

How does the Public perceive Alliances? The Central and Allied Powers in World War I

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Abstract: World War I was fought by numerous countries siding together as the Central Powers and, respectively, the Allied Powers. The former established around the German Empire and Austria-Hungary and grew to four allies when the Ottoman Empire in late 1914 and Bulgaria in late 1915 entered the scene; the latter centered on the alliance between England, France, and Russia and was informally extended to many more countries as they entered into the war ad-hoc by signaling common interests with the core Allied Powers. This article addresses an oft-neglected dimension of the alliance formation phenomenon, namely how alliances were perceived by the public, in contrast to military leaders' perceptions of each other. Were the Central and Allied Powers perceived as credible alliances – monolithic blocks – right at the time? We seek to determine the degree of "alliance integration" among pairs of countries by applying cointegration analysis based on securities prices. It is assumed that prices of countries perceived as "integrated" should show signs of co-movement. More specifically, we focus on the Amsterdam market for foreign government bonds providing us with a neutral's view on that matter. Our analysis is based on the yields for 13 belligerent countries' representative bonds traded during the war, but also before and after. Among other things, we cannot corroborate that investors recognized two monolithic blocks simply fighting the war.

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1. Introduction

World War I was fought by numerous countries siding together as the *Central Powers* and, respectively, the *Allied Powers*. The former centered on the alliance between the German Empire and Austria-Hungary (the *Dual Alliance*), which grew to four allies when the Ottoman Empire in late 1914 and Bulgaria in late 1915 entered the scene; and the latter centered on the alliance between England, France, and Russia (the *Triple Entente*) and was informally extended to many more countries from all over the world by them just entering into the war at some point in time and signaling common interests with the core Allied Powers. A good deal of political, politico-economic and historical research focuses on explaining alliance formation and behavior in the run-up to and during the First World War.¹ Alliance research 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?"; and "what are/were the effects of alliance formation on the international system?"² Historical research has especially examined the complex web of diplomatic and military relations between the *de facto* alliance partners and opponents as they, for example, showed up in the war aims discussions.³

Instead of directly examining alliance formation and behavior around the outbreak of and during the First World War, this article addresses another, oft-neglected dimension of the phenomenon, namely alliance perceptions among the public, of which the military leaders usually demand commitment to the cause. To be more specific, we are interested in the historical question of whether the Central and Allied Powers were perceived as credible alliances right at the time – that is, 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 – e.g., Bulgaria and the Ottoman Empire. 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 actual opponents; for example, as in Christensen's 1997 study, along the lines "perceived power of frontline potential ally in com-

¹ Cf., for example, Langer (1951); Gulick (1955); Rothstein (1968), pp. 181-220; Lee (1974); Singer (1979/80 I & II); Kennedy (1980); Weitsman (2004); White (1995); Snyder (1997); Bridge / Bullen (2005); Miller (2012); Neilson (2014).

² Olson / Zeckhauser (1966); Levy (1981); Thies (1987); Conybeare (1992); Conybeare (1994); Sandler / Hartley (2001).

³ Cf., for example, Fischer (1964); Fest (1978); Linke (1982); French (1986); Stevenson (1988); Michalka (1997); Stevenson (2004), pp. 127-151; Burhop (2016), pp. 19-42; Soutou (2017).

parison with immediate rivals" and "perceived efficacy of offensive versus defensive military doctrines".⁴

Since public opinion or, respectively, perception is a wide field, we confine our study to examining perceptions as revealed by the nameless crowd that traded in the securities market. More specifically, we focus on the Amsterdam market for foreign government bonds providing us with a neutral's view on that matter. Our analysis is based on the yields for 13 belligerent countries' representative bonds traded during the war, but also before and after. Among the countries covered are the great players Germany, Austria, France, England, and Russia. Additionally, we consider Bulgaria, the Ottoman Empire, Japan, Serbia, Italy, Romania, Portugal, and China.⁵

In the spirit of many studies examining the degree of financial and commodity market integration, we seek to determine the degree of "alliance integration" among pairs of countries by applying cointegration analysis. The baseline assumption of our approach is that bond yields of allies perceived as "integrated" should be cointegrated, that is, be in long-term equilibrium, while yields of countries not perceived as "integrated" – especially opponents – should not show signs of positively correlated country risk. To that end, we propose one *ad-hoc* test for the start: A "global test" searching for cointegration over the war period as a whole.

Conceptually, this approach has close ties with the turning points literature that centers on measuring contemporary perceptions by screening historical financial time series for structural breaks and matching those breaks with economic, diplomatic, political, and military events. This literature has established securities – and especially bond – prices as reliable predictors of investor opinion.⁶ 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 investor opinion, working through investors' reluctance or willingness to buy sovereign issues, also determined to a good deal the financing options of states.

The analysis proceeds as follows: In Section 2, a brief overview of alliance formation in the run-up to World War I and during the war itself is provided. The research design centering on testing for cointegration is described in Section 3. Section 4 introduces the data. Empirical evidence on the test is presented in Section 5 and broader implications are discussed in Section 6. Finally, Section 7 concludes the article.

⁴ Christensen (1997), pp. 67–70.

⁵ The US cannot be included due to data unavailability; see Section 4.

⁶ Willard / Guinnane / Rosen (1996); Frey / Kucher (2000); Brown / Burdekin (2002); Ferguson / Voth (2008); Waldenström / Frey (2008); Christodoulaki / Cho / Fryzlewicz (2012); Oosterlinck / Ureche-Rangau (2012); Collet (2013); Ho / Li (2014); Jopp (2014); Haber / Mitchener / Oosterlinck / Weidenmier (2014); Adams (2015); Hudson / Urquhart (2015); Jopp (2016); Hanedar / Hanedar / Torun (2016).

2. Alliance Formations before and during World War I

The Central and Allied Powers formed around the Dual Alliance of 1879 between the German Empire and Austria-Hungary and, respectively, 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 the First World War on the Allied Powers side in 1915. The Dual Alliance fulfilled a basic security need for Germany and Austria-Hungary as the partners committed themselves to come to the other's rescue in case of an attack by Russia and, in any other case, to remain neutral.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 main Triple Alliance's 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 fundament was decisively softened by Italy concluding arrangements with France (1900/1902) and Russia (1909)¹⁰ as well as with 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 over 1887-1890, the Reinsurance Treaty with Germany, centering around neutrality if one partner was involved in a great power conflict (with the exceptions of a German-French and Russian-Austrian conflict). The Triple Entente formed with the Anglo-French treaty of 1904 originating mainly in the wish to settle colonial disputes and the Anglo-Russian treaty of 1907 settling differences that had arisen in the Asian theatre; France and Russia already had an agreement dating back to 1893, mainly as a reaction to the nonrenewal of the German-Russian neutrality agreement.¹²

This cursory overview 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, often had been formed between partners that later became opponents; there were also cases where alliance opponents later became

⁷ Conybeare / Sandler (1990), p. 1197.

⁸ Schroeder (1976), p. 242.

⁹ Cf. Levy, p. 585, for a formal definition of "Great Power Status".

¹⁰ Conybeare / Sandler (1990), p. 1198.

¹¹ Schroeder (1976), p. 246.

¹² Conybeare / Sandler (1990), p. 1198. For a discussion of alliances between 1815 and 1879, cf. Schroeder (1976), pp. 231-242.

alliance partners: Among others, there were the German-Serbian (1881) and German-Romanian (1883) alliances;¹³ the Anglo-Japanese alliance of 1902 targeting Russia;¹⁴ and the Balkan League of 1912 that consisted of Bulgaria, Greece and Serbia and was directed against the Ottoman Empire.¹⁵

In the spirit of studies asking how burdens within alliances were shared,¹⁶ Table 1 assembles some statistics on the major powers' starting positions around 1913/1914. Given are figures on 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.¹⁷ The degree of the state's indebtedness, for example, gives an impression of the players' room for financial manoeuvre; the UK and Germany certainly had the greatest. However, in terms of the peacetime strength of military forces indicative of what pressure a player may immediately be put upon its opponents and of population indicative of the potential to levy an army in the medium-term, the Allies dominate the picture.

Table 1: Main Belligerents' Characteristics before the outbreak of World War I

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
Russia	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

Notes: GDP and public debt figures are for 1913. Population figures are for 1914/15. Colonial population is excluded. Population and strength of land forces of Russia refer to its European part. Peacetime strengths refer to 1912/1913. *Sources:* GDP: The Maddison-Project (<http://www.ggd.net/maddison/maddison-project/home.htm>, 2013 version, accessed 24 February 2015). Public debt: Abbas / Belhocine / ElGanainy / Horton (2010). Population data: Keltie / Epstein (1916), p. xxiv. Military data: Keltie / Epstein (1913), pp. 53-55, 616-617, 796-798, 871-872, 1201-1203, 1309-1311.

¹³ Schroeder (1976), p. 243.

¹⁴ Schroeder (1976), p. 246.

¹⁵ Schroeder (1976), p. 248.

¹⁶ Cf. Thies (1987), pp. 308-309.

¹⁷ On the importance of the dreadnought as a "breakthrough technology", cf. Herwig (1991), pp. 273-283.

A more structured approach towards measuring the military potential of a nation, in general, and of the Central and Allied Powers, in particular, is to make use of the *Composite Index of National Capabilities* (CINC) as reported on *The Correlates of War Project's* homepage.¹⁸ This multidimensional index has been created to operationalise the concept of "national power", that is, a nation's possibilities to "exercise control over the behavior of another", "to punish or reward [it; the author]", to wage war or to sustain one it has been dragged into.¹⁹ Per observed year²⁰ the CINC assembles and aggregates six indicators of a nation's material capabilities or, we might alternatively say, reaction potential. Two indicators each cover the (a) short- (military forces at immediate disposal), the (b) medium- (industrial capacity to produce war goods) and the (c) long-term (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*.²¹

Based on the CINC the baseline assumption was tested that nations that can rely on greater material capabilities are more war prone than others. In his 1980 study Bremer argued that more capable nations indeed fought more and heavier wars.²²

Table 2 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.²³ The cumulated CINC of 0.188 for the Central Powers and 0.346 for the Allied Powers for 1913 are for all belligerents that would enter into the war up until August 1914.

¹⁸ Cf. the project's homepage at <http://www.correlatesofwar.org/>.

¹⁹ Bremer (1980), p. 59.

²⁰ Currently figures are available for the period 1816 to 2012.

²¹ Bremer (1980), p. 60. For the aggregation procedure itself, cf. *ibid.*, pp. 63-66.

²² Bremer (1980), pp. 57-59, 79-82.

²³ Note, however, that France's and especially Britain's colonial empires are ignored here.

Table 2: 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
		<i>.188 (Jul/Aug 1914)</i>	<i>.204</i>
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
		<i>.346 (Jul/Aug 1914)</i>	<i>.732</i>

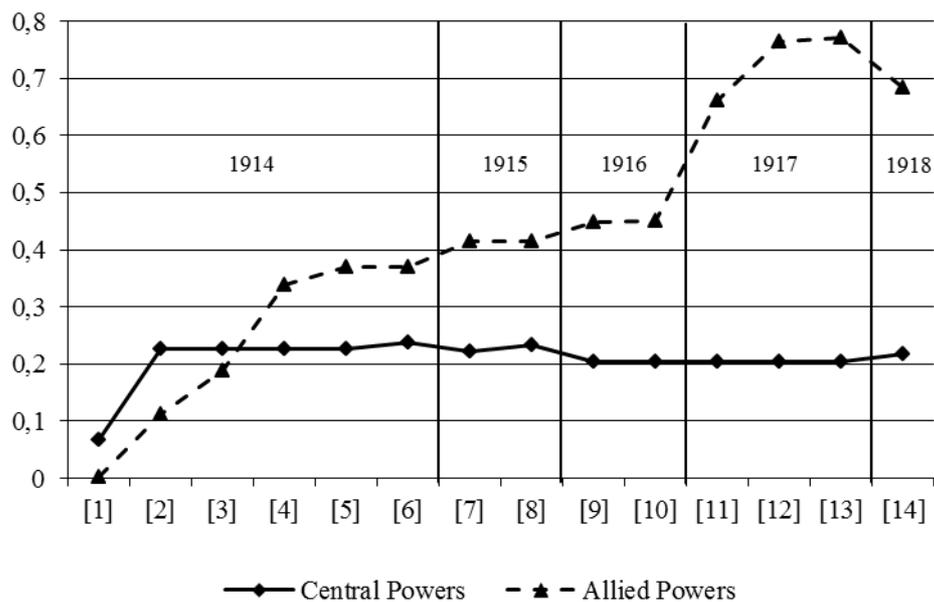
Notes: CINC abbreviates Composite Index of National Material Capabilities according to the Correlates of War project. 1913: cumulative CINC for all countries that went to war in late July and August 1914. Enumeration is not complete.

(^a) CINC only available for Yugoslavia.

Sources: http://www.correlatesofwar.org/COW2Data/Capa-bilities/NMC_5_o.zip, accessed 7 August 2017; Singer / Bremer / Stuckey (1972), pp. 19-48.

In terms of the CINC, one can certainly argue that the German Empire and its alliance partners could only lose the war – even before the US entered the scene. However, such argumentation certainly introduces hindsight bias as the picture – the information set, so to speak – for military leaders as well as the public at the time was very probably different; and, as it stands, Table 2 does not convey a sound impression of the dynamics inherent in the alliance formation process, that is, of the shifts in material capabilities over which an alliance could *formally* command. Therefore Figure 1 displays the evolution of both alliances' CINC values by entry event. Entry events are numbered one to thirteen (see the brackets in column two in Table 2); what is labeled entry event fourteen in Figure 1 is simply the cumulated CINC for 1918.

Figure 1: Cumulated CINC Values by Entry Event



Sources: See Table 2.

All belligerents displayed in Table 2 were counted into the cumulated CINC with their annual values 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. It is, of course, needless to say that the presence of material capabilities to a particular amount is not the same as being able to exploit them efficiently.

Given the list of countries that fought the First World War – the list in Table 2 is incomplete and could be extended by further, yet minor, players (e.g., Liberia or Nicaragua) –, it is reasonable to speak of a global conflict made of multiple layers, where the great powers' conflict only was one layer, even though the most visible. Smaller regional conflicts were fought under the veil of this large conflict, mostly to press home manifold territorial agendas. Following Janz, this kind of motivation for entry equally holds, at least, for Italy, Romania, Bulgaria, Portugal, Turkey, China, and Japan. Others such as most Latin American states wanted to secure their possibilities to carry on commerce via the sea – possibilities that were decisively threatened by the unrestricted submarine warfare.²⁴

²⁴ Janz (2014), pp. 152-153. On the war's global character, cf. Strachan (2010). On the motives of the Latin American states to enter into the war, cf. especially Rinke (2014), p. 296.

3. Alliances and Credibility

From the brief historical account it follows that the military 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, others may have reflected weaker alliances. There also were 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).²⁵ And, what is more, 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 article asks for the public's real-time opinion on the credibility of the militarily, politically, and historically established alliances.

To that end, we turn to the capital market and examine prices of government bonds at Amsterdam over 1914–1919 – thus prices formed in a neutral's market.²⁶ The reason for concentrating on capital market data is twofold: First, mass data from which to construct contemporary perceptions is rather scarce; financial market data, in contrast, are available in good quantity. Second, recent research has highlighted the fact that financial market data – securities prices in the first place – can function as a meaningful predictor of contemporary investor opinion on any matter – economic, political, diplomatic, or military.²⁷ So our approach does rest on what prices implicate on a larger mass of individuals of which, however, we know little in detail (except for the fact that they may not be perfectly representative for the population as a whole).

How is the term "alliance" used here? With respect to the political science literature, there are two definitions that one may stick to. In a more narrow 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 (and the alliance being "formal" then).²⁸ Most alliances we are dealing with here were formed *ad-hoc* and were not backed by written treaties. So it seems appropriate to stick to the other, less narrow definition which is that an alliance of two or more states simply reflects a "working partnership" between states backed by verbal, but not necessarily writ-

²⁵ Cf. Levy (1981), p. 583, on the terms "ad-hoc" and "permanent" alliance. On the categorization of alliances in terms of the dichotomy "close-distant", cf. Small (1979), p. 244.

²⁶ On Dutch neutrality, cf. Jopp (2016), pp. 4–5, and Tames (2012).

²⁷ Cf. Footnote 6.

²⁸ Schroeder (1976), p. 227.

ten commitment, or simply by conclusive action.²⁹ Apart from the pre-existing alliances among the Great Powers, partnerships were conclusively declared by just entering in on one side and fighting against a player that committed itself this way to the other side.

What is meant with "credibility" or the term "credible alliance"? In our view, an alliance was credible in the eyes of investors if the partners were perceived being compatible, which may have depended, among other things, on the compatibility of each partner's declared war aims, on the size differential or resource potential, or a common pre-war history of good relations whatsoever. According to Miller, for example, international relations studies may define the credibility of an ally as "[...] a state's willingness to follow through on its threats."³⁰ And according to Morrow, "[a]lliances could operate as signals of common interests among allies."³¹ Regarding our case, we might ask whether the capital market bought the signals. So our definition, we think, should entail these notions. Another understanding of the term "credibility" could be that 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 win the war. This notion may also be entailed in our definition. However, separating investor opinion into these two basic notions is a problem that we do not try to solve here. Rather, we bear in mind that both aspects may explain our observations.

This approach rests on the idea that the behavior of sovereign yields signals average investor opinion, but not necessarily in a way that provides us with an easy-to-read picture. We draw on the literature on financial and commodity market integration that uses cointegration analysis to determine the degree of integration of two (or more) markets and we apply this methodology to a one-market scenario.³² Our baseline *assumption* is that the sovereign yields of two countries should show signs of cointegration – that is, signs of a long-term equilibrium – if the average investor regards them as close, compatible allies (that may even win the war together). In this case, we suppose, do country risks become blurred. In the 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).³³ So the focus in the following is on country pairs, meaning that we check for the existence of a cointegration relationship between exactly two countries at a time.

²⁹ Schroeder (1976), p. 227.

³⁰ Miller (2012), p. 4.

³¹ Morrow (1994), pp. 270-271.

³² Cf., for example, Choudhry (1996); Chan / Gup / Pan(1997); Hout / Rojo Cajigal (2010); Worthington / Andrew / Higgs (2010); Federico (2012); Brunt / Cannon (2014).

³³ Here we, broadly, follow Small (1979), p. 244.

The basic assumption of the simple "global" test put forward in this paper is that if two yield series were cointegrated, the cointegration relationship held over the entire war period. We formulate three baseline hypotheses:

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 pair-wise 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 pair-wise cointegrated.

H0-C: Opposing countries were viewed as dis-integrated – i.e., the yields of opposing countries are not found to be cointegrated.

In a sense, 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 is to hold to get unambiguous findings.

4. Data

To examine public opinion on First World War alliances as formed among investors in more detail, we make use of an extensive hand-collected original database on government bond prices in Amsterdam. The database principally covers the entire cross-section of bonds that were traded there between 1 January 1914 and 31 December 1919.³⁴ Prices were collected on a daily basis and reflect the days' mean price in percent of par value as reported in the (*Uittreksel uit de*) *Officieele Prijs-courant der Vereeniging voor den Effectenhandel te Amsterdam*. The official price list was regularly re-printed in the Dutch newspapers, and we especially used the *Algemeen Handelsblad*, *De Telegraaf*, *De Tijd: Godsdienstig-Staatkundig Dagblad*, and *Het Centrum* as sources for prices. To gather additional information on the cross-section, we made use of several volumes of the relevant handbooks on the Amsterdam stock exchange, the *Gids bij de Prijscourant* and the *Effectenboek* edited by the *Vereeniging voor den Effectenhandel te Amsterdam* ("Amsterdam Corporation for Trade in Securities") and S. F. van Oss, respectively. We counted over 270 different bond series as having been traded during the observation period (approximately 145,000 raw price

³⁴ For discussions, cf. Jopp (2014), pp. 164-168; Jopp (2016), pp. 4-5.

quotes). Note that this number refers to sub-series – e.g., the German 3 % imperial loan with coupon dates 1 January and 1 July; and that with coupon dates 1 April and 1 October.³⁵

Of the thirty-seven different sovereign issuers the bonds of which comprise the cross-section, 19 had been war party right from the beginning of war or became war party sometime over the course of war. Table 3 lists those countries separately by alliance, and within alliance by date of entry into the war. As in Jopp's study, the analysis is based on single representative bonds rather than on country indices. More specifically, the most liquid bond per country over the war-time itself (i.e., 9 February 1915 to 11 November 1918, due to the temporary closure of the stock exchange) has been selected as being "representative".³⁶ Column four reports the corresponding liquidity scores. Some bonds were still quite liquid during the war (e.g., the Austrian or the Russian bonds). Others, even though being the relatively most liquid issue for the particular country, were exceptionally illiquid at all. Analyzing representative bonds instead of country indices seems appropriate as both the number of bonds per country and within-country liquidity is highly unequally distributed.

³⁵ If we only counted the main series (i.e., simply condensed the two German 3 % imperial loan series into one), we would arrive at some 180.

³⁶ Liquidity is measured by the relative incidence of non zero-returns – i.e., the number of non-zero returns divided by the number of potential trading days between 9 February 1915 and 11 November 1918; cf. Lesmond / Ogden/ Trzcinka (1999); Jopp (2016), pp. 5-7.

Table 3: A Set of Representative Bonds for the Belligerent Countries

Country (1)	Entry into the war (2)	Representative bond (3)	LIQ (4)	CCI (5)	DUR (6)	CUR (7)	COU (8)
A. Central Powers							
Austria	28/07/1914	4% Kroner perpetual 1892 (Jan/Jul)	.599	.99	∞	K	2x
Germany	01/08/1914	3% imperial 1890 (Apr/Oct)	.127	.98	∞	M	2x
Ottoman Empire	05/11/1914	4% Baghdad railway 1 st series 1904	.320	.78	2001	F	2x
Bulgaria	09/10/1915	5% tobacco 1902	.234	.91	1952	LF	4x
B. Allied Powers							
Serbia	28/07/1914	4% 1895 (500)	.245	-	1967	F	4x
Russia	01/08/1914	4% Hope & Co 1885 (625r)	.649	.98	1953	R	4x
France	03/08/1914	5% war bond 1915	.207	.95	n/a	F	n/a
England	04/08/1914	5% war bond (1915/1916?)	.163	.96	n/a	P	n/a
[Belgium]	04/08/1914	2.5% 1842	.001	.45	∞	F	2x
Japan	23/08/1914	5% imperial 1908/09 (500- 1,000)	.183	.36	1956	Y	2x
Italy	23/05/1915	3.5% 1862/81	.017	-	∞	L	2x
Portugal	09/03/1916	4.5% tobacco 1890	.428	.80	1925	F	2x
Romania	27/08/1916	4% 1910 (2,500-5,000)	.009	.86	1950	F	2x
[USA]	06/04/1917	4% State of Louisiana 1874	.000	-	∞	D	2x
[Cuba]	07/04/1917	5% 1904/05	.090	.97	1939	D	2x
[Liberia]	04/08/1917	5% customs loan 1913	.023	-	1952	D	2x
China	14/08/1917	4.5% 1898	.158	.87	1944	P	2x
[Brazil]	26/10/1917	5% 1914 (20-100)	.425	.77	1927	P	4x
[Nicaragua]	07/08/1918	5% 1909	.093	-	1944	P	2x

Notes: "Entry into the war" either is the date of the first declaration against another country or the first declaration of war the respective country received. In (3) the relevant sub-series 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; CCI its correlation with an equal-weighted country index comprising all the country's government bonds; DUR its duration; 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; D=US Dollar; Y=Japanese Yen); and COU the frequency of coupon payments per year (e.g., "2x" indicates semi-annual payments).

Sources: Own calculations; dates of declarations of war taken from Gleichen (2000); bond prices hand-collected from several Dutch Newspapers (i.e., *Allgemeen Handelsblad*, *De Telegraaf*, *De Tijd: Godsdienstig-Staatkundig Dagblad*, *Het Centrum*, *Leeuwarder Courant*, *Nieuwsblad van het Noorden*, and *Nieuwe Rotterdamsche Courant*; accessed digitally via *Koninklijke Bibliotheek van Nederland*); bond characteristics taken from *Vereeniging voor den Effectenhandel* (1914-1918).

This is reinforced by a look at column five which reports the zero-order correlation of the selected representative bonds with simple country indices where each daily observation on the indices was generated as an equal-weighted average of the relevant (imputed) price series. In all but two cases (Belgium and Japan), the correlation is reasonably high so that we can neglect the small loss of

information when proceeding with representative bonds. Columns six to eight display information on the remaining duration, currency denomination, and coupon frequency of the bonds.

In the analysis below, we keep all countries that are *not* in brackets and typed in italics. Thus, our database perfectly covers the Central Powers as bonds of the German Empire, Austria-Hungary, the Ottoman Empire, and Bulgaria were, more or less regularly, traded in Amsterdam. We also find at least one bond of every main ally traded, and fifteen allies are principally covered on the whole. However, some qualifications have to be noted. First, the United States cannot remain in the sample because we found exactly one daily price quote for the only US bond traded in Amsterdam over 1914-1919 (a bond of the State of Louisiana); second, likewise due to insufficient observations, we drop Belgium; third, in order to keep the computational demands manageable, we drop Brazil, Cuba, Liberia, and Nicaragua as they were really minor players. Finally, fourth, there is a peculiarity that should be mentioned concerning the remaining sample: The English and French 5 % bonds are the only war bonds we look at; all other bonds had already been issued before the outbreak of the war. We have to take these bonds into account because English and French peacetime issues were not traded in the observation period at all. The war bonds we are looking at were traded since late November 1915 (the French 5 %) and, respectively, May 1916 (the English 5 %) in the unofficial market, and prices were separately reported in the newspapers under the header "niet-officieel genoteerde fondsen". Unfortunately, as columns six and eight imply, we could not gather further information on the bonds as the newspapers and the handbooks were generally short on information on unofficially traded securities.³⁷

Instead of using price series in the cointegration analysis, we focus on daily current yields – i.e., interest divided by price; as column six in Table 3 shows, the time until maturity, seen from the perspective of 1914, was sufficiently long for all but, maybe, the English, French, and Portuguese bonds so that duration effects can be neglected. For the thirteen series remaining in the sample, Table 4 reports the number of raw observations, some descriptive statistics, and the observation period over 9 February 1915 to 31 December 1919.

Note that from each yield series, we subtracted the "market yield". 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

³⁷ Cf. Jopp (2016), pp. 4-5, for details.

(because, for example, existing barriers-to-trade can be verified).³⁸ So this transformation is performed to mitigate the potential distorting effect of global factors on the bond prices we study.

Table 4: Summary Statistics on Sovereign Bond Yields (1915-19)

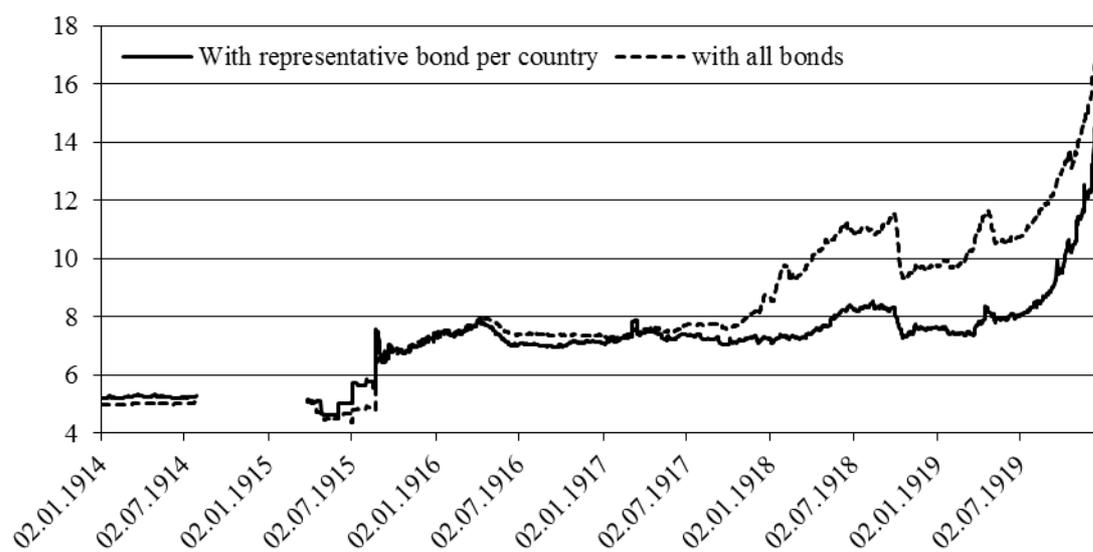
Country and bond	Obs.	Mean	Std. dev.	Min	Max	Observation period
A. Central Powers						
Austrian 4%	1,226	13.9	11.5	6.8	97.6	24/08/1915-29/12/1919
Bulgarian 5%	663	8.5	2.1	6.7	17.8	24/08/1915-16/12/1919
German 3%	514	7.9	4.6	5.1	31.6	03/09/1915-27/12/1919
Ottoman 4%	761	7.6	1.7	6.4	40.0	26/08/1915-27/12/1919
B. Allied Powers						
Chinese 4.5%	606	6.7	.6	5.8	9.7	26/08/1915-29/12/1919
English 5%	413	5.4	.3	5.0	6.4	27/11/1915-19/12/1919
French 5%	346	7.2	.7	6.2	12.6	06/05/1916-18/12/1919
Italian 3.5%	45	9.0	3.1	5.8	15.9	30/09/1915-14/05/1919
Japanese 5%	689	6.0	.4	5.5	7.7	27/08/1915-29/12/1919
Portuguese 4.5%	1,033	5.7	.5	5.0	8.2	14/07/1915-29/12/1919
Romanian 4%	82	8.1	1.5	7.1	13.3	06/03/1916-25/11/1919
Russian 4%	1,185	10.6	4.7	5.9	29.6	03/09/1915-29/12/1919
Serbian 4%	780	9.4	1.9	6.8	20.0	22/09/1915-27/12/1919

Notes: Summary statistics refer to the raw yield series.

Sources: See Table 3.

³⁸ Federico (2012), p. 482.

Figure 2: Market Yield in Sovereign Bond Segment



Notes: Yields are equal-weighted.

Sources: See Table 3.

The daily market yield series used is computed as the equal-weighted average over each country's representative (i.e., most liquid) bond. Overall, 36 bonds – including the thirteen already introduced – form the basis for this market yield series. It is plotted in Figure 2 over 1 January 1914 to 31 December 1919, along with a version that is based on the entire cross-section. The main difference between the two market yield proxies lies in the series' behaviour in 1918 and 1919. In order to understand the gap, it should be noted once more that the number of bonds per country is very unequally distributed (see Table 5). Of 37 sovereign issuers, 21 were European countries accounting for roughly three quarters of all bond series traded. About half of all traded series were Brazilian, Dutch or Russian issues. Russian bonds alone accounted for 29 percent (39 percent) of all (European) bonds. It is especially the Russian bonds' price, or yield, behaviour that visibly drives the "all bonds market yield" in the last two years. Country risk increased for Russia due to Russia having been defeated by the Central Powers at the end of 1917; and due the Bolshevik repudiation of all Tsarist bonds in February 1918.³⁹ Therefore, in our view, the "all bonds" version is perhaps not the best reflection of the general market development since it attaches too much weight to the risk pattern of those sovereign issuers that had a relatively greater number of their issues traded.⁴⁰

³⁹ Oosterlinck / Landon-Lane (2006), pp. 507-535.

⁴⁰ Since the methods used below require series that cannot have gaps, we have filled 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 benchmark.

Table 5: Bonds traded in Amsterdam during the War by Regional Origin of the Sovereign Issuer

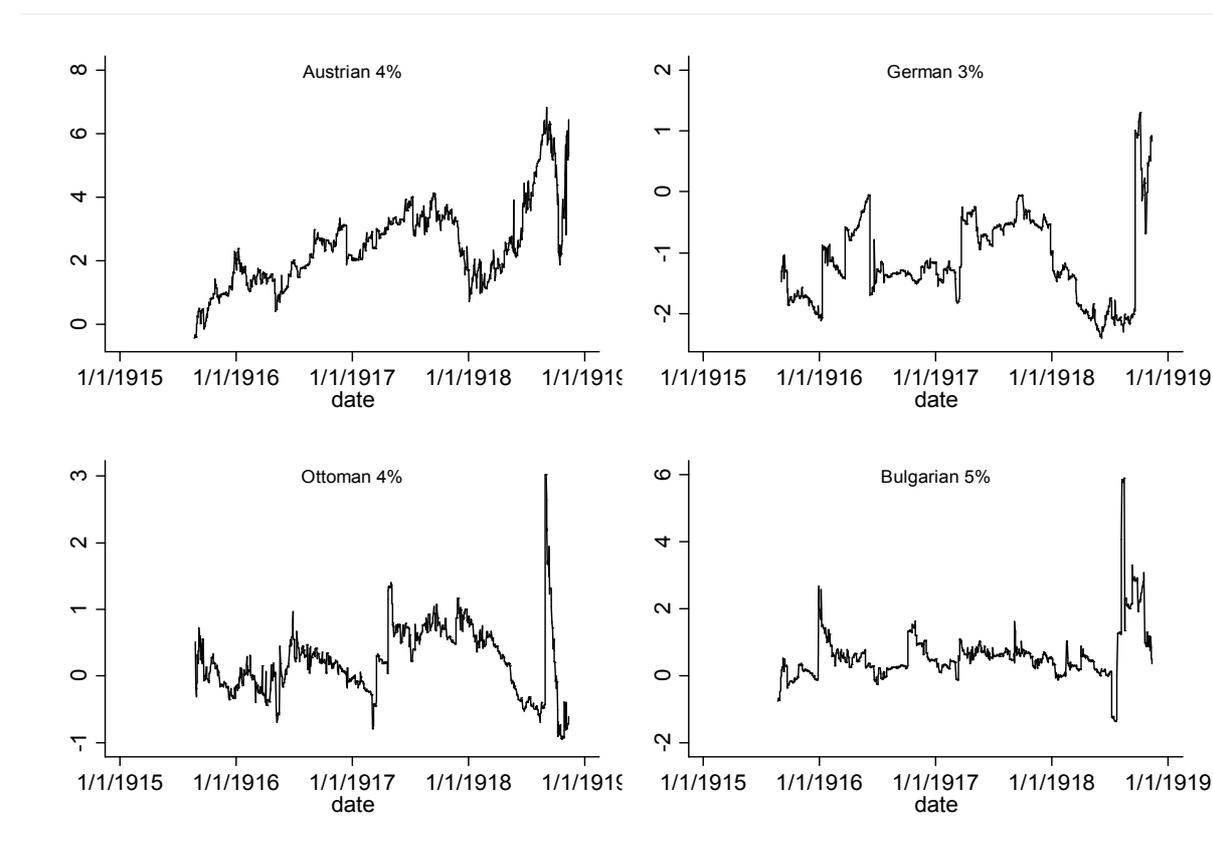
Issuers' regional origin	# of sovereign issuers	# of sub-series traded	Share in continent	Share in all issues
Europe	21	199		74.2 %
<i>thereof Russia</i>		78	39.2 %	29.1 %
<i>thereof Netherlands (and its colonies)</i>		39	13.6 %	10.1 %
America	11	56		20.9 %
<i>thereof Brazil</i>		30	53.6%	11.2 %
Africa	2	2		0.7 %
Asia	2	11		4.1 %

Notes: Dutch colonies are Netherlands-East India and Surinam.

Sources: See Table 3.

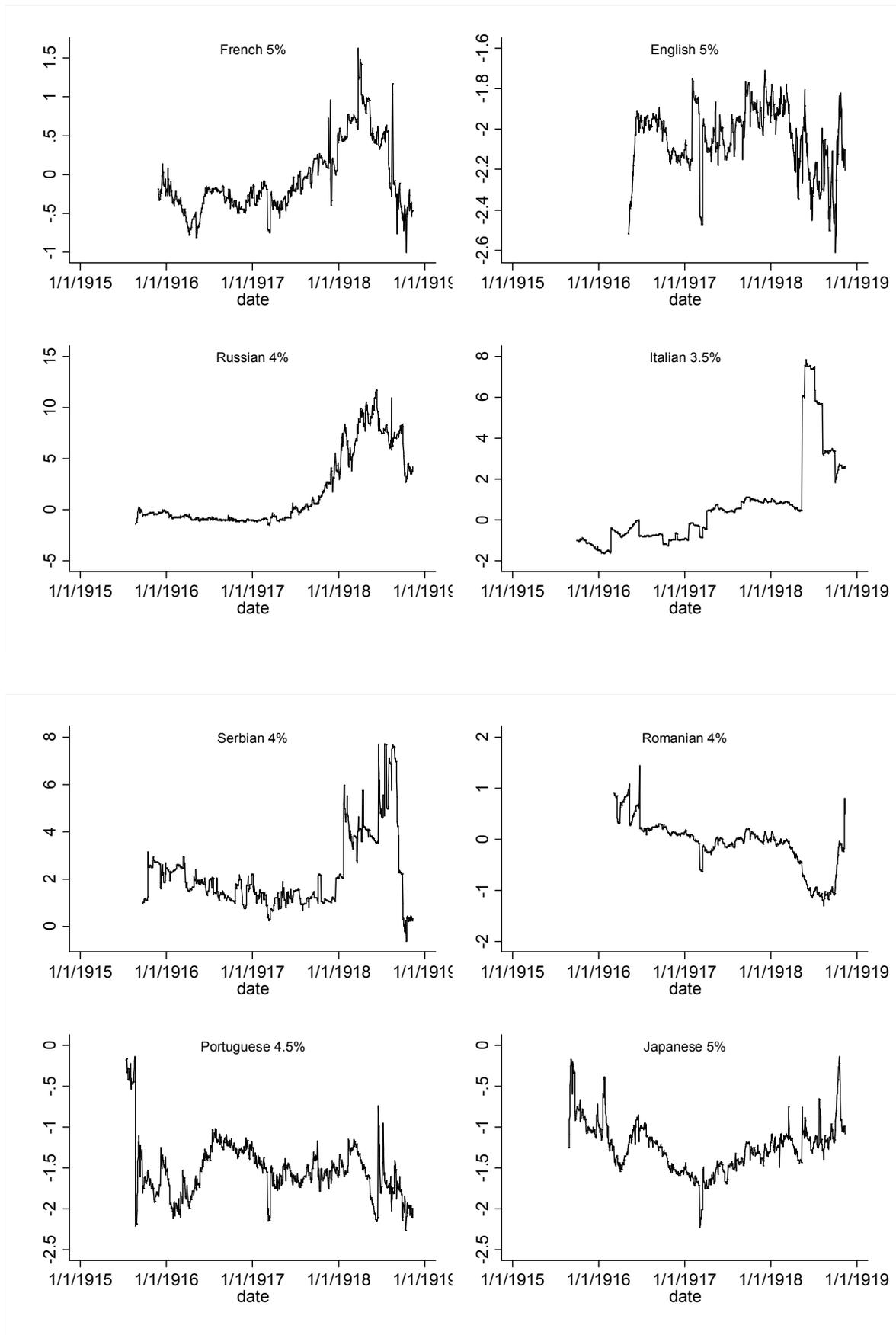
Figures 3 and 4 depict the spreads over the war period and up until the end of 1918, for the four Central Powers and the nine Allied Powers in our sample. So, precisely, we are going to look for cointegration between those spreads, and generally between country risks.

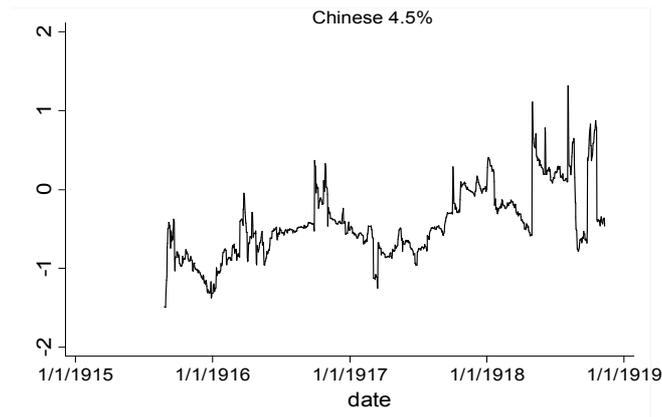
Figure 3: Yield Spreads of Central Powers' Bonds' (2/9/1915-11/11/1918)



Sources: See Table 3.

Figure 4: Yield Spreads of Allied Powers' Bonds' (2/9/1915-11/11/1918)





Sources: See Table 3.

5. A Global Test on Publicly Perceived Alliance Credibility

An easy-to-implement, standard tool of detecting co-movement in prices between two securities or commodity markets, or generally between two time series, is the coefficient of correlation.⁴¹ According to the idea of a global test outlined above, we may start the empirical analysis with a look at such coefficients of correlation. Table 6 presents them as averages over pair-wise coefficients calculated for subsets of the Central and Allied Powers, and also calculated across the alliances' boundaries. Analogous to Table 1, we focus here on the very core of each alliance.

Table 6: Average Correlation of Yield Series among and across Main Belligerents

	Pre-war period	War period	Post-war period
Central Powers	+0.37	+0.17	+0.62
Allied Powers	n/a	+0.26	-0.09
Across factions	+0.46	-0.01	-0.32

Notes: Central and Allied Powers here are AUT, GER and TUR and, respectively, ENG, FRA and RUS. "n/a" is "not available".

Sources: See Table 3.

The Central Powers' spreads show, on average, strikingly low zero-order correlation during the war compared to the post-war and to the short pre-war period we consider. And while the average

⁴¹ Federico (2012), pp. 481-482; Waldenström (2014), p. 25.

correlation among the Allied Powers' core during the war was higher, though not remarkably higher, it was even negative after the war which is due to the fact that the Russian bond's price moved differently. Finally, computing the average pair-wise correlation across opponents reveals a marginally negative correlation 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 positive and quite high with 0.46. And 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). Based on simple coefficients of correlation, we might not suspect that there were many significant pair-wise cointegrating relationships to be found for the alliance cores.

Let us 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, we also check for cointegration over 1 January–28 July 1914 and 12 November 1918–31 December 1919.⁴² To that end, we will go through three steps: In a first step, all yield 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; stationary series drop out, and valid country pairs are then specified. In a second step, we perform Johansen Trace and Maximum Eigenvalue tests for cointegration; all country pairs for which both tests unanimously reject a potential cointegrating relationship (cointegration rank is zero) drop out. In a third step, for all remaining pairs, we estimate two Johansen Vector Error Correction (VEC) models – one with an unrestricted constant and one with an unrestricted trend.⁴³ To determine whether a cointegrating relationship between two yield series exists, we 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 only if the freely-chosen coefficients *both* are statistically significant on the ten-percent level or better.⁴⁴

Regarding our first step, we checked for the presence of a unit root in the yield series by applying the Dickey-Fuller generalized least squares test (DFGLS). This test is said to have the ad-

⁴² To extend the post-war period further seems not to be helpful since disguised inflation set in for many countries (e.g., Germany).

⁴³ Johansen (1988), pp. 231–254; Johansen (1991).

⁴⁴ Here we follow the recommendation by Hjälmarsson/ Österholm (2007).

vantage of having greater power over the commonly used Augmented Dickey Fuller and Philipps-Perron tests. The test has the null of a random walk. Alternatively, the series may be stationary about a linear time trend or around a (zero or nonzero) mean. The test is performed on specifications with between one and k lags.⁴⁵ For the thirteen belligerents in the sample, Table 6 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 sequential t in parentheses.⁴⁶ Technically, applying cointegration analysis requires series to be integrated of the same order, and at least of order one. As Table 7 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.⁴⁷

More substantially, (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 pair-wise allied with any belligerent. Whether or not China and Italy in the war period and Bulgaria, France and Russia in the post-war period were, 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.⁴⁸

In the following, we are not going to present intermediate results after applying Johansen's Trace and Maximum Eigenvalue tests, but focus on the end results – that is, existing pair-wise cointegration relationships given that the cointegrating vectors' slope coefficients have been subjected to an additional hypothesis test as outlined above. Table 8 summarizes our estimations on cointegration relationships among the belligerents from a global perspective.⁴⁹ For twelve different subsamples of country pairs, the possible and the identified number of significant cointegrating relationships is reported. For a number of those subsamples, we also give the pairs in parentheses.

⁴⁵ Elliott/ Rothenberg / Stock (1996).

⁴⁶ Ng / Perron (1995).

⁴⁷ For Austria, we can reject the presence of a second unit root in the pre-war period only on the ten-percent significance level.

⁴⁸ For illustrative purposes, Table A.1 in the Appendix displays test results if the war and post-war periods are merged 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, we favor splitting the period 1915-1919.

⁴⁹ The estimation results on the cointegrating relationships are not displayed in the following, but available upon request.

Table 7: DFGLS Unit Root Test on Representative Bonds' Yield Spread

Country and bond	Prewar		War		Postwar	
	H1: Stat. around trend	H1: Stat. around mean	H1: Stat. around trend	H1: Stat. around mean	H1: Stat. around trend	H1: Stat. around mean
A. Central Powers						
Austrian 4%	-0.35 (12)	1.37 (12)	-2.51 (18)	0.21 (18)	-0.84 (17)	2.24 (14)
Bulgarian 5%	-1.84 (3)	-1.79 (3)	-3.70*** (22)	-1.89* (22)	-3.59*** (1) ^a	-1.14 (11)
German 3%	-1.24 (10)	-0.79 (10)	-2.27 (21)	-1.64 (21)	-0.50 (1) ^a	1.63 (1) ^a
Ottoman 4%	-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%	n/a	n/a	-1.74 (14)	-1.00 (14)	-0.84 (17)	1.45 (17)
French 5%	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%	-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%	-1.36 (13)	-1.06 (13)	-1.26 (12)	-0.75 (12)	-3.40** (17)	-3.22*** (17)
Russian 4%	-1.56 (5)	0.16 (5)	-1.57 (19)	-0.41 (19)	-2.76* (8)	-1.22 (8)
Serbian 4%	-0.71 (13)	0.13 (13)	-2.34 (17)	-1.90 (17)	-3.55*** (13)	-3.69*** (13)

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". – (1)^a According to the Ng-Perron sequential t , the optimal lag order is zero; however, given is the test statistic for lag order one.

Sources: Own calculations.

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. 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.

Table 8: Johansen Tests for Cointegration of Central and Allied Powers' Representative Yields
(taking Unit Root, Trace and Maximum Eigenvalue Tests into account)

Countries [possible no. of cointegrating vectors]	Number of significant cointegrating vectors by sub-period		
	Pre-war	War	Post-war
Within Central Powers			
(1) AUT, BUL, GER, TUR [6]	2 (G/B; T/B)	1 (A/G)	1 (A/G)
Within Allied Powers			
(2) ENG, FRA, RUS [3]	n.a.	2 (F/E; F/R)	0
(3) ENG and CHN, ITA, JAP, POR, ROM, SER [6]	n.a.	3	0
(4) FRA and CHN, ITA, JAP, POR, ROM, SER [6]	n.a.	1	1
(5) RUS and CHN, ITA, JAP, POR, ROM, SER [6]	1	1	0
(6) CHN, ITA, JAP, POR, ROM, SER [15]	2	5	1
Between factions			
(7) AUT, BUL, GER, RUS, TUR [4]	0	1 (G/R)	0
(8) AUT, BUL, ENG, FRA, GER, TUR [8]	n.a.	5 (A/F; A/E; G/F; G/E; B/E)	2 (G/F; B/F)
(9) AUT, CHN, ITA, JAP, POR, ROM, SER [6]	1	0	1
(10) GER, CHN, ITA, JAP, POR, ROM, SER [6]	0	2	2
(11) TUR, CHN, ITA, JAP, POR, ROM, SER [6]	0	0	0
(12) BUL, CHN, ITA, JAP, POR, ROM, SER [6]	0	1	0

Notes: Johansen vector error correction model estimated with either unrestricted constant or unrestricted trend; superior model selected according to the Akaike information criterion.

Sources: Own calculations.

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 at all in the immediate post-war period. This is a remarkable finding since – under the technical conditions of our approach – the very core of the Allied Powers appears to have been none in investors' eyes. Moreover, subsamples (3) to (6) add another ten significant cointegrating relationships, of thirty-three possible ones. A monolithic block certainly looks different.

As argued in Section 3, 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 problem-

atic, 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 our 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.

In a very simple fashion then, looking at the relative incidence of significant cointegrating relationships for the war period, we might conclude up to here that the perceived degree of credibility, globally taken, is as follows:

Central Powers: 16.6 % (expectation: 100 %)

Allied Powers: 33.3 % (expectation: 100 %)

Cross-faction: 25.0 % (expectation: 0 %)

To mention only the biggest flaw connected with this way of expressing perception of alliance credibility in numbers, qualitative differences between the countries – whether it is a Great or Minor Power – are neglected. So, only focusing on the five Great Powers, the proportions are: Central Powers: 100 %; Allied Powers: 66 %; and Cross-faction: 80 %.

6. Discussion

What are we to make of these ambiguous findings? How can we explain the seemingly cross-integrated alliance cores? What we find, technically, is that the Great Powers' bonds (except for Russia's, essentially) bilaterally were in long-term equilibrium – that is, the bonds' yields may have diverged from one another in the short-term, but they did not in the long-term. One substantive explanation might be that this simply is an expression of investors acknowledging the deep-rooting pre-war financial interrelationship between the Great Powers that a war would not quickly

unmake.⁵⁰ In fact, the war negatively impacted on this interrelationship through the capital and other market restrictions 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).⁵¹ But one 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". It would be interesting to see whether one made a similar observation when analyzing other principal trading places in the fashion put forward in this paper.

Another suggestion we 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 knowing" regarding the question as to which alliance is going to win the war investors saw the major belligerents mutually entrapped so that, financially seen, perceived country risks did not decisively diverge from each other in the long-run.⁵²

A way to further deconstruct this puzzling finding might be to assume from the start that alliance perception is potentially instable over time. More formally, if instability were an issue, we would need a test allowing for an alternating pattern of cointegration and of no cointegration applicable to our observation period. There indeed is technical literature supporting the meaningfulness of this idea.⁵³ To the best of our knowledge the available tests that allow searching for structural breaks in a cointegration relationship are based on the rather unfitting assumption of a valid cointegration relationship on either side of the break(s).⁵⁴ However, it would go beyond this paper to attempt establishing such a formal framework (this is under way though). We therefore restrict the discussion here to illustrating that the thought of instable perceptions is not too far-fetched and might help to explain our ambiguous findings in the "global model".

⁵⁰ Cf., for example, Moore's study that highlights considerable stock market integration before 1914; Moore (2006). Also cf. Neal (1986); Bordo / Rockoff (1996); Goetzmann/ Li / Rouwenhorst (2001); Estevadeordal / Frantz / Taylor (2002); Findlay / O'Rourke (2003); Obstfeld / Taylor (2003); Volosovych (2005); Moore (2014).

⁵¹ Cf. Schwabe (1915); Henning (1992); Kiehling (1998); Michie (1999); Silber (2005); Oosterlinck / Landon-Lane (2006); Bernal / Oosterlinck / Szafarz (2010).

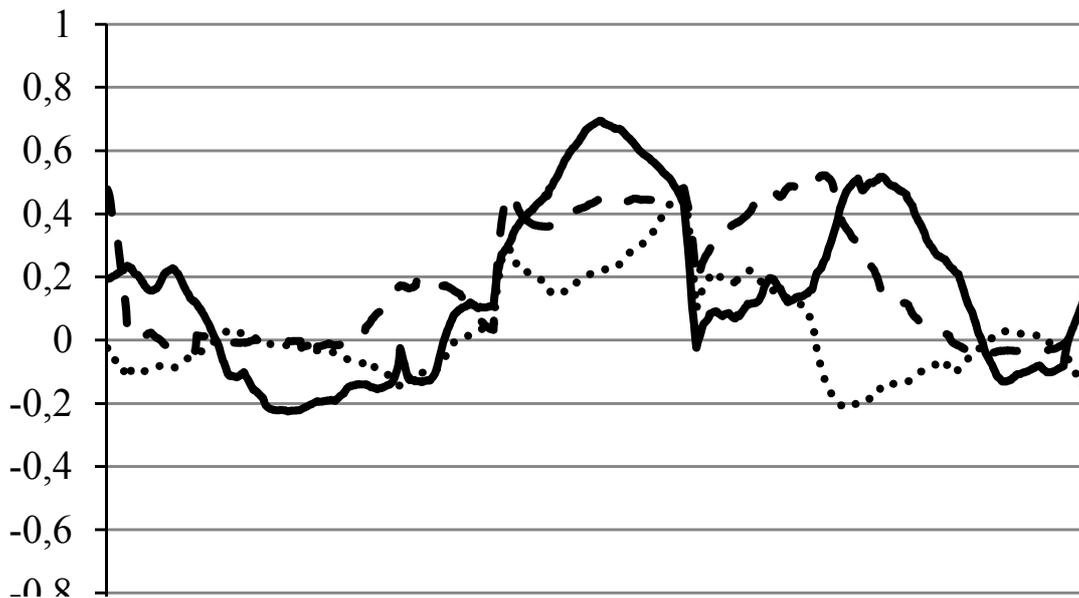
⁵² This seems to qualify for an endogenous shock, rather than an exogenous one. Besides, note that this view appears not to be out of line with the turning points literature highlighting that investors judged particular events to be more important than others; cf. Adams (2015); Jopp (2016); Hanedar / Hanedar / Torun (2016).

⁵³ Davidson / Monticini (2010).

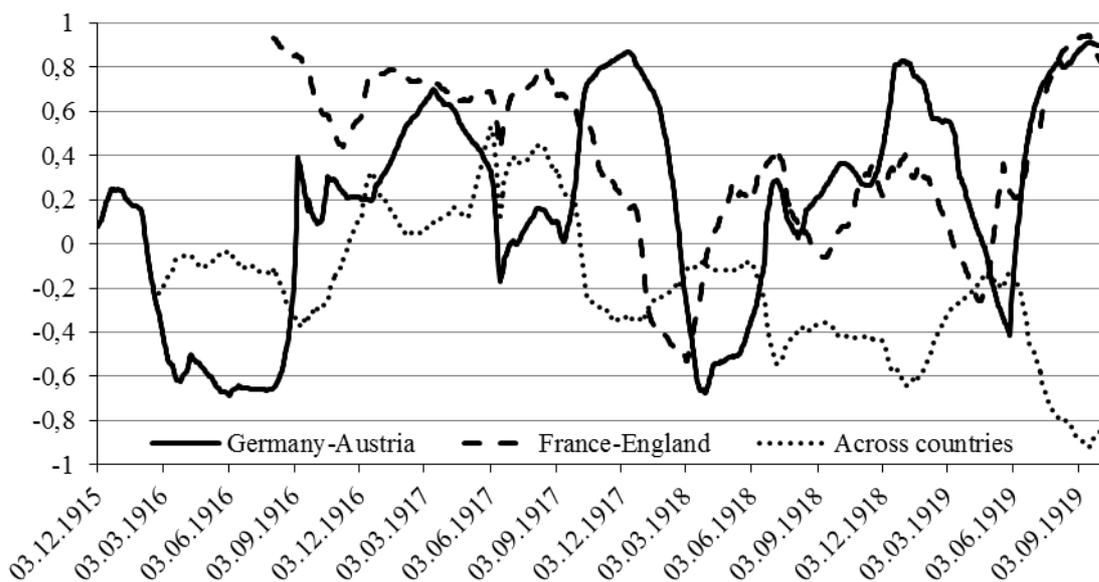
⁵⁴ Gregory / Hansen (1996a); Gregory / Hansen (1996b); Kejriwal / Perron (2008); Hatemi-J (2008); Maki (2012).

Figure 5: Centered Six-month Moving Correlations

Panel A: Full Sample of Belligerents



Panel B: Four Belligerents



Notes: Panel A: All belligerents used that are mentioned in Table 3 (including those in square brackets).

Source: Own calculations.

Recall that coefficients of correlation have been mentioned above as an easy-to-implement way to gain a first insight into co-movement of prices. The picture of "global" correlation can be deconstructed, in a first step, by using moving correlations drawing a more accurate picture of co-

movement.⁵⁵ For this purpose, Figure 5, Panels A and B, depict the average centered six-month moving ("time-varying") correlations among all country pairs within the Central Powers and the Allied Powers, and across opponents. While Panel A includes every country mentioned in Table 3, Panel B is based only on the Great Powers' pairs (except for pairs entailing Russia). 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 diverging movement. As expected, diverging movement (negative correlation) was more prevalent in cross-alliance relationships. Given the moving correlations' implications, publicly perceived alliance credibility, or incredibility, should certainly not – and this may not be a surprise after all – be thought of as stable over time as the global view presumes.

Another line of discussion involves a generalization on investor behaviour: We can ask how perception determined action, that is, the willingness of investors to buy, hold, or sell government debt. In the context of the capital market the way investors perceived alliances should have, in general, a *material* bearing on the respective governments' borrowing options. We think here of a credibility or "alliance" discount or, respectively, markup not unlike that associated with mutually guaranteed debt recently discussed as a means to overcome the European sovereign debt crisis.⁵⁶ A highly indebted country that borrows at high interest rates (due to its higher default risk) might be able to issue new debt at lower interest rates once its debt service is guaranteed by strong, financially capable states. The highly indebted country would then benefit in terms of borrowing costs from what might be called a credibility spill-over. In our context it is imaginable that a smaller power that is perceived to be part of a credible alliance with one of the great powers benefits (or as well suffers), as a side effect, just in these terms if the alliance is perceived to win (or lose). By definition a small power is militarily less capable than a great power.⁵⁷ Thus, the spill-over worked through the smaller power being associated with the military capabilities of the great power on which the smaller power may then, indirectly, capitalize.

As Table 8 implies, there is the theoretical chance that such spill-overs might be found on the Allied Powers' side, in subsamples (3) to (5). However, testing for the presence of a credibility discount in the context of the First World War seems to be problematic as government legislation shut down the primary market for foreign government debt at the principal trading places in Europe. What we needed to know – whether, for example, Romania were 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. Besides effects on the primary market, it is also imagi-

⁵⁵ Cf., for example, Waldenström (2014), p. 25.

⁵⁶ Esteves / Tuñer (2016a); Esteves / Tuñer (2016b).

⁵⁷ Cf. the definition of "small power" in Rothstein (1968), p. 29.

nable that the prices or, respectively, yields of that smaller power's bond(s) in the secondary market contain such a credibility discount (or markup), besides other markups such as that investors demand for holding a less liquid security. However, testing this contention requires a more elaborate model of bond pricing that goes beyond this paper's intention.

7. Conclusion

The historical question posed in this article certainly is in and of itself relevant as historians are interested in acquiring knowledge on contemporaries' real-time perceptions on what was happening around them, in whatever epoch. It was asked how contemporary investors at the Amsterdam stock exchange perceived the various ad-hoc alliances that formed during the First World War. Basically, it was assumed that the yields of two belligerents' bonds that were perceived by the capital market to be in an alliance must be cointegrated. To this end, a framework was established to test for cointegration among a set of the main belligerents' representative bonds over the war period, but also before and after. Focus was put on bilateral cointegration relationships as this setting fits the alliance formation process quite well.

Based on the findings in the main part, the three baseline hypotheses established in Section 3 can be answered as follows: The Central Powers, indeed, did not form a credible alliance in the sense that all country pairs separately were 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 the First World War was a global conflict made of multiple layers; the hegemonic struggle of the Great Powers establishing the frame and, arguably, attracting most attention; and 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 in cases had been. What is surprising is that there are pairs of opponents – especially within the great players – that show cointegrated yields although they should not (H0-C). Two explanations were proposed to get a hold of this puzzle: First, investors thereby acknowledged the still deep financial interrelationship of the major players – and interrelationship that became disturbed by the war, but that would not simply vanish; here, then, we would have a "mental measure" of capital market integration at hand as compared to a "material measure" (ef-

fective restrictions on arbitrage between two trading places) that would tell of immediate disintegration over the war. Second, investors might thereby have acknowledged the "trench warfare trap" leading into a stalemate that affected all players to the same degree.

These answers should be taken as preliminary since more effort can be exerted to draw an even more accurate picture of alliance perceptions at the time. First, the global test established in this article may be extended to what might be called a "sub-periods" test allowing for intermittent non-cointegration. This would allow for instable public alliance perceptions. Second, another line of work may address the material effects of alliance perception on securities prices in the secondary as well as primary market, with lots of possibilities to extend the picture to other time periods. Third, alliance perceptions as regards the First World War may be measured for other trading places, too. This certainly would come with the problem that the trade restrictions imposed by belligerent countries were harsher than those established by neutral countries raising doubts about the reliability of reported securities prices.

Appendix

Table A.1: An Alternative DFGLS Unit Root Test on Representative Bonds' Yield Spread

Country and bond	Pre-war		War and post-war	
	H1:stat. around trend	H1: Stat. around mean	H1:stat. around trend	H1: Stat. around mean
A. Central Powers				
Austrian 4%	-0.35 (12)	1.37 (12)	-0.98 (23)	5.91 (18)
Bulgarian 5%	-1.84 (3)	-1.79 (3)	-4.57 *** (14)	-1.49 (23)
German 3%	-1.24 (10)	-0.79 (10)	0.17 (23)	3.49 (23)
Ottoman 4%	-1.83 (11)	-0.61 (11)	-4.22*** (22)	-5.28*** (22)
B. Allied Powers				
Chinese 4.5%	-2.45** (1) ^a	-2.39** (1) ^a	-0.39 (11)	-0.17 (11)
English 5%	n.a.	n.a.	0.28 (22)	2.55 (22)
French 5%	n.a.	n.a.	-2.32 (11)	-1.77* (11)
Italian 3.5%	-2.05 (2)	-1.99 (2)	-1.41 (17)	-1.45 (17)
Japanese 5%	-1.69 (8)	-0.54 (12)	0.46 (23)	3.95 (23)
Portuguese 4.5%	-1.40 (14)	-1.30 (14)	-0.57 (21)	2.89 (20)
Romanian 4%	-1.36 (13)	-1.06 (13)	-3.56*** (23)	-2.22** (23)
Russian 4%	-1.56 (5)	0.16 (5)	-2.75* (8)	0.27 (11)
Serbian 4%	-0.71 (13)	0.13 (13)	-2.77* (18)	-2.59*** (18)

Notes: ***, **, * denote significance on the one-, five- and ten-percent levels. Optimal truncation lags according to Ng-Perron sequential t in parentheses. "n.a." is "not available". – (^a) According the NG-Perron sequential t , the optimal lag order is zero; however, given is the test statistic for lag order one.

Sources: Own calculations.

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