in the rooms of the stock exchange, which are said to have remained open. It was a characteristic of the Berlin unofficial market that the large universal banks – in contrast to private banks – did not, at first, participate in transactions. Sooner or later, however, they joined and traded over the counter, presumably lucratively, by their own account *(Handel auf eigene Rechnung*) giving up their function as pure intermediaries. This annoyed their contemporaries. Clearly, forming and publishing official prices was forbidden early on, and publishing unofficial prices likewise. However, unofficial price sheets apparently were produced which customers could take a look at in the rooms of the banks, but which were not to be sent to them on a regular basis (Klebba 1920, pp. 28-35; Obst 1915, pp. 77-78).

not quite assessable; and even if unofficial prices were available to contemporaries, price formation was undoubtedly all but transparent (Henning 1992, pp. 222-225; Kiehling 1998, p. 18).

The series on the 4 percent imperial does not show much variation. The outbreak of war and immediate military actions led to a drop of 7 percent, from 99.5 percent of par in July 1914 to 92.4 percent in January 1915. A price minimum occurred in October 1917, with 85.2 percent. Thereafter, prices climbed to their levels of the initial war period and dropped more heavily after mid-1918 to levels at the end of that year that were still relatively high regarding the bond's price history in the preceding years. So, if we take the price's evolution seriously, we have to admit that the unofficial Berlin capital market did react to war since prices gradually fell or climbed for a while. However, it did not react as strongly as the Amsterdam and London prices imply that lenders there had reacted. Thus, in Germany, the perception of the country's prospects was apparently rather positive; the capital market seems to have retained a good deal of confidence until quite late.[19]

Figure 2: German debt priced at Berlin, London and Amsterdam (price in percent of par)



[19] I tried to trace the (archival) sources Kronenberger used to construct his series. He was not very precise about them, in fact. He described them only as "Effektenbücher[n] deutscher Großbanken und Privatbankiers" – in English, we might call these *stock books* that big German banking houses and private bankers used to keep – and, more precisely, as "Kursblätter für den freien Verkehr" – *unofficial lists*. To date, I have not been able to locate sources he might have consulted with the consequence that I cannot track the way he constructed prices. I can only speculate that it could be that, technically speaking, fluctuations inherent in daily price quotations available to him were smoothed out by converting them into a monthly series.

Notes: Berlin prices between January 1915 and December 1918 reflect conditions on the unofficial market. Plotted are end-of-month prices or, if none were reported in the original sources, the last reported prices per month (only relevant regarding Amsterdam prices). Two German 3 percent imperial loan issues were separately traded in London and Amsterdam – one with coupon payment on January 2nd and July 1st, the other on April 1st and October 1st. The series were combined into one.
Sources: Berlin 1/1913-6/1914 and 1919: Neumann's Kurs-Tabellen der Berliner Fonds-Börse: Zusammenstellung der monatlichen und jährlichen höchsten, niedrigsten und letzten Kurse innerhalb der letzten sechs Jahre von allen an der Berliner Börse gehandelten Wertpapieren, Sorten und Wechseln sowie der Ultimo-Liquidations-Kurse, Berlin/Leipzig/Hamburg, Volumes 26 (1914) and 28 (1919); Berlin 7/1914-12/1918: Fritz Kronenberger, Die Preisbewegung der Effekten in Deutschland während des Krieges, Berlin 1920, fold-out table between pages 28 and 29. London 1/1913-12/1919: The Investor's Monthly Manual: A Newspaper for Investors. Amsterdam: See Figure 1.

The London price of the 3 percent imperial shows a marked immediate drop from June to July 1914, implying that war indeed came as a surprise. In the following, the drop in *Reich* debt's price was heavier; it fell from 71.5 percent to 53.7 in February 1915, fluctuated, and then fell to its wartime minimum of 44.4 in February 1916. After that, price seems to have followed a slightly positive trend until March 1918, when it temporarily recovered to 53.5 percent. It then fell until May/June 1919, followed by another temporary increase of 4.5 percent, which can be connected to the Treaty of Versailles.

In all, the London price did not show as marked an amplitude as the Amsterdam price. The highest wartime quotation in Amsterdam – 59.7 percent of par – dates from the restart of trading in August 1915, and the lowest – 31.5 percent – from November 1918, when hostilities ended. This implies a range of about 28 percent. In comparison, for the London price series, the range is less than 14 percent over February 1915 to November 1918. This might have been a matter of trade regulation or of London bondholders simply not reacting as strongly to events as bondholders active in Amsterdam.

Two particular differences in reactions should be highlighted. The first concerns the deep bulge between December 1915 and June 1916.[20] The Amsterdam price of the 3 percent imperial decreased from 57 percent in December to 42.5 percent in February – the second-lowest value reached during wartime – and increased again to 55 percent in June. The bulge exists in the London price, too, but is not as pronounced (50.6 in December; 44.4 in February; and 48.7 in June).

[20] Into this phase fell, among other things, the start of the first Battle of Verdun in late February, the resignation of Admiral Alfred von Tirpitz as head of the Imperial Naval Office in mid-March, and the Battle of the Skagerrak ending on June 1st in an alleged victory for Germany (vom Bruch and Hofmeister 2002, p. 495).

The second difference in reaction concerns the year between January 1917 and January 1918.[21] More specifically, the Amsterdam price shows a long-term drop by about 8 percent, from 52 to 44, before the price recovered to 50.7 percent. In contrast, the London price evidently did not drop as that greatly, but, rather, fluctuated around a mean of 47.7 percent. Without providing a complete explanation here, we can still say that German debt was apparently not priced symmetrically and that the reaction in Amsterdam was stronger.

4.2 Turning points in bondholders' perception

Due to the data situation, we completely miss the first year of the Great War. Thus, it is not possible to get an impression of how the Amsterdam capital market perceived the sequence of mobilizations and declarations of war in late July and August 1914 and other, arguably important, events afterwards.[22] What we can say is that the capital market answered the sequence of events that took place up until August 24th 1915 with a severe *net* discount of about 15 percent in the price of the 3 percent imperial (last pre-war quote: 75 percent; first wartime quote: 60 percent; see Figure 1). Although I conclude that the capital market had been very skeptical of the German war effort since the beginning of 1916 at the latest, this does not rule out the possibility that the picture had been quite different before that, in the first year of war. Price data are lacking before late August 1915, and, thus, my approach leans towards being unsuited to identifying a possible fundamental change in perception occurring at that stage of the war.

Let us turn to the empirical evidence derived from the price series directly by applying the baseline model. Given conventional significance levels (10 percent or better), Table 2 reports on our primary interest in this paper – namely, *turning points* in bondholders' perception and events that likely caused those adjustments in market behavior.[23] The corresponding econometric modeling is explained in the Appendix. Presented in Table 2 are the identified dates of statisti-

[21] A phase initiated by the war aims declaration of the Allied Powers, Germany declaring unrestricted submarine warfare, and the cancellation of US-German diplomatic relations, and closed by the peace negotiations at Brest-Litowsk between the Central Powers and Russia and US president Wilson's peace offensive (vom Bruch and Hofmeister 2002, pp. 495-497).

[22] E.g., the Battle of Tannenberg (late August '14), the Battle of the Marne (September '14), the removal of Helmut von Moltke as chief of the general staff by Erich von Falkenhayn (mid-September '14), the conquest of Belgium (mid-October '14), the start of submarine warfare (late February '15), or Italy coming in on the Allied Powers' side (April '15), to name but a few events (vom Bruch and Hofmeister 2002, p. 494).

[23] I cannot prove with absolute certainty that the events I propose as being those that are identified by the bond price series itself really are the events that drove bondholders' buying and selling decisions. In particular, the per-day supply with events in WWI chronologies as well as in the newspapers (see Appendix Table A.1), is abundant. At least, I tried to check by consulting the Dutch print media which events were reported, so that bondholders could have read about and reacted to them.

cally significant structural breaks, the corresponding percent changes in price between the last available price quotes and the actual price quotes, the date of the last available price quote, and the event(s) that may have caused the breaks.

Table 2: Turning points regarding Germany's performance in WWI

Date of turning point	Estimated percent change in price	Date of previous price quote	Suggested event
[1] January 11th 1916	–14.6 %	Jan 1st	Conscription controversy in Britain[a]
[2] March 17th 1916	–1.5 %	Mar 16th	Admiral Tirpitz had resigned shortly before on March 15[b]
[3] June 8th 1916	+5.6 %	Jun 2nd	End of Battle of Jutland on 1 June; Lord Kitchener drowned on 5 June; German conquest of Fort Vaux near Verdun on 7 June[c]
[4] March 22nd 1917	–4.5 %	Mar 16th	February Revolution in Russia (7-15 March); British offensives on the Western Front[d]
[5] December 27th 1917	+3.1 %	Dec 17th	Russia defeated; peace negotiations at Brest-Litowsk[e]
[6] April 10th 1918	+1.1 %	Mar 20th	German offensive opening the Second Battle of the Somme (since 21 March)[f]
[7] June 6th 1918	–0.8 %	Jun 5th	Unsuccessful operation Blücher-Yorck on the Western Front as part of German spring offensive[g]
[8] September 19th 1918	–17.6 %	Jul 30th	Allied Powers finally break through German lines at Amiens (Aug 8th); allied advances[h]
[9] November 9th 1918	–4.7 %	Nov 8th	Republic proclaimed; emperor Wilhelm II. resigns; revolutionary uprisings[i]
[10] May 8th 1919	+9.5 %	May 7th	Publication of peace terms and immediate German complaint about them[j]

Notes: The estimated event date is given in column (1); column (2) informs about the percent change, which is recovered using 100*[exp(coefficient)-1]; coefficients and *t*-statistics omitted. Since, as a matter of fact, the 3 percent imperial was not traded on every (working) day, there are some considerable gaps in the price series. Thus, a turning point identified as statistically significant may refer to any event that lies within the time-span elapsed since the last reported price quote; this time span could have been zero because the last quote refers to the previous day, or it could have been a number of days or even weeks. Take the first entry – January 11th 1916 – as an example. Column (3) tells us that the last quote before that day dates to January 1st 1916. So the severe drop in price likely was a reaction to something happening in the previous ten days. To interpret the figures and understand why the events are proposed as they are, it is crucial to be aware of what is reported in this third column. Events that may be associated with the change are mentioned in column (4). Corresponding major news headlines to be found in the newspapers (taken from *Algemeen Handelsblad*; abbreviated *AH*; date of headline in brackets) were: [a] *De dienstpflichtquaestie in Engeland* (Jan 1st; also Jan 3rd-8th); AH, No. 28291, 28293-29298; [b] *Het aftreden van von Tirpitz* (Jan 17th); also *De strijd bij Verdun* (Jan 14th; also Jan 15th-17th); AH, No. 28364-28367; [c] *De zeeslag by Jutland* (Jun 3rd; also 5th-6th, and 8th); *Rouw over Lord Kitchener* (Jun 7th; also 8th); and *Fort Vaux door de Duitschers genomen* (Jun 8th); AH, No. 28445-28450; [d] *De revolutie in Rusland* (Mar 16th; also Mar 17th, and 21st-22nd); *De oorlog wordt voortgezet*

(Mar 16th); *Anti-Duitsche gevoelens in Rusland* (Mar 17th); and *De terugtocht der Duitschers aan het Westfront* (Mar19th); AH, No. 28729-28732; [e] *De wapenstilstand aan het Russische front gesloten*; and *De vredesonderhandelingen beginnen* (Dec 17th; similar Dec 18th-27th); AH, No. 29003; [f] *Het offensief op het Westfront begonnen* (Mar 22th, similar Mar 23rd-Apr 2nd, Apr 5th-7th); AH, No. 29097; [g] *Het Duitsche offensief* (Jun 5th; also Jun 6th); AH, No. 29170-29171; [h] *Het Entente-offensief op het Westfront* and *De Ostenrijksche vredesnota* (both Sep 18th); more battle news before; AH, No. 29275; [i] *Oproer en revolutionaire bewegingen in verschillernde plaatsen* (Nov 8th); AH, No. 29326; [j] *Het vraagstuk der verantwoordelijkheid* and *Vredesonderhandelingen* (May 8th); AH, No. 29503-29504.
Sources: Own calculations. Chronologies for cross-checking: *U. Büttner*, Weimar – die überforderte Republik 1918-1933, Stuttgart 2010, pp. 742-744; *German Historical Museum*, 1917 Chronik, www.dhm.de/lemo/html/1917 (30 July 2013, 13:01); *Ibid*., 1918 Chronik, www.dhm.de/lemo/html/1918 (30 July 2013, 12:56); *Ibid*., 1919 Chronik, www.dhm.de/lemo/html/ 1919 (30 July 2013, 12:57); *E. Gleichen (Ed.)*, Chronology of the Great War 1914-1918. Part II: 1916-1917, London 2000 [1919]; *Ibid*., Chronology of the Great War 1914-1918. Part III: 1918-1919, London 2000 [1920]; *G. Hirschfeld/G. Krumeich/I. Renz (Eds.)*, Enzyklopädie Erster Weltkrieg, Paderborn et al. 2009, pp. 1014-1017; *W. J. Mommsen*, Die Urkatastrophe Deutschlands. Der Erste Weltkrieg 1914-1918, Stuttgart 2002, pp. 157-172; *S. C. Tucker (Ed.)*, WWI Encyclopedia. Volume IV: S-Z, Santa Barbara 2005, pp. 1308-1317; *R. vom Bruch/B. Hofmeister (Eds.)*, Deutsche Geschichte in Quellen und Darstellung. Band 8. Kaiserreich und Erster Weltkrieg 1871-1918, Stuttgart 2002, p. 495-497. Newspapers: see *Notes*.

The empirical analysis identifies nine turning points during wartime and one shortly after war had ended. It is reasonable to imagine a turning point as implying that the related event came as a surprise to bondholders (in contrast to an event that had already been factored into prices beforehand).[24] It is immediately obvious that two event dates stand out. In bondholders' perception, these were January 11th 1916 – a likely reaction to the debate in Britain on the passage of the Military Service Act – and September 19th 1918 – a modification due to the Allied Powers' summer offensive, finally *turning the tables* in their favor and breaking Germany's opposition almost completely. These dates show the largest negative, long-lasting impacts on price throughout the observation period. The price decrease induced between January 1st and 11th was 14.6 percent, and the summer offensive of 1918 drove the price down by not less than 17.6 percent; both heavy plunges were sustained for a while, and the events responsible for them definitely

[24] 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 may no longer be mainstream. Turning points might have also 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 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 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, either at the beginning of war or at some later time. But this does not mean that they had not been negatively affected by censored information streaming from the belligerent countries.

dominate the long-term price pattern of the 3 percent imperial more than any other event. In the following, I briefly go through all turning points in chronological order.

So why might have bondholders attached so much significance to the debate on the Military Service Act? In contrast to all other belligerents, who sooner or later committed to maintaining a standing army based on compulsory military service, the British stuck with voluntary enlistments into military branches up until December 1915.[25] However, after the initial sequence of campaigns in 1914, 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 their 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 for this flaw in January 1916. At least since mid-1915, when the numbers of volunteers began to fall, the question of introducing compulsory military service arose and was discussed more intensely. After two unsuccessful measures – the National Registration Act of July 1915 and the Derby Scheme of October/December 1915 – Prime Minister Asquith finally openly advocated the Military Service Act as a workable solution. Originally, the act called for all single men between ages 18 and 41 to be conscripted (Stevenson 2004, pp. 198-214). It was formally introduced into parliamentary debate on January 5th 1916 and became a controversial topic of discussion (Gleichen 2000, p. 7).[26] The act finally passed the House of Commons successfully on January 25th (Gleichen 2000, p. 13). It seems as if the capital market perceived the debate on the Military Service Act as showing Britain's will to commit herself to total war and to prepare to draw upon resources much more heavily in the coming months.[27] The severe plunge in price as early as January 11th can be interpreted as a sign that bondholders anticipated that the act would pass parliament soon, and they seemingly attached much importance to its likely effects. Either they 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; or they simply expected the war to be prolonged and *Reich* finances to be so burdensome as to make debt moratorium more likely. Whatever the expectations,

[25] Approximately 2.4 million men coming from all quarters of the British Empire volunteered to fight in WWI – almost half of all British soldiers that would have been deployed overall (Stevenson 2004, p. 202).

[26] According to Stevenson (2004, pp. 202-203), the basic 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, indispensable to maintaining a high level of shell production.

[27] According to Stevenson's judgment, "[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." (Stevenson 2004, pp. 202 and 203).

this assessment is reinforced by the fact that the major headline that most frequently occurred in the *Algemeen Handelsblad* between January 1st and 11th was about the *conscription controversy*.[28]

The second turning point, on March 17th might be understood as bondholders' reaction to the resignation of Grand Admiral Alfred von Tirpitz due to disagreement among naval leaders regarding whether or not Germany should carry out unrestricted submarine warfare. Tirpitz, then head of the Imperial Naval Office and leading strategist, advocated a solution without restrictions, which did not match the opinion of the Chief of the Admiralty Staff that controlled the operational business of the navy and apparently favored a compromise: sinking allied merchant vessels, but not neutral ones (Stevenson 2004, pp. 258-259). That bondholders reacted negatively can be explained by the fact that Tirpitz obviously was perceived as a symbol of German naval power. As an instrument to support Germany's ambitions to rank equally among the traditional imperialist powers, he essentially created the fleet that, though it would, perhaps, not outmatch Britain's, would be a valuable deterrent and prerequisite for balanced negotiations in case of military conflict. Bondholders might have thought that Germany's strength at sea had gone with him (Strachan 2003, pp. 196-197; Stevenson 2004, pp. 84-85).

Definitely connected with the issue of naval power was the third turning point, which occurred on June 8th. During the preceding week, there had been news from the battlefield that bondholders received with some euphoria. First and foremost, rumors spread that the German High Seas Fleet had won the Battle of Jutland (May 31st-June 1st) 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 indeed have achieved victory.[29] Second, Lord Kitchener died on a sea passage to Russia; Kitchener was, at the time, head of the British war office and, thus, one of the highest-ranking administrators of war on the side of the Allied Powers. Third, on June 7th, German troops gained a prestigious victory during the Battle of Verdun when

[28] Indeed, there was news from the fronts, too, including, for example, the Dardanelles theatre (Southern Front). But Ottoman troops' efforts inducing the Allied Powers to eventually evacuate the Gallipoli Peninsula on January 8th, 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. There also was bad news from the Eastern Front because Russia had launched the *Offensive on the Strypa and the Styr* on New Year's Day, according to Gleichen. 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 confidence, as reflected in the 3 percent imperial's price plunge (Stevenson 2004, pp. 117-120; Gleichen 2000, p. 6; Algemeen Handelsblad, No. 28295, 5 January 1916: "Tsjernowitsy door de Ostenrijkers ontruimd").

[29] According to Stevenson (2004, p. 253) once again, 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 (versus 2,550 German ones). The long-term effects of this alleged victory were, however, judged negligible.

they took Fort Vaux, an important part of French fortifications. In net terms, these events came as a surprise and were met with a long-term, 4 percent increase in price.[30]

The data suggest a fourth turning point in bondholders' perception connected with March 22nd, when a longer-lasting 4.5 percent decrease in price occurred. This adjustment, it seems, was predominantly a reaction to news about the revolution in Russia over the previous few days. However, what really mattered for bondholders were apparently not the revolution's outbreak on March 7th and its provisional ending on March 15th with Tsar Nicolas II abandoning his throne, but, rather, the news that the new government would continue the war efforts.[31] In line with German authorities, any expectations that interior turmoil would keep Russia from continuing to battle Germany turned out to be too optimistic in the eyes of bondholders. Interestingly, the long-term price trend around this time was apparently not affected by the significant deterioration of US-German-relations since the beginning of the year and, in particular, not by the threat of American intervention.

The fifth turning point, which occurred on December 27th, definitely relates to *the* major event in the previous days – namely, the final defeat of Russia sealed with the armistice on the 15th of the month and the beginning of the peace negotiations in Brest-Litowsk on December 22nd (Gleichen 2000, p. 15 of part II). What the German Empire achieved was a long-cherished goal since it had become clear at the end of 1914 that the two-front war would continue and make the highest demands on resources. Now that there was calm on the Eastern Front, the remaining resources could be concentrated in the Western theatre. Against this background, the order of magnitude of bondholders' reaction appears rather small. In all, the capital market reacted to the defeat of Russia with only a longer-lasting markup of 3 percent. This can be interpreted as a signal that bondholders were already very skeptical that the defeat of Russia would significantly turn the tables in favor of the Central Powers.

Turning points six and seven, dated April 10th and June 6th 1918, were both smaller in magnitude. The former most likely reflects bondholders' change in confidence due to the German offensive at the Western Front after March 21st instigating the Second Battle of the Somme.[32] Bondholders' reaction was rather cautious. What the price of the 3 percent imperial

[30] I stress *in net terms* because there also was negative news, such as the beginning of the great *Brussilov-offensive* by the Russians on June 4th (Gleichen 2000, p. 38).

[31] Sondhaus (2011, p. 247) states that "[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."

[32] According to Keegan (2003, p. 556), "[O]n the evening of the March 21st 1918, the British Expeditionary Force suffered its first true reverse in the trench warfare that had already lasted for three and a half years;" own translation.

had gained through the initial success at the Somme, it lost on June 6th – a likely reaction to one of five large-scale German attacks between spring and summer. More specifically, it seems to have been the so-called *Blücher-Yorck*-advance (Battle of Chemin des Dames) that caused the negative structural break. While it began favorably for the German troops, it eventually failed and helped to pave the way for the Allied Powers' revival (Stevenson 2012, p. 88).

The eighth turning point in price dates to September 19th1918 and, in terms of magnitude, was the most severe structural shock in the observation period. This turning point consisted of a real chain of battle events that 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 at sea, in the air, and on land on all fronts (Stevenson 2004, pp. 421-427). 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 July 16th and August 4th, opened with a German offensive that backfired terribly; and the Battle of Amiens between August 8th and 12th, 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 (Gleichen 2000, pp. 76-84 of part III). Regarding the Southern Front, Bulgaria's defeat was almost completed on September 19th, and definitely so on September 22nd; a Bulgarian armistice offer followed another three days later Before, on September 15th, the Austro-Hungarian Empire had already signaled willingness to seriously negotiate about peace (Gleichen 2000, pp. 101, 104-107 of part III). In all, bondholders perceived the sequence of events between July 30th and September 19th 1918 as driving the probability of default up enormously and, thus, the probability of a German victory down enormously. The Franco-British-US revival from the summer of 1918 onwards appears to mark *the* decisive turning point of war (Stevenson 2012, pp. 112-113). The severe price drop of 17.6 percent strongly suggests that bondholders thought so.

The ninth structural shock, and the last of the war, occurred on November 9th and matches news on the revolutionary turmoil in Germany, with Wilhelm II abdicating his throne and the republic being proclaimed. Note that it was apparently not the armistice itself on November 11th that bondholders perceived as making the military defeat of Germany a true *fait accompli;* rather, it was the signs of political collapse of the old order.

Finally, the first post-war turning point occurred on May 8th 1919, when the price made a jump upwards by not less than +9.5 percent, lasting for the next fifty-plus days. On May 7th, the

Allied Powers had revealed the peace terms, including the war guilt paragraph assigning the German Empire the sole responsibility for unleashing the war. I believe that bondholders reacted positively to the fact that the German government immediately protested against the official peace terms, thereby fueling hopes that the unfavorable terms would be revised (Gleichen 2000, pp. 132-147 and 232-237 of part III). The ratification of the Treaty of Versailles on June 28th did not induce a significant structural shock at all. This simply shows that formal acceptance by the German Empire had already been factored into prices.[33]

4.3 The structural model

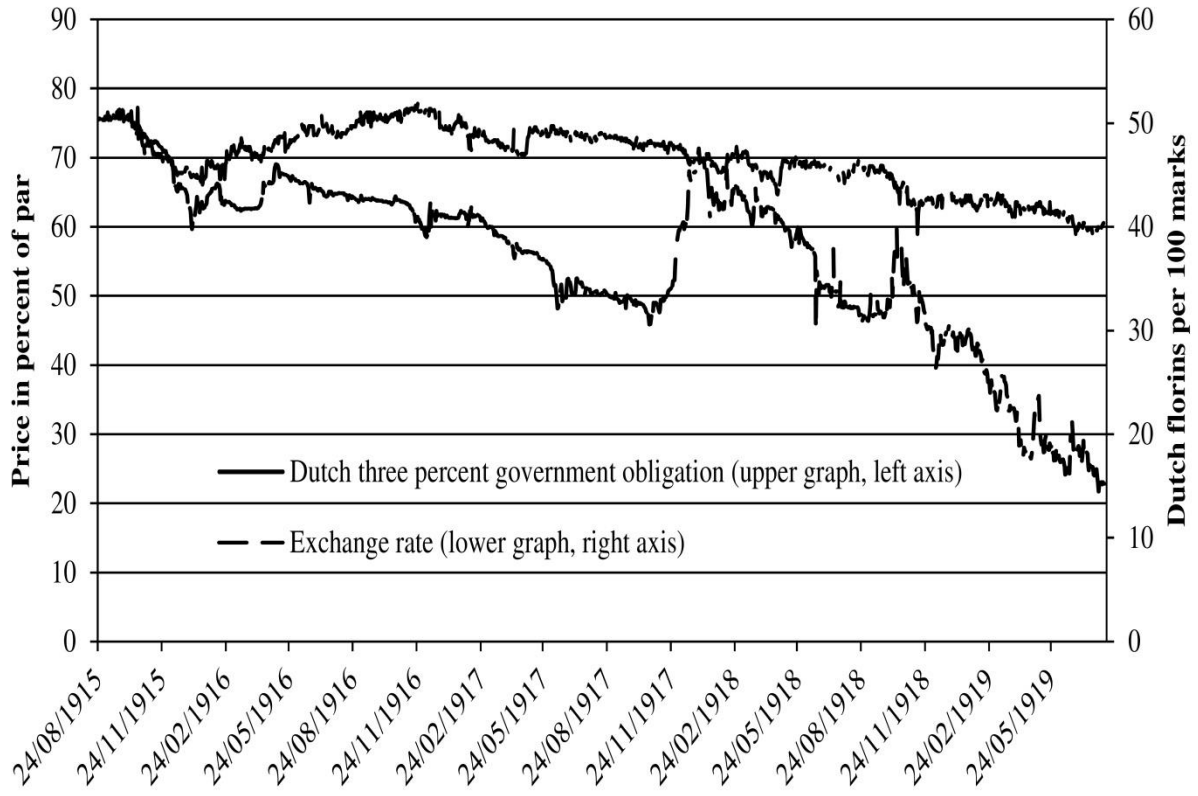
Is the baseline model, which contains little economic rationale, robust against inclusion of co-variates other than lags of the dependent variable? In the following, I briefly explore the implications of a structural model that additionally incorporates the Dutch-German exchange rate (Dutch florins per 100 marks) and the price of the Dutch 3 percent government obligation. There are two reasons for including these two particular variables. First, from a rather technical point of view, there are not many potentially relevant economic variables for which historical data can be collected on a daily basis at all. Second, since interest payments related to the 3 percent imperial were made in marks, it must 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 florins rather than marks, a declining value of the mark vis-à-vis Dutch florins would have made it increasingly expensive to exchange mark for florins. Put differently, per unit of interest payment, anyone willing to go into Dutch florins would *ceteris paribus* have lost money. Additionally, including the price of the Dutch 3 percent bond may help eliminate price fluctuations that affected the Netherlands *and* Germany similarly.[34]

Figure 3 plots the Dutch-German exchange rate and the price of the Dutch 3 percent government obligation over the extended sample period. As with the 3 percent imperial, both series exhibit a negative trend. Especially noteworthy are the large increase in the exchange rate around the turn of 1917-1918, coinciding with the German advance against and final defeat of Russia, and the temporary increase between the beginning of September and mid-October.

[33] The apparently major structural shock around August/September 1919 visible in Figures 1 and 2 occurred on August 27, when the price plummeted from 31 percent the day before to only 19 percent of par value.

[34] Unfortunately, I am not able to include a proper Amsterdam market index for government bonds at this stage. I am currently gathering the data to construct one.

Figure 3: The price of the Dutch 3 percent government obligation and the Dutch-German exchange rate, 1915-1919



Sources: Exchange rate 1915-1917: *G. van der Heyden*, Der ausländische Zahlungsverkehr in Holland vor, bei Ausbruch und während des Krieges von dessen Beginn bis Ende 1917, Frankfurt am Main 1918, pp. 179-198. Exchange rate 1918-1919: Algemeen Handelsblad; De Telegraaf. Dutch bond's price: See Figure 1.

As Table 3 shows, estimating the structural model (see Appendix) does yield slightly different results. First, the ten turning points previously identified are validated, though the estimated percent change in price associated with them is generally higher than in the baseline model. In fact, this does not alter the basic conclusions about bondholders' evaluation of Germany's war performance elaborated above. Second, two further turning points enter the stage.[35] The one on June 28th 1917 is not easily attributable to an event since the last available price quote prior to that day is dated May 22nd 1917. More importantly, the structural shock is positive even though its magnitude is rather small. If we pay attention only to the news reported on the previous day, we find

[35] To be precise, four further turning points were identified. But two of them – October 28th 1916 (–1.0 percent) and December 28th (+2.1 percent) – were dates on which no actual change in the raw data occurred with regard to the previous days. Therefore I do not consider them here.

that the first comment in the *Algemeen Handesblad*'s war news section refers to a meeting that had only just begun between English and German delegates in The Hague, not to discuss peace terms, as the newspaper pointed out, but to discuss matters of prisoners of war. Besides, news on the peace conference held by Social Democrats in Stockholm earlier in the month may have led bondholders to expect that peace was possible (Algemeen Handelsblad No. 28830 of June 27th 1917). In all, I am not confident in clearly attributing this turning point to a particular event.

The second turning point, on January 17th 1919 (last available quote dates to January 16th), coincides with Germany having signed revised armistice terms on that day (extension of armistice to February 17th), but especially with the fact that the Paris Peace Conference was to start on the next day. So bondholders apparently reacted positively (+3.6 percent) to the fact that peace seemed inevitable at that time (Gleichen 2000, pp. 232 and 239 of part III).

Table 3: Comparison of the estimated percent change in price over the baseline and the structural model

Turning points	Baseline model	Structural model	Turning points	Baseline model	Structural model
January 11th 1916	–14.6 %	–15.6 %	April 10th 1918	+1.1 %	+1.2 %
March 17th 1916	–1.5 %	–4.7 %	June 6th 1918	–0.8 %	–0.9 %
June 8th 1916	+5.6 %	+9.1 %	September 19th 1918	–17.6 %	–25.5 %
March 22nd 1917	–4.5 %	–4.9 %	November 9th 1918	–4.7 %	–4.4 %
June 28th 1917	-	*+1.6 %*	*January 17th 1919*	-	*+3.6 %*
December 27th 1917	+3.1 %	+3.4 %	May 8th 1919	+9.5 %	+13.1 %

Notes: See Appendix for model specification.

Sources: Own calculations.

5 Conclusions

The meaning contemporary observers ascribed to a particular event may well differ from the meaning historians, or the public mind, ascribe to it retrospectively. Thus, analyzing bond prices or other types of capital market data may lead to a correction of historically accepted findings; doing so has the potential of contributing to a more integrated historical picture of the perceptions of a country's prospects in war. Since investors lose money if they make the wrong decision, they are arguably prone to assessing the situation rationally, keeping in mind the risk they take. Thus, prices as manifestations of investors' actions are a reliable historical source on contemporaries' *ex-ante* beliefs. By using Amsterdam wartime price quotations for the German 3 percent imperial loan, constituting part of the German Empire's peacetime debt, this paper un-

covers the events that fundamentally influenced bondholders' perception of Germany's prospects for winning or losing WWI. It adds a new perspective to the historiography of World War I and suggests ways to reconsider the importance of certain historical events.

In all, regarding the period from August 1915 to November 1918, the Amsterdam bond market assessed Germany's performance as having been rather poor. Seen through the lens of bondholders, a concise WWI narrative centering on Germany should consist of twelve events that, alone, determined the long-term trend of their confidence. Of those events, which are compatible with significant structural shocks in the price of the particular German bond addressed, six were perceived as having a negative impact on Germany and, through the channel of debt service, on bondholders' position. Of these six events, the most important in the eyes of bondholders were the conscription controversy in Britain, finally ending in a signal that Britain was likely to get fully involved in the war; and the groundbreaking efforts in driving German troops back at the Western Front around mid-1918, as well as the subsequent transition into an offensive that brought war to a head. The loss of confidence due to those events alone was monumental. Interestingly, historians usually do not attribute too much importance to the conscription controversy as it stood in January 1916. This may be due to the fact that, in hindsight, the conscription program in Britain was not a great success in mobilizing human resources; a basic reform of the Military Service Act followed, for example, in May 1916. However, evidence strictly supports the view established in the historiography that the happenings on the fronts in the spring and summer of 1918 deserve to be seen as *the* major turning point in war. Finally, another six events induced positive reactions among bondholders, but most of these were rather weak, so they dwindle in importance against the cumulative negative shocks. After all, bondholders seemed to have perceived the course of things as playing right into the hands of the Allied Powers.

Appendix: Econometric approach

In order to identify structural breaks in the German bond price series, I adopt a four-step procedure according to Banerjee et al. (1992) often applied in the relevant literature. To determine how long a *structural shock* should have lasted in order to be called a structural shock, I follow Willard, Guinnane and Rosen (1996, p. 1008), who established a period of at least 50 days for which the change in the mean price should hold.

As is standard, I checked the logged price series for the presence of a unit root by applying the Dickey-Fuller generalized least squares (DF GLS) test. The test results (not displayed here) suggest that the series is stationary around a trend over the extended sample period of August 24th 1915 to August 11th 1919.[36] Thus, I feel safe in continuing with log level data as long as a deterministic time trend is included in any regression as an explanatory variable.

In the following, I will present two models – the baseline one and a variant that functions as a robustness check. Turning to the baseline model, the first step is to estimate the process given by equation (2) with OLS for rolling windows that are each specified to be 101 days long:

$$(2) \qquad \ln P_t = \beta_0 + \sum_{k=1}^{K} \beta_k * \ln P_{t-k} + \beta_{K+1} * TIME + u_t \ .$$

Here, $\ln P_t$ denotes the bond's logged price at day t. The β_ks mark the coefficients of k lagged dependent variables, and β_{K+1} is the coefficient of the deterministic time trend (advancing by one unit per day); u_t is the error term. According to the modified Akaike information criterion (MAIC) developed by Ng and Perron (2000), I chose to use $k = 8$.[37] Concretely, we begin by estimating equation (2) for the window from August 24th to December 2nd 1915. Then, we move the window by one day so that the next window is August 25th to December 3rd 1915, and we pro-

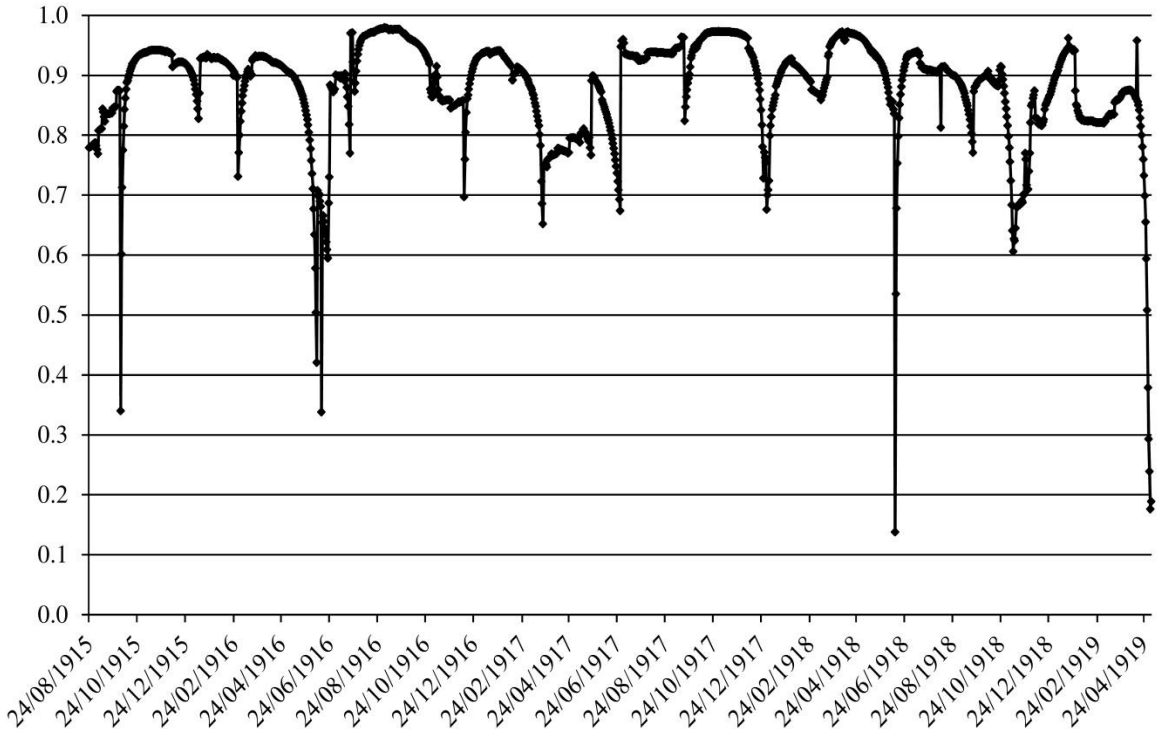
[36] Since the Dickey-Fuller generalized least squares test (in STATA) does not work with gaps in the series, I interpolated them. Precisely, I closed the gap between day *x* and day *z* by assigning day *y* the price valid on day *x*.

[37] By default, STATA supplies as part of the results for the Dickey-Fuller GLS test three lag selection criteria – 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, p. 5), 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. This is actually the range of observations defining window size in my turning points analysis (see step three).

ceed in this manner until the whole sample period is covered. In all, this was done for 1,349 101-day intervals.[38]

In a second step, windows were identified where the model performed least well. One of three different approaches has usually been applied in the empirical literature to measure performance: retain R-squared values from the regressions; perform an F-test of the null hypothesis that there is an omitted variable; or perform an F-test of the null hypothesis that there is a structural break at the center of the window. I followed variant one and restored the R-squared values from the regressions, plotted them (see Figure A.1) and screened the plot for the windows with the locally lowest fit. In all, I identified eighteen windows, partly overlapping, in which structural breaks may have occurred. Most promising to contain turning points are certainly windows I, IV, XIII, and XVIII, centering on November 22nd 1915, August 3rd 1916, August 1st 1918, and June 22nd 1919.

Figure A.1: R-squared values from estimation of equation (2)



Notes: R-squared values successively derived for all 1,349 101-day windows over August 24th 1915 to August 11th 1919. Note that the dates on the horizontal axis mark the beginning of the window, not the center itself.
Sources: See text.

[38] Estimating equation (2) over the whole extended sample, the results of a Breusch-Godfrey LM test do not suggest the presence of autocorrelation in the error terms up to lag eight.

The third step requires recursively estimating equation (3) for all the 18 isolated windows:

$$(3) \quad \ln P_t = \beta_0 + \sum_{k=1}^{K} \beta_k * \ln P_{t-k} + \beta_{K+1} * TIME + \beta_{K+1} * D_s + u_t \ .$$

Equation (3) is a modification of equation (2) in that a dummy variable D_s is incorporated on the right side. It takes the value 1 for the event day and all subsequent days, and zero for all days up to the event day. To be able to identify turning points at the beginning or the end of a window, I extend the window to be searched by 25 days on both sides, such that it consists of 151 days; a turning point at the end of a window would, thus, be reversed after 50 days at the earliest. As an example, take the window centering on November 22nd 1915.

Equation (3) is first estimated in a way that the dummy variable takes the value 0 for observations for September 8th to October 2nd 1915 (the additional 25 days on the left side) and 1 for all days between October 3rd 1915 and February 5th 1916. Then, the equation is estimated again with the dummy being zero for the first 26 observations and 1 beyond and including October 4th 1915; the procedure is repeated until the whole window has been recursively estimated. The final step is to identify whether there are statistically significant coefficients (10 percent or better) in a particular window at all. If so, the date of the statistically significant dummy variable with the highest *t*-statistic within the window marks the turning point. The baseline model identifies ten turning points (nine referring to the war period itself, and one referring to the immediate postwar period).

The alternative model is a structural one – i.e., it includes explanatory variables other than simply lags of the dependent variable. In the following, I incorporate first lags of the exchange rate (*ER*) and the price of the Dutch three percent government obligation (*PDUTCH*) as quoted at Amsterdam, too; see the main text for the economic logic behind this. Using log level data again, we can write

$$(4) \quad \ln P_t = \beta_0 + \sum_{k=1}^{K} \beta_k * \ln P_{t-k} + \beta_{K+1} * TIME + \beta_{K+2} * \ln ER_{t-1} + \beta_{K+3} * \ln PDUTCH_{t-1} + u_t \ .$$

Steps one and two combined yield an R-squared plot almost like that depicted in Figure A.1. In particular, the windows implied to contain potential break points remain the same for the struc-

tural model. Steps three and four combined, on the one hand, confirm the appearance of the turning points identified in the baseline model and, on the other hand, add an additional two turning points of minor magnitude to the list. Using the contemporaneous values for the exchange rate and the Dutch bond price does not affect results significantly differently.

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