

Sustainability of Public Debt in Germany – Historical Considerations and Time Series Evidence

Heiko T. Burret, Lars P. Feld and Ekkehard A. Köhler*

Walter Eucken Institut and Universität Freiburg

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Summary

We analyse German public finances against a theoretical background using a unique database, retrieved from multiple sources covering the period between 1850 and 2010. Multiple currency crises and force majeure offer anecdotal evidence contradicting the historical perception of Germany being the poster child of European public finance. Given these corresponding breaks in time series, the empirical analysis is conducted for the sub-periods 1872-1913 and 1950-2010. In addition to anecdotal historical analysis, we conduct formal tests on fiscal sustainability, including tests on stationarity and cointegration and the estimation of Vector Autoregression (VAR) and Vector Error Correction Models (VECM). While we cannot reject the hypothesis that fiscal policy was sustainable in the period before the First World War, the tests allow for a rejection of the hypothesis of fiscal sustainability for the period from 1950 to 2010. This evidence leads to the conclusion that Germany's public debt is in dire need of consolidation. Albeit constituting a much needed reform to this development, the incompleteness of the German debt brake and fiscal federalism will have to be addressed in the coming years, in order to ensure that fiscal consolidation actually takes place – for the sake of public debt sustainability.

Experience, however, shows that neither a State nor a Bank ever have had the unrestricted power of issuing paper money without abusing that power.

David Ricardo (1817/1932: ch. XXVII)

1 Introduction: sovereign debt as a recurring issue in economics – the JNS at 150 years

Sovereign debt sustainability has attracted attention in the wake of the Great Recession and its European sibling, the Euro crisis. Both events have painfully reconfirmed the negative effects of the growing costs of servicing an ever increasing amount of public

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debt on economic growth, monetary stability and public finance. Despite having a seemingly sound economy when compared with its crisis-ridden southern European periphery Germany, too, may account for unsustainable government finances. The German debt-to-GDP (Gross Domestic Product) ratio has never been higher during peacetime; the six year average increase in nominal debt has only been outperformed once – during the German hyperinflation. A unique database, retrieved from multiple sources covering the period from 1850 to 2010, provides us with anecdotal and empirical evidence that rejects the hypothesis of German fiscal sustainability – at least for the period after the Second World War. Therefore, we support a fiscal consolidation strategy and refute the perception that German fiscal policy is on a sustainable path.

The Journal of Economics and Statistics (JNS) has reported on the phenomenon of sovereign debt in Germany since its inception. With its publications spanning a period of 150 years, the JNS proves to be an outstanding resource for a re-evaluation of the scholarly discourse on public debt over generations of economists, mirroring paradigm shifts and large scale exogenous events. In addition and most relevant to empirical economists, the JNS offers a primary source for historical data, especially before official records of the *Statistisches Jahrbuch für das Deutsche Reich* (Statistical Yearbook of the German Reich) were published.¹ Both characteristics turn the JNS into a unique resource for our attempt to re-discuss the development of public debt in Germany from 1850 to 2010 in a conjoint anecdotal and empirical analysis.

As the complete record of JNS volumes offers a unique literature set regarding the historicity of the discussion on public debt in the discipline of economics we first outline some major contributions to prove the JNS' impact on this recurring issue. The first volume of the JNS already features an article dealing with a debt related problem in the realm of public finance: Hildebrand (1863) explores the monetary effects of the debasement of money in the United States that was undertaken to finance the American War of Independence. In fact, the majority of the following 232 volumes include analyses of issues related to sovereign debt. The geographic focus does not rest exclusively on Germany and Prussia (Warschauer 1883; Gerstfeldt 1883; Frick 1890): JNS' authors cover the public finances of many of the young European nation states, e.g., Ireland (Raffalovich 1885), Denmark (Peterson-Studnitz 1888), Hungary (Mandello 1897), and other European states (Paasche 1878; Kaufmann 1887; Raffalovich 1888; Eheberg 1892; von Heckel 1900). The American continents were subject to analyses concerning public debt as early as the second half of the 19th century, e.g., Argentina (Hübner 1891) or the United States (Hildebrand 1863).

The early 20th century volumes are especially devoted to issues of war financing, e.g., Heinemann (1914), Graner (1915), Köppe (1916a, 1916b, 1916c, 1916d, 1916e, 1918a, 1918b, 1919), Inhülsen (1919), Regensburger (1921), and war related economic consequences, particularly with respect to the relation between debt and inflation, e.g., Menger (1892), Seidler (1894), Helander (1915), Heyn (1919), Terhalle (1923), Rittershausen (1943). The JNS thus offers evidence for the emergence of a remarkably strong bias among German economists against inflation and non-sustainable fiscal policy, even before WWII. However, by 1933 a paradigm shift had swayed German economic thought in the direction of nationalist economics. The resulting tensions between the editorial

¹ The widely used historical debt dataset of Hoffmann (1965) refers, among others, to the contributions by Warschauer (1883) and Kaufmann (1887) that were first published in the JNS. Without these unique contributions, our empirical analysis would probably have started in 1871.

board of the JNS and the National Socialists led to a surge in contributions that focused more on foreign countries and theoretical economics rather than on the national socialist economics (Krawehl 1986). Aside from minor concessions, the commitment of the editors Otto von Zwiedineck and Gerhard Albrecht was successful in curbing the NS influence on the JNS until its cessation in 1944 (Ott/Strecker 1986).² The Journal was relaunched five years later.

The initial focus of the post-war period lay on emerging Keynesian ideas and the methodological re-orientation of economics towards the neoclassical school of thought and towards macroeconomics, marking another paradigm shift in German economic thought. Accordingly, public debt was hardly an issue until the 1970s (Lampert et al. 1986). Subsequent volumes include both theoretical and empirical analyses of issues related to public debt, with the frequency of the latter increasing over time. The interdependency of public credit and price stability is the subject of numerous analyses in the JNS (e. g., Wittmann 1966; Lang/Welzel 1992). In addition, problems regarding the measurement of different fiscal variables (Scherf 1989; Larch 1993; Brümmerhoff/Reich 1999), limits to public borrowing (Mückl 1985), effects of budget deficits (Jaeger 1982, Lachmann 1984; Aschinger 1985), and the impact of anti-cyclical fiscal policy (Oberhauser 1985; von Zameck 1988) are addressed.

More recent contributions focus mainly on the effect of various institutional arrangements regarding public debt (Lang/Welzel 1992; Wenzel/Wrede 2000; Blume et al. 2008; Schulz/Wolff 2009). Institutional changes in the wake of the European debt crisis are covered by Meyer (2011) regarding the costs of the European Financial Stability Facility and the independence of the European Central Bank. In one of the latest volumes of the JNS, Spahn (2012) addresses the issue of Target 2 balances in the European Monetary Union. If there is a common denominator in the publication record of the JNS, it can be summed up in the two lessons economists have learned from the debt crisis: first, that institutions matter, and second, that sound fiscal policy works best in combination with a rule-oriented approach.

On the basis the JNS has laid down, we are conducting an analysis of the sustainability of public finances in Germany. The remainder of this paper is organized as follows: Section 2 draws on some theoretical considerations regarding fiscal sustainability and reviews empirical studies. In Section 3, anecdotal evidence on the development of German public debt and the relation between economic growth and interest rates is provided. Section 4 presents the empirical strategy and the results. Section 5, finally, concludes the paper.

2 Theoretical framework and empirical literature review

Most studies on fiscal sustainability are based on the theoretical foundation by Domar (1944). According to his widely accepted theoretical approach, public finances can be classified as sustainable, if the growth rate of GDP exceeds, or at least equals the growth rate of public debt. The Present Value Budget Constraint (PVBC) that is closely related to the approach of Domar can be described as:

$$d_0 = - \sum_{t=1}^{\infty} \left(\frac{1+y}{1+r} \right)^t * p_t + \lim_{T \rightarrow \infty} \left(\frac{1+y}{1+r} \right)^T * d_T, \quad (1)$$

² For a further analysis of the JNS during the Third Reich see Jansen (2000: 181 ff.).

where y is real GDP growth, r is the real interest rate, d denotes the debt-to-GDP ratio, p is the primary budget balance to GDP ratio and t indicates the period.

Equation (1) implies two complementary definitions of fiscal sustainability, which may be tested in empirical research. One line of empirical studies tests if the transversality condition holds, i. e. whether the second term on the right hand side equals zero, by conducting stationarity tests for public debt and deficits, respectively. If the transversality condition is satisfied, public finances are expected to be stationary, i. e., sustainable. Hamilton and Flavin (1986) conducted one of the first empirical studies on the sustainability of public finances by applying this approach to the U. S. fiscal policy.³ The second line of empirical studies tests, whether current public debt equals the first term on the right hand side of eq. (1), i. e. if current public debt equals the discounted future primary budget surpluses (Kirchgässner/Prohl 2008). This approach commonly applies cointegration models for testing. Early studies in this line of research include Elliot and Kearney (1988), Hakkio and Rush (1991), Smith and Zin (1991), MacDonald (1992), Tanner and Liu (1994), Liu and Tanner (1995), Ahmed and Rogers (1995), Haug (1995) and Quintos (1995).

The first analysis of German public finances was presumably conducted by Grilli (1988). Using data for the period from the early 1950s to 1986, he concludes that the hypothesis of non-stationarity (unsustainable) fiscal deficits can be rejected. While most subsequent studies basically apply similar approaches, the findings are not unambiguous (see Afonso 2005 for an overview). Since the late 1990s, the German debate has been enhanced by the results of cointegration tests, predominantly providing evidence in support of the hypothesis of fiscal sustainability (e.g., Payne 1997; Bravo/Silvestre 2002; Afonso 2005). Due to their strong assumptions, the tests for stationarity and cointegration have been criticized, however, by Bohn (1995, 1998). He proposes to test whether the reaction of primary surplus to GDP ratio is sufficient to offset changes in the public debt-to-GDP ratio. If this condition holds, i. e., if primary surplus increases at least linearly with debt, then public finances are sustainable. By applying this method, Greiner et al. (2006) and Greiner and Kauermann (2007) conclude that public finances in Germany are basically sustainable. Similar conclusions are offered by Greiner and Kauermann (2008). They perform semi-parametric tests using penalized spline smoothing. Polito and Wickens (2011) find contrary results by analysing the fiscal adjustments required to reach a targeted debt ratio and by testing for stationarity. Unit root tests are also used by Kitterer (2007) in order to analyse the finances of the German states. He concludes that fiscal policy does not comply with the PVBC in 13 out of 16 states.

In contrast to the above-mentioned studies, this paper focuses on a much longer time span (1872-2010) and applies a more in-depth analysis of the sustainability of German public finances. In fact, we apply a wide range of approaches and tests, including various stationarity tests (partly allowing for structural breaks), cointegration tests, VAR tests as suggested by Bohn (1995, 1998) and the estimation of a VECM. While previous studies focus mainly on one period, we additionally cover different sub-periods, thus allowing for period-specific peculiarities in German fiscal policy. Furthermore, by performing statistical tests for all four indicators of fiscal policy, i. e., public revenue, expenditure,

³ Notable subsequent stationarity tests for the U. S. debt and deficits have been conducted by Kremers (1988), Trehan and Walsh (1988, 1991) and Wilcox (1989). Other empirical tests on the sustainability of the U. S. finances have been performed by Haug (1995), Bohn (1998, 2008), Greiner and Kauermann (2007) and Polito and Wickens (2011).

deficit and debt, our approach differs from previous studies.⁴ In consequence, this paper contributes to existing empirical literature by providing a thorough and extensive analysis of German fiscal policy since 1872. In addition to empirical evidence, anecdotal evidence is drawn upon to arrive at a more complete understanding of the development of German public debt.

3 History of public debt in Germany 1850-2010: anecdotal evidence

Before formally testing the sustainability of German public finances, it is useful to consider Germany's fiscal history. Figure 1 illustrates the development of German public debt from 1850 to 2010. This time span can be divided into four separate phases: The first phase spans from 1850 to 1870 and it is characterized by relatively steady levels of sovereign debt on the one hand and changing governance structures on the other. The second phase describes the peaceful era of the German Empire leading up to World War I, the so called Kaiserreich (1871-1913). According to Obstfeld and Taylor (2003), the first two phases coincide with the first era of globalization (1850-1913). The third phase includes the two World Wars and their aftermaths, each culminating in a severe debt crisis and currency reform (1923 and 1948; see also Figure 2). The fourth phase starts with the founding of the Federal Republic of Germany and comprises large scale events as the collapse of the Bretton Woods system, the German Reunification and the Great Recession. The fourth phase coincides with the second era of globalization.

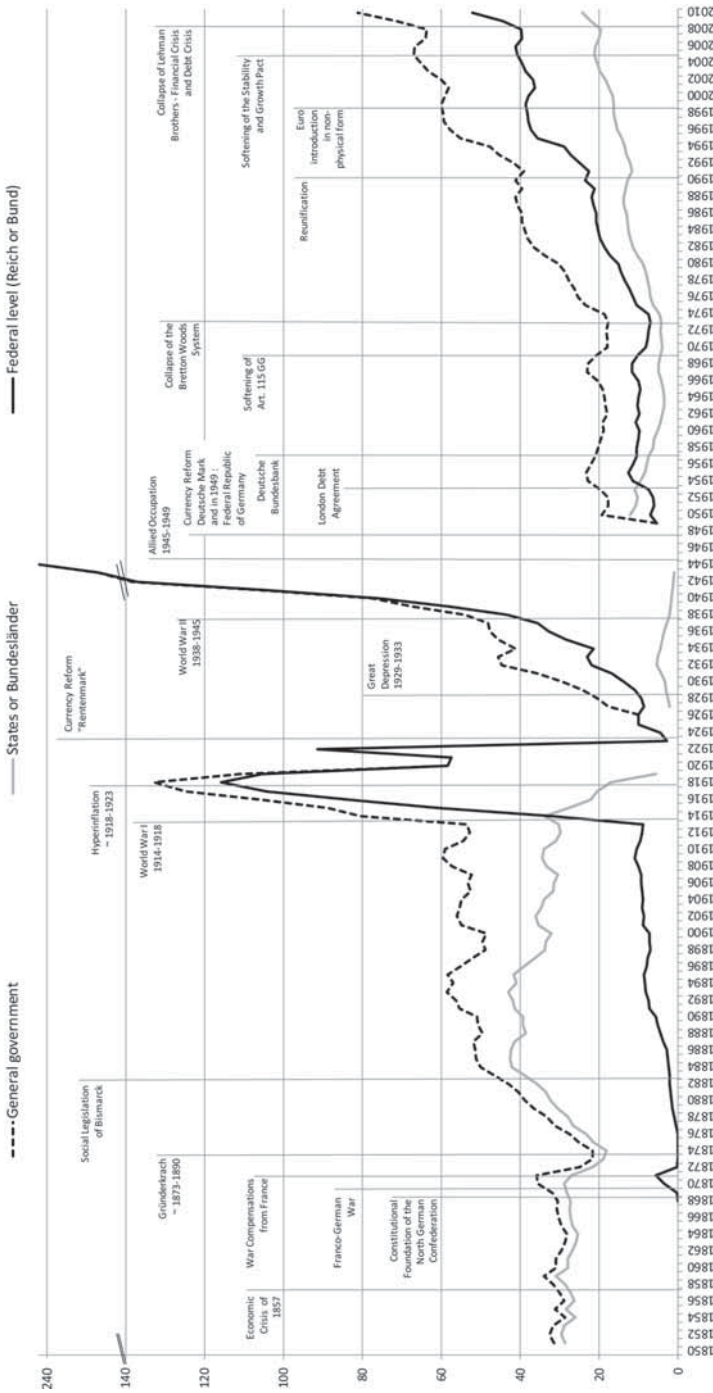
3.1 Phase I: debt and fiscal policy in the (North-) German Confederation (1850-1870)

Following the unsuccessful attempt to establish a German nation state in the wake of the so-called March-Revolution of 1848, federal government debt did not accrue due to the mere lack of a central government. Public debt was, however, not non-existent: The sovereign states of the German Confederation (Deutsche Bund) had run fiscal deficits even before the starting point of our analysis (Figure 1). While debt statistics for most states are only available sporadically, coherent data series on public debt can be retrieved for the larger states such as Prussia, Bavaria, Saxony and Baden.⁵ In 1851, the aggregated debt-to-GDP⁶ ratio of these states was 30 percent. This debt can be explained by the fiscal burden of the Napoleonic Wars. However, in comparison to France (200 %) or the United Kingdom (149 %), German public debt was still relatively low (Abbas et al. 2010). This large difference might have been caused by the debt defaults of several German states, e.g., Prussia in 1807 and 1813, Hesse in 1814, Schleswig-Holstein in 1850 or Westphalia in 1812 (Reinhart/Rogoff 2009). The two decades following the March-Revolution of 1848 are characterised by ostensibly sound finances, the only exception being the economic crisis of 1857, which resulted in the Bank of Hamburg receiving a 15 million Marks bail-out from Vienna (Bordo/Schwartz 1999). Besides the relatively stable debt-to-GDP ratio, the amount of nominal debt had nearly doubled

⁴ Indeed, Afonso and Jalles (2011) analyse a similar period (1880-2009), yet they apply almost exclusively stationarity tests regarding public debt levels, only. In addition, they do not focus on different sub-periods.

⁵ The German Empire was later composed of 26 states (including three Hanseatic cities and Alsace-Lorraine). Missing data are derived by interpolation (Hoffmann 1965). Hoffmann (1965) retrieves some of the data from the early volumes of the JNS.

⁶ Before 1913 no consistent data on nominal GDP are available. Instead, GNP was used (see Appendix A1).



Missing data: 1945-1948; for 1920-1926 and 1944-1949 no data for states; for 1915-1926 and 1940-1945 no data for municipalities. Before 1949 fiscal year ends 31st March/1st April. The reference date for 1923 is 15th November, 1945 debt refers to the level at the end of World War II. General government data includes federal, state and local tiers; since 1954, it includes Federal Special Funds; since 2006, it includes most, and since 2010, all public funds, institutions and companies. Federal level data includes the Mefo bills for 1932-1944. For further details refer to data sources listed in Appendix A1.

Figure 1 Public debt as percentage of GDP in Germany, 1850-2010

by the time of the foundation of the North German Confederation in July 1867 after the victory over the Habsburg Empire in the Austro-Prussian war in 1866 (Figure 2).⁷ The main tasks of the North German Confederation were to enlarge its navy, to build a coastal defence system and, at least partly, to finance the Franco-German War of 1870/71. Aside from matters of military, bank regulation and the standardization of weights and measures hardly any responsibilities were assigned to the federal level. Nevertheless, beginning in 1868, federal government debt had risen to 692 million Marks by March 1871.

3.2 Phase II: struggling decentralization of fiscal policy in the Kaiserreich (1871-1913)

The Kaiserreich, constituted in April 1871, inherited not only the debt burden of its predecessor states, but also a high degree of political autonomy, a system of bottom-up fiscal federalism and a dominant influence of Prussia. While most of the states were relatively small, Prussia comprised 60 percent of the total population and economic power, and delegated both the Chancellor (Reichskanzler) and the German Emperor (Kaiser). Despite Prussian dominance, the federal states were granted extensive legislative competence, including the power to tax. While the lower chamber of parliament, i.e., the Reichstag, remained rather weak, the Federal Council, i.e., the Bundesrat was the dominant legislative body, having been granted a veto right pertaining to all federal legislation, including taxation and the right to dissolve the Reichstag. Since small states were represented disproportionately strongly in the Bundesrat, they were – at least formally – able to overrule Prussia. In general, the competencies between the federal and the subnational level were clearly assigned, remaining mostly at the state level (Stegarescu 2005).

The high degree of fiscal autonomy allowed for (fiscal) competition between the states. Hence, fiscal responsibility of the jurisdictions was fostered and political incentives to incur debt had been curbed. Due to their political (veto) power the states were relatively successful at obstructing the expansion of central taxation powers. The federal government had to rely on revenues from tariffs (27 %), indirect taxes and matricular contributions (29 %).⁸ The states were obliged to pay for the latter in order to balance the ordinary federal budget. Therefore, the federal government's means of accruing debt were limited. Since matricular contributions were collected in accordance with the state's population, the federal government was highly dependent on the Prussian state (Gerloff 1913). In addition to these contributions, no further fiscal equalization scheme was established.

After receiving war indemnities from France, totalling 4.2 billion Marks, the federal debt was completely paid for in 1874 and regional debt decreased significantly (Gerloff 1913).⁹ This increase in liquidity fuelled economic growth and led to a period known as the *Gründerzeit*. The Kaiserreich experienced an extraordinary increase in production

⁷ In contrast to the North German Confederation, the German Confederation and German Customs Union (*Deutsche Zollverein*) were relatively noncommittal unions of sovereign states without a common constitution.

⁸ The numbers in parentheses indicate the respective percentages of total federal revenue, excluding debt obligations in 1871.

⁹ The outstanding debt could be repaid at any time since the *Zwangstilgung* (coerced coverage) was abolished in 1870 and a *freie Tilgung* (free principal) established (Neumark 1976). Aside from debt repayment, the indemnities were used in order to obtain gold and subsequently introduce a gold currency.

Table 1 Adjusted matricular contributions to the Reich (in million Marks)*

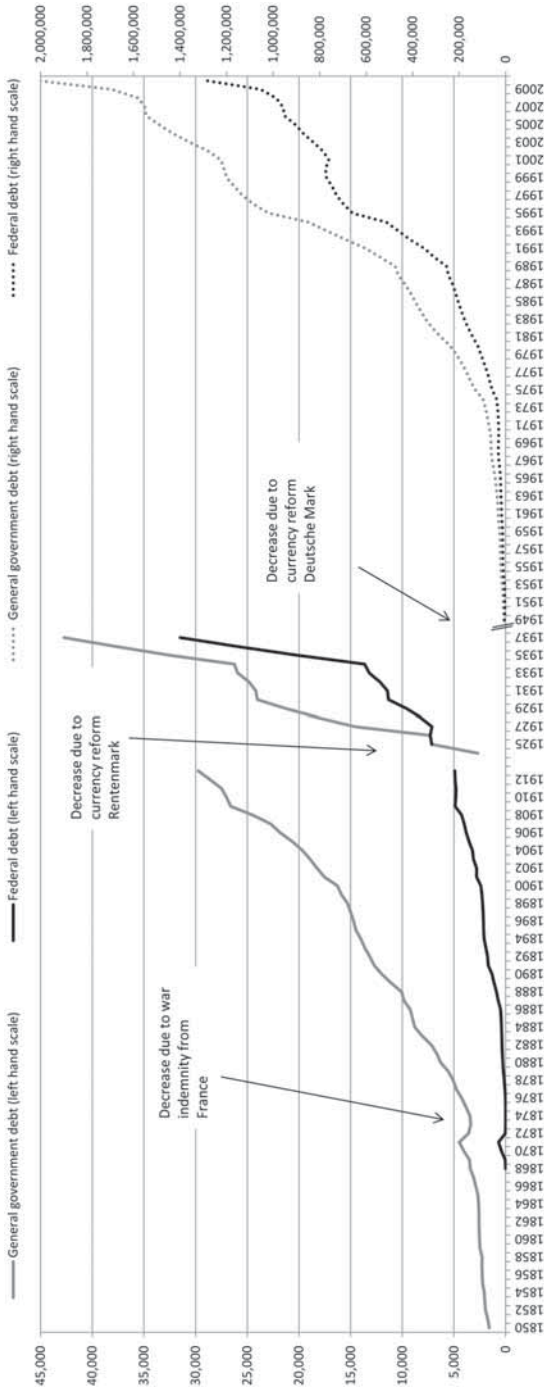
1879/80	1881/82	1883/84	1885/86	1887/88	1889/90	1891/92	1893/94	1895/96	1897/98
64.1	17.2	-11.5	-13.0	-5.4	-139.8	-66.9	30.3	-17.4	-13.2

* The numbers are derived by subtracting the Frankenstein Payments to the states from the matricular contributions to the Reich. *Source:* Gerloff (1913: 522).

capacities and in the number of companies and banks. Most stock prices in Berlin doubled between 1870 and 1872. It is often argued that the Kaiserreich transitioned from an agricultural to an industrialized country during this time. Although the spoils of war and the subsequent boom of the Gründerzeit initially had a stabilising effect on public finances, this stability retarded the progress of fiscal reforms. The existing tax system was not designed to cope with the new structural pattern of the economy, resulting in decreased tax revenues. In 1873, economic growth slowed down due to global financial turmoil that was described as the Gründerkrach in Germany. This resulted in the most extensive economic crisis of the 19th century in Germany, lasting almost three decades (Plumpe 2010). The subsequent rise in public debt on the regional level (Fig. 1 and 2) is particularly remarkable, as the federal government was, at least in part, able to finance its growing expenditures by collecting higher matricular contributions. To do so, these contributions had to rise by an average of 40 percent during the period from 1874 to 1879 (Gerloff 1913: 522). Though the debt level continued to increase in the years following the Gründerkrach, an international comparison reveals that German public finances were in better shape than those of other countries (Appendix A3). Nevertheless, a (weak) debt constraint was imposed on the Kaiserreich. While article 73 of the federal constitution of 1871 restricted debt obligations to extraordinary circumstances, i. e., war finance, the law was obviously interpreted quite loosely.

As part of its protectionist trade policy, and in order to improve its finances, the federal government increased tariff rates in 1879. Although central government revenue had doubled by 1887, the effort was hardly rewarded. In order to prevent fiscal independence by the federal government, the states enacted the so-called Frankenstein Clause in 1879. According to this law, all federal revenues from tariffs and the tobacco tax exceeding 130 million Marks per year (the amount was increased later) had to be transferred to the states (Gesetz betreffend den Zolltarif des Deutschen Zollgebiets und den Ertrag der Zölle und der Tabacksteuer, § 8). The excess revenue was deducted from the states' matricular obligations, regardless of potential fiscal deficits at the federal level. The resulting reverse matricular payments (Table 1) may explain the decrease of the debt-to-GDP ratio at the state level in the following decades and, in combination with the armament of the German fleet, the rise of the federal debt-to-GDP ratio (Figure 1).

The additional increase in federal debt predating WWI was fuelled by rising colonial and educational expenses from 1885 onwards, the introduction of the social insurance systems by Bismarck (e. g., health insurance in 1883, pensions insurance in 1891) and the costs of war preparations. While the military expenses accounted for roughly 60 percent of total federal expenditures in the pre-war years, this share increased to an average of 86 percent during the war (Table 2). The percentage of social spending increased from an average of 18 percent in 1876-1880 to 31 percent in 1911-1913 (Hefeker 2001). In addition to new functions being assigned to the federal level, the loss of the states' autonomy is also reflected by the introduction of the inheritance tax in 1906, a state tax shared with the Reich, and the Wehrbeitrag (war contribution) in 1913, the first direct tax on the



*Public debt in Mark, Reichsmark, and Euro, respectively. For further definition and sources, refer to Figure 1. For 1914-1923 and 1938-45 debt is not mapped due to distortive outliers. For 1945-48 no data are available. 1850-1937 refer to the left hand scale, 1949-2010 refer to the right hand scale.

Figure 2 Nominal public debt in Germany, 1850-2010 (in millions) *

Table 2 Ordinary and extraordinary expenses of the Reich (in billion Reichsmark)

	Total	of which:			
		Military and War		Debt Service	
1911	2.12 (100 %)	1.28	(60.34 %)	0.27	(12.63 %)
1913	2.64 (100 %)	1.66	(63.08 %)	0.25	(9.29 %)
1914	8.78 (100 %)	7.76	(88.36 %)	0.47	(5.36 %)
1915	25.80 (100 %)	24.06	(93.22 %)	1.35	(5.22 %)
1916	27.84 (100 %)	24.81	(89.13 %)	2.62	(9.40 %)
1917	52.20 (100 %)	42.23	(80.91 %)	6.52	(12.49 %)
1918	44.43 (100 %)	33.95	(76.42 %)	6.77	(15.24 %)
1919	53.16 (100 %)	*30.64	(57.64 %)	8.40	(15.80 %)

* Including fiscal burdens of war consequences, demobilization and reparations. *Source:* Roesler (1967).

federal level (Neugebauer 2000: 133; Stegarescu 2005). This centralization tendency is accompanied by an increase in public debt, particularly at the federal level. Figure 1 shows that the total public debt-to-GDP ratio increased by 148 percent between 1873 and 1913. As indicated by Figure 2, the amount of total nominal debt rose by 783 percent during this period. Aware of this increase in public debt, the Reich followed the example of the states and enacted a law specifying that, beginning in 1908, 3-5 percent of federal debt is to be repaid each year. However, the law never really came into effect (Neumark 1976). The state of German public finances provoked a political debate on tax reforms, particularly on the introduction of direct federal taxes. Dissent on this matter finally resulted in the resignation of chancellor Bülow in 1909.

3.3 Phase III: two World Wars, sovereign defaults and currency reforms (1914-1949)

The amount of debt accumulated during the war years indicates how the war was financed. With the outbreak of WWI, numerous laws with the purpose of enhancing the ability to generate public revenue came into effect. The Reichsbank, not independent in 1914,¹⁰ was finally released from its duty to exchange Marks for gold, implying flexible exchange rates. As a result, the gold standard, which Schumpeter (1952) called “Die goldene Bremse an der Kreditmaschine” (the golden brake on the credit machine) was abolished. Additionally there was a de facto cessation of almost all quantitative restrictions on the money supply (Pfleiderer 1976). These amendments led the government to finance its expenditures directly through the central bank. The rise in short term treasury bills held by the Reichsbank is evidence for the extensive use of this instrument, resulting in an increasing inflation rate (Table 3). Due to the already high inflation rate, neither the introduction of new taxes nor the increase of existing ones could offset the fiscal deficits anymore. In the period between 1912 and the end of WWI, the increase in public debt exceeded the inflation-driven increase in nominal GDP, resulting in an upward shift of the debt-to-GDP ratio. In 1915 the debt-to-GDP ratio and the nominal debt of the central government exceeded the debt level of the states for the first time. Apart from a short time period after WWII, this has not changed up to today (Figure 1).

¹⁰ “Die dem Reiche zustehende Leitung der Bank wird vom Reichskanzler...ausgeübt...” (Deutsches Reichsgesetzblatt Vol. 1875, Nr. 15, 177-198, as amended on: 14th March 1875, § 12). This could be translated to: The administration of the Bank in the powers of the Reich is conducted by the Chancellor (Translation by the authors).

When the Weimar Republic was established in 1919, Art. 87 of the new constitution restricted the use of public credit to extraordinary needs and to projects leading to a return. The crisis and the confusion after the First World War enabled the new Republic to reduce the fiscal and political autonomy of the states in such a way that the Reichstag became the dominant authority. In order to improve public finances, the Erzberger reform of 1919/20 altered the structure of fiscal federalism further towards a more centralized top-down approach. The federal level of government was institutionally supplemented with a financial administration and the authority to levy most taxes, leading to a unification and equalization of regional tax laws. The states were provided with shares of certain tax revenues in order to compensate them for the loss of fiscal autonomy. Furthermore, a vertical equalization scheme was established (Stegarescu 2005). The states were now fiscally dependent on the federal government. The growing federal sector may also explain the evident increase in the share of federal debt (Figure 1).

In 1919/20 the Treaty of Versailles obliged the Weimar Republic, contrary to its own intentions,¹¹ to pay reparations to the Entente. Indebtedness and inflation prevented the Weimar Republic from issuing government bonds on the capital markets.¹² The methods of generating public revenue were limited to taxes and the further (ab)use of the Reichsbank. Although the Erzberger reform led to an increase in various taxes, no substantial revenues could be generated in real terms (Haller 1976). Thus the government had to rely on further increases in the amount of floating debt held by the Reichsbank and in money supply (Table 3). The hyperinflation induced a decrease of the total debt-to-GDP ratio from its high level of 131 percent of GDP in 1918, with an exception in 1922, when the increase in debt exceeded the inflation driven rise in nominal GDP. In 1923, almost 90 percent of state revenue was generated by issuing debt obligations. Due to inflation, the possibility of paying contributions in government bonds and then repurchasing them, the debt-to-GDP ratio approximated zero in 1923.¹³ The debt-to-GDP ratio of the states had already been zero in 1919, as most of their debt had been transferred to the federal level as compensation for the acquisition of the railway (Gesetz betreffend den Staatsvertrag über den Übergang der Staatseisenbahnen auf das Reich, § 4).

The hyperinflation ended in November 1923, with the currency reform and the Reichsbank ceasing to discount treasury bills. The newly issued currency, the Rentenmark (backed by real estate, land and later by gold), was exchanged for 1 trillion Marks. While smaller amounts of debt were simply deleted, the majority of outstanding public obligations were transferred according to the principle “Mark für Mark” (Mark for Mark). Thus, public debt was notably reduced. Outstanding liabilities still existed in the form of reparations, which Germany had previously suspended. Negotiations on restructuring

¹¹ In 1916 the State Secretary of the Reich Treasury announced in the Reichstag: “Das Bleigewicht der Milliarden haben die Anstifter dieses Krieges verdient; sie mögen es durch die Jahrzehnte schleppen, nicht wir.” (The burden of the billions is the merit of the instigators of this war; they may carry it through the decades, not us. Translation by the authors.) (Helfferich 1916: 224).

¹² Exceptions are some “value stable” bonds expressed in Goldmark, rye or other goods (Pfleiderer 1976).

¹³ Since no data on nominal GDP are available for the time period between 1914 and 1924, we had to derive them from real GDP estimates deflated by the respective CPI. The amplitude of our data in 1922 may be due to the fact that CPI is measured at the end of the year, while debt is measured at the end of the fiscal year (i. e., the end of March of the following year). However, our estimated debt-to-GDP ratios are rather similar to those of Holtfrerich (1996) and to data kindly made available by Schularick. For further details see Appendix A1 and A2.

Table 3 Macroeconomic indicators, 1915-1923

	Floating debt (in million Marks)			Money in circulation ^{1,2}	Exchange rate to U. S. Dollar ²	Consumer Price Index
	total	Held by the Reichsbank		1913=1	1914 = parity	1913=100
1915	7.2	6.0	83.33 %	1.5	1.16	135
1916	9.3	7.3	78.49 %	1.7	1.26	180
1917	18.5	13.1	70.81 %	2.3	1.69	225
1918	33.0	15.7	47.58 %	5.5	1.97	310
1919	63.7	29.9	46.94 %	8.3	11.1	490
1920	91.5	42.7	46.67 %	13.4	17.4	1'044
1921	166.3	64.5	38.79 %	20.3	45.7	1'337
1922	271.9	146.5	53.88 %	213.0	1'808.0	15'036
1923³	191.6tri	189.8tri.	99.06 %	81.8bn.	1'000bn.	15'897bn.

¹Stückgeldumlauf (Reichsbanknoten, Privatbanknoten, Reichskassenscheine, Darlehenskassenscheine and coins).²1915-1917 at mid year, 1918-1922 end of year. ³Until 23th November. Sources: Deutsche Bundesbank (1976) and Haller (1976).

these external liabilities resulted in the Dawes Plan of 1924. According to this agreement, Germany had to pay a rate of 2.5 billion Marks per annum, starting in 1928/29. An expiry date was not agreed upon. Discontent of the involved parties and the onset of the Great Depression led to a new agreement in 1929. The so-called Young Plan reduced annual payments to 2 billion Marks for the next 59 years. In order to service the payment schemes, Germany issued the Dawes and Young bond, respectively (Glasemann 1993).

Soon after reparations had been agreed upon, public finances were hit by the Great Depression, placing a high burden on public finances, especially on the local level. Two developments played a major role in this: First, the main sources of local revenue (corporate and personal income tax) decreased by over one third and, second, higher costs of social services caused local expenditures to rise (Petzina 1986: 246-251). Due to the fiscal situation during the Great Depression, the Weimar Republic introduced capital controls in 1931 and stopped servicing most of its debt in compliance with the contracts. The capital controls led to an erosion of the gold standard, which gave the Reichsbank leeway for discretionary monetary policy. After the takeover of the National Socialists in 1933, most debt payments were discontinued, the Reichsrat was dissolved and the federal structure of Germany was factually abolished. Subsequently, the share of federally determined tax revenues increased from 50 percent in 1913/14 to 98 percent in 1938 (Terhalle 1952: 317).

While there was a legal ceiling on the amount of treasury bills discountable at the Reichsbank before 1933, the National Socialists found various ways to circumvent fiscal and other disciplining rules of the Weimar Republic constitution. The rule of the National Socialists can be divided into four stages, each characterised by different methods of public finance. The practice predominantly used during the first stage of the regime (1933-1936) was the issue of bills of exchange by dummy firms redeemable at par in Reichsmark and expansive fiscal policy. The latter was already common before the National Socialists came to power: Job-creating measures were initially introduced in 1930, and their intensive use in 1932/1933 was re-financed by tax credits (Schiller 1936: 54).¹⁴

¹⁴ This included the installation of institutions that financed work programmes, such as the Deutsche Gesellschaft für öffentliche Arbeiten (Oeffa) (e.g., Papen-Programm, Sofort-Programm and the Reinhardt-Programm).

In addition to these waivers, several shadow and off-budget activities became the backbone of the National Socialist work programme.¹⁵ The second stage (1936-1939) of National Socialist fiscal policy was directed to install a system of “silent” war financing operations. Wages and prices were frozen in June and November 1936, while money supply was increased. In 1939, the *Kriegswirtschaftsverordnung* (§ 1, RGBl. I, 1939, 1609-1613) imposed penalties on the hoarding of money, extending to bank deposits at commercial banks. Consumer demand was capped by the introduction of consumption stamps in September 1939, while the investment operations of banks were limited and restricted to locally issued products. This boosted savings even further. Since commercial banks were prohibited to invest savings abroad (capital controls had been previously established) and were regulated to buy national securities, savings indirectly, but inevitably, ended up at the Reichsbank – or in government bonds. This “silent” war financing procedure turned the German citizens into creditors of the National Socialist war finance strategy. In 1939, by means of the “Gesetz über die deutsche Reichsbank” the bill financing arrangement became obsolete, since public expenditures could now be financed, to a nearly unlimited extent, directly through the Reichsbank (Hansmeyer/Caesar 1976).¹⁶

The beginning of the third stage (1940-1943) was marked by the occupation of neighbouring countries. Additional revenue was obtained by integrating them into the above mentioned scheme, while selling off their central bank’s securities (including their gold) on the still existent international capital market (Vogler et al. 2012). The implementation of subsidiaries of the Reichsbank in Krakow (December 1939), Brussels (June 1940) and Bohemia (August 1940) illustrates the extent of this strategy. The leverage of the war financing operations increased, as more and more citizens were forced into this scheme. The fourth and final stage (1943-1945) saw the capital inflow from the occupied territories slow down. Additionally, the limits of the war financing operations between the Reichsbank and private savings had been reached. The Reichsbank started financing public spending by directly buying bonds and printing money. The cumulated debt overhang and the loss of credibility of the institutions of the Reich finally led to a rejection of the Reichsmark in May 1945.

The pursued strategies of war finance, combined with decreasing economic growth, resulted in a rise of the debt-to-GDP ratio, exceeding 240 percent in 1944 – not including shadow budgets and other liabilities by foreigners (Figure 1). This increase in the debt-to-GDP ratio surpassed the experience of WWI and exceeded the debt-to-GDP ratios of most other nations (Appendix A3). In contrast to WWI, the freezing of prices and wages curbed inflation. A currency reform was enacted in June 1948, three years after the German capitulation (Goldschmidt/Köhler 2008).

¹⁵ An often cited example is the Metallurgische Forschungsanstalt (Mefo) which was installed to emit bonds to further increase the fiscal power of the Reich. The bonds served as bills of exchange to finance rearmament, while at the same time camouflaging the war preparation from foreign observers (Cohn 1997: 271). In an interrogation, Hjalmar Schacht (1945), president of the Reichsbank from 1933-1939, said about this technique that it “enabled the Reichsbank to lend by a subterfuge to the government what it normally or legally could not do”. From a quantitative point of view though, the Mefo bills were not very important (Table 4).

¹⁶ According to the “Gesetz über die deutsche Reichsbank”, as amended on 15th June 1939, the Reichsbank was essentially assigned directly to Hitler.

Table 4 Debt and money circulation 1938-1945 (in billion Marks)

	1938/39	1939/40	1940/41	1941/42	1942/43	1943/44	1944/45 ²
General Government debt	53.2	73.5	102.6	153.3	208.0	284.9	387.9
of which:							
Mefo Bills	11.9	11.4	10.8	10.1	9.5	8.8	8.1
New Domestic short-term debt	6.5	18.0	38.2	66.9	103.5	154.2	241.0
in %	12.2	24.6	37.2	43.6	49.8	54.1	62.2
of which:							
Reichswechsel	0.4	6.5	14.9	26.0	37.3	61.2	116.0
Money circulation¹	11.0	15.2	18.3	23.8	29.8	38.7	73.0

¹Including Reichsbanknoten, Rentenbankscheine and Scheidemünzen; 31th June. ²Partly estimates; data are valid until the end of WWII. *Source:* Hansmeyer and Caesar (1976).

3.4 Phase IV: fiscal policy in the Federal Republic of Germany (1950-2010)

The currency reform of 1948 went hand in hand with a default on liabilities of the National Socialist regime. The claims of outstanding German debt were not decided and settled before the London Debt Agreement in 1953. By that time, the Bank deutscher Länder (BdL) had already gained autonomy from the Allies and had successfully organized an asset re-allocation (i. e., Ausgleichsforderungen) to maintain the supply of capital and credit from the start of the Deutsche Mark. The Ausgleichsforderungen accounted for nearly 50 percent of the BdL balance on December 31st 1950. Larger liabilities were haircut against newly issued securities, eligible to be discounted at the Federal Reserve Banks (i. e. Landeszentralbanken) of the newly established Central Bank System headed by the BdL. In short, the debt-to-GDP ratio had decreased, since most public debt was converted into Deutsche Mark with an exchange ratio of 1:10. In 1952, Germany joined the Bretton Woods System and pegged its exchange rate to the U.S.-Dollar. This can be seen as an attempt to return to a rule-based monetary policy. In the two decades following the formation of the Federal Republic of Germany, the general debt-to-GDP ratio fluctuated around 22 percent (Figure 1). However this situation owes far more to the extraordinary economic growth during the “economic miracle” than to fiscal prudence. In fact, the average nominal GDP growth between 1953 and 1973 reached almost 10 percent (Figure 3), while the nominal debt increased from 14.78 to 86.42 billion Marks (Figure 2). In the late 1960s, a realignment of macroeconomic policy in Germany took place. A new law authorized the government to stabilize economic cycles, using countercyclical fiscal and economic policy (StabG 1967). The implementation of this law is often interpreted as a move towards Keynesian demand side economics. In addition, the constitutional rule restricting public deficits to the volume of investment (Art. 115 GG) was amended in 1969.¹⁷ In the following years both the debt-to-GDP ratio and the amount of nominal debt increased (Figure 1 and 2). While the initial rise in public debt might have resulted

¹⁷ Until then article 115 GG, adopted from the Weimar constitution, allowed public credit in exceptional situations and for projects leading to a return. Following the financial reform of 1967/69, Art. 115 GG allowed the accrual of debt for public investments and to fight macroeconomic disequilibrium. Further exceptions were allowed for off-budget special funds. The article was amended with the introduction of the debt brake in 2009. For an analysis of this debt brake see Feld and Baskaran (2010).

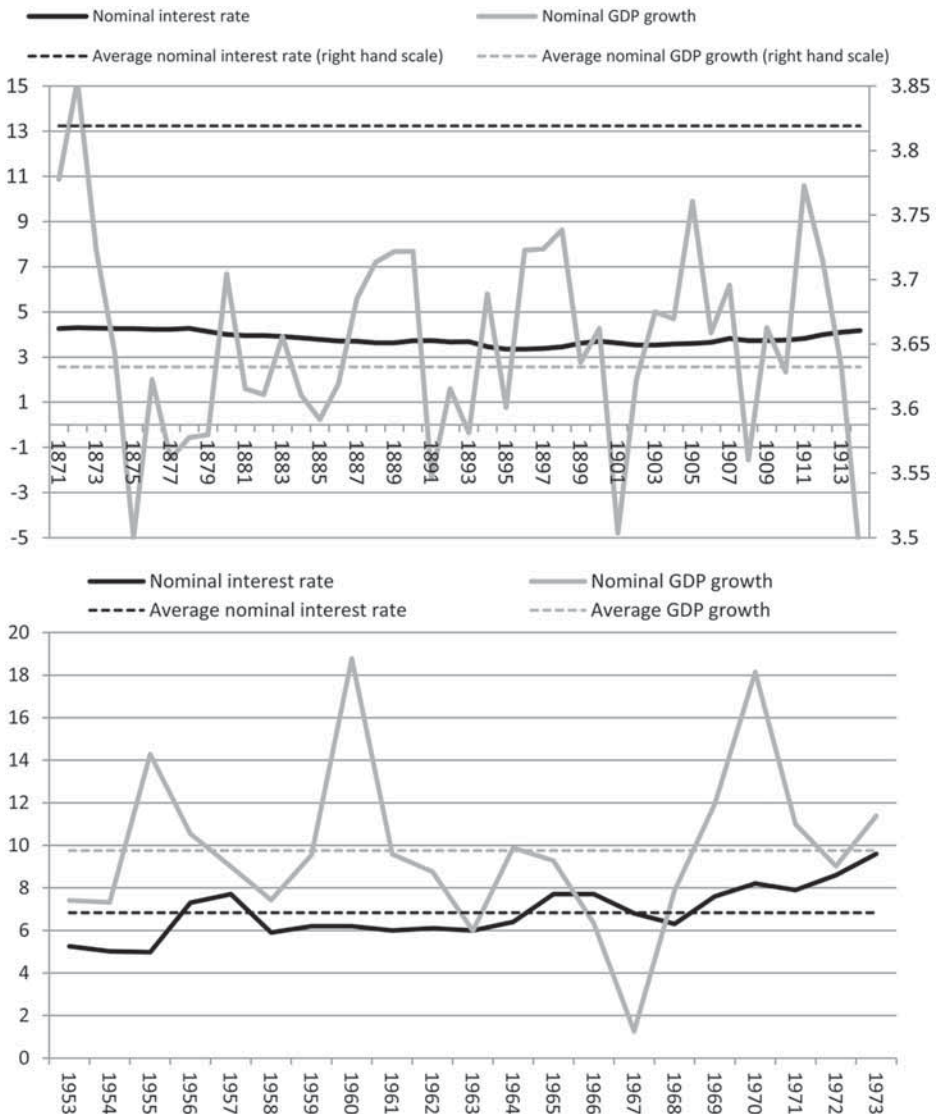


Figure 3 Nominal interest and growth rates in percentage points, different periods

from the first serious recession of the post-war era in the 1970s, the German Council of Economic Experts (2005: 478) and the Academic Advisory Board at the Federal Ministry of Economics and Technology (2008), among others, report a bias towards public debt since the constitutional amendment. The debate on the evident increase in public debt marked the starting point of the break-up of the social liberal coalition in 1982. The following government under Chancellor Kohl succeeded in consolidating the structural deficit until the eve of German Unification.

However, the costs of the German Unification, combined with the recession of the 1990s resulted in a new increase in public debt (Figure 1 and 2). After the establishment of the European Monetary Union and the implementation of the Stability and Growth Pact (SGP), which limits the amount of national debt and deficits as percentages of GDP to 60 percent and 3 percent, respectively, the German debt-to-GDP ratio has continuously exceeded the Maastricht benchmark of 60 percent. Due to an intervention by Germany and France, the SGP was weakened in 2005. Finally, the Great Recession has led to an increase of the general debt level to over 80 percent or above 2 trillion Euro in 2010 (Figure 1 and 2). An international comparison, however, shows that the fiscal situation is even worse in several other states (see Appendix A3).

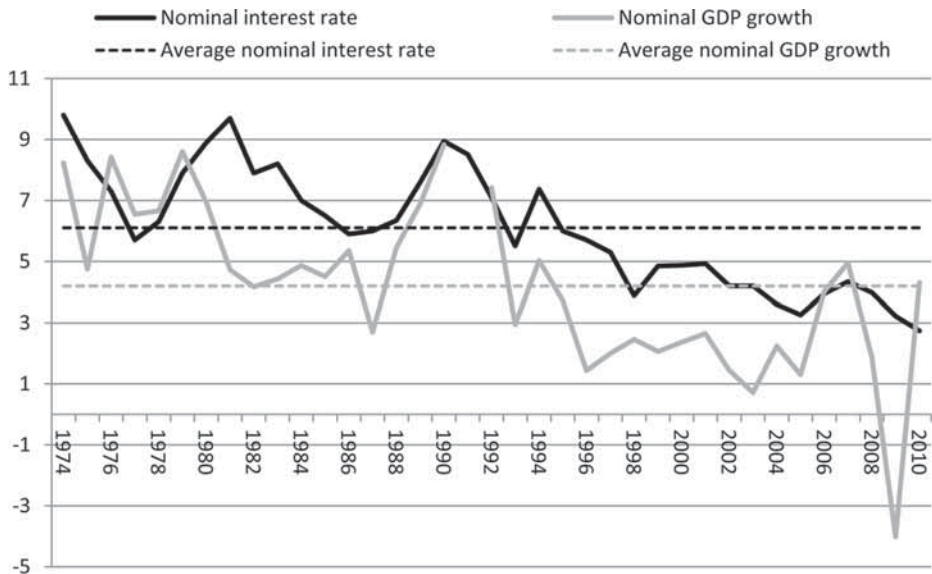
Although Germany has experienced steep increases in its public debt before, both the debt-to-GDP ratio and the nominal amount of debt have never been higher in peacetime than today. The introduction of a constitutional debt brake replacing the former Art. 115 GG is a reaction to this development. Today, the debt rule is in a transition period, giving the state and federal governments time to consolidate their budgets. Starting in 2016, the federal budget has to be close-to-balance after adjusting for cyclical fluctuations. Four years later, the states will be no longer permitted to run a structural deficit. Exceptions are narrowly defined and tied to repayment rules, but automatic triggers in the case of contravention are missing. At this stage, several states are struggling to balance their budget, thereby risking an unbalanced budget in 2020 (Deutsche Bundesbank 2011; German Council of Economic Experts 2011). Since legal restrictions to the accumulation of public deficits have been evaded in Germany since the Kaiserreich, and nowadays even on the EU level, the sustainability of public finances is still questionable.

3.5 Summary and further evidence

The anecdotal evidence on the development of public debt in Germany has revealed some key characteristics. First, public debt has particularly increased during economic crises, wars or extraordinary circumstances (i. e., unification). Apart from potentially “good” reasons for fiscal deficits in those times, it is evident that debt has hardly decreased afterwards. Second, constitutional rules restricting the amount of public debt were in place since the formation of the first German nation state. They have obviously been interpreted very loosely. These two characteristics can be explained by Buchanan and Tullock’s (1962) theory of the fiscal commons (Schaltegger/Feld 2009). Third, since 1949 the share of the federal debt level has increased. Fourth, the largest rises in the public debt ratios were accompanied by a loss of independence of the central bank. Fifth, although the Bundesbank gained independence and committed itself to price stability, German fiscal policy was not constrained effectively, as supposed by Sargent and Wallace (1981).¹⁸

In the current debate on the European debt crisis the call for a growth-oriented policy instead of austerity measures gains popularity. Such a policy is supposed to enable economies to grow out of their debt without the need of (primary) surpluses. As discussed in Section 2, this is only feasible under the assumption that the nominal interest rate remains below the nominal GDP growth rate in the long run. This is not the case. After

¹⁸ In contrast, the fiscal theory of price level (Leeper 1991, Sims 1994, Woodford 1995) indicates that fiscal policy determines the price level, while monetary policy plays at best an indirect role. Permanent fiscal deficits may induce inflation by their effect on aggregate demand irrespective of monetary policy. In monetary unions – but also in federal states – excessive spending of one state over a long horizon may therefore lead to heterogeneous inflation patterns (Neck and Sturm 2008).



Sources and description see Appendix A1.

Figure 4 Nominal interest and growth rates in percentage points, different periods

1974, economic growth in Germany was lower than the interest rate (Figure 4). Average economic growth is notably below the average interest rate for this period. In the period before WWI, regarding average values for this period, the interest rate also remained above the rate of economic growth (Figure 3, top). Only in the years of the “economic miracle” the average growth rate of nominal GDP comes close to 10 percent. It therefore exceeds the average interest rate (Figure 3, bottom). Given these facts, it is hardly feasible – at least for Germany – to grow out of its debt. The years of the “economic miracle” are the exception rather than the rule.

4 Empirical analysis

In order to test whether the development of public debt described in Section 3 is sustainable, we conduct a time series analysis. Any of the assumptions made and set in the estimations will be discussed subsequently. The four staged approach of this paper is framed by methodological remarks in the introductory (4.1) and in a concluding section (4.6).

4.1 Data and empirical test strategy

The empirical analysis is based on annual data covering the period from 1872 to 2010. The dataset is composed of multiple sets of institutions and sources – including the JNS (see Appendix A1). The two most commonly stated problems of long time series are inconsistency and timeliness of the data (Reinhart/Rogoff 2009). The available data is indeed not fully consistent, due to varying reporting standards and statistical procedures, causing statistical discrepancies within public spending and income statistics. The

Table 5 Descriptive statistics

Variable	Unit	Frequency	Obs**	Mean	Std. Dev.	Min	Max	
Public Debt	Share in GDP*	Year	1872-2010	135	0.472	0.319	0.029	2.427
			1872-1913	42	0.476	0.110	0.215	0.596
			1950-2010	61	0.365	0.183	0.176	0.812
Public Expenditures	Share in GDP*	Year	1872-2010	135	0.296	0.192	0.000 ¹	1.095
			1872-1913	42	0.147	0.058	0.362	0.356
			1950-2010	61	0.403	0.897	0.213	0.514
Public Revenues	Share in GDP*	Year	1872-2010	134	0.271	0.155	0.000 ²	0.609
			1872-1913	42	0.143	0.071	0.013	0.356
			1950-2010	61	0.383	0.081	0.216	0.481
Budget Surplus	Share in GDP*	Year	1872-2010	133	-0.032	0.068	-0.521	0.143
			1872-1913	42	-0.004	0.020	-0.085	0.012
			1950-2010	61	-0.020	0.015	-0.062	0.014
Primary Budget Surplus	Share in GDP*	Year	1950-2010	61	-0.001	0.016	-0.048	0.042
CPI Inflation	Percentage change in CPI	Year	1950-2010	61	0.025	0.022	-0.062	0.075
Yield	Percentage points	Year	1950-2010	61	6.305	1.720	2.743	9.8

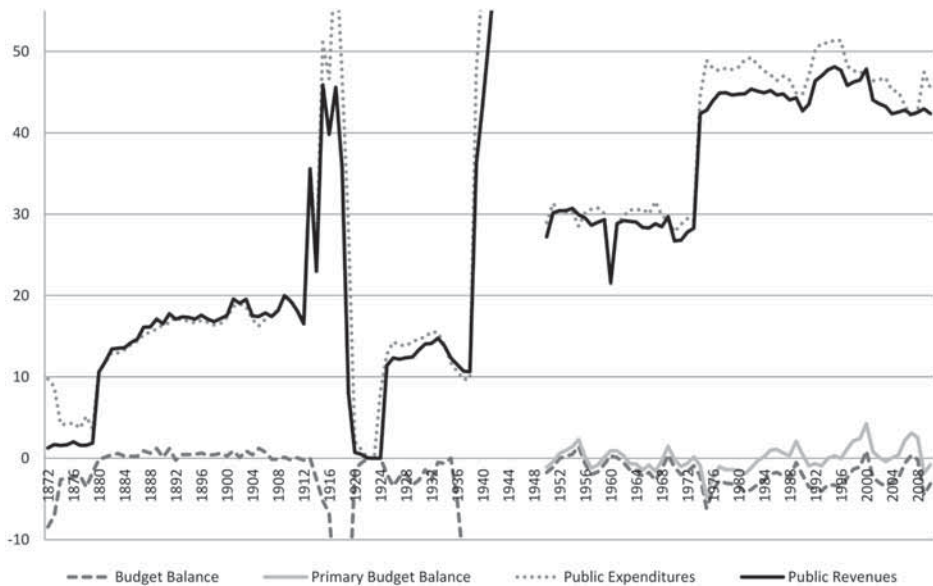
*See footnotes 6 and 13. **Observations for budget deficit in 1924 and 1949, and for revenues in 1924 are not included. Between 1945 and 1949 data are unavailable. For further details see Appendix A1. ¹ i. e. $7.85e^{-13}$; ² i. e. $8.75e^{-14}$.

consistency of the data is improved, however, when we consider the two sub-periods 1872-1913 and 1950-2010 (see Appendix A1). In addition, some data are unavailable before 1950: Budget surplus is therefore calculated from the annual differences between revenues and expenditures, until the officially approved data series for annual surpluses started in 1950. Data on primary budget surpluses could not be obtained for this early period.

The data are measured in relation to GDP. Drawing on Bohn (2008), such a procedure guarantees a similarly scaled series that offers more credible information, in contrast to raw data or their respective logs. According to Kirchgässner and Prohl (2008) the ratios, as indicated by eq. (1), provide a more natural definition of sustainability. This holds especially with regard to the widely observed phenomenon in time series analysis on debt sustainability of a common stochastic trend in GDP on the one hand and public debt and deficits on the other hand, indicating that “stationarity of the latter two is not necessary for a sustainable fiscal policy” (ibid.: 68). Table 5 provides a summary of the descriptive statistics of all variables used in the empirical analysis. The development of expenditure, revenue and budget surpluses (in % of GDP) is shown in Figure 4.

In order to test for fiscal sustainability in a more formal manner, we basically follow the approach summarized in section 2. In a first step, we test whether the transversality condition is met (i. e. whether the second term of the right hand side of eq. (1) converges to zero over time) by conducting various stationarity tests on public debt, deficits, and, if available, primary surpluses. These tests are also performed with respect to expenditures and revenues.¹⁹ In order to examine the stationarity properties of the time series, we

¹⁹ For a discussion of the limits of stationarity as an indicator for sustainability, see Bohn (2008).



For reasons of clarity, values below -10 % of GDP and above 55 % of GDP are not depicted. Own calculations.
 Source: Refer to Appendix A1.

Figure 5 Public expenditures, revenues and budget surplus (in % GDP), 1872-2010

apply different unit root tests: first, the Augmented Dickey Fuller (ADF) test, determining the number of lags using the Hannan-Quinn criterion; second, the Philipps-Perron (PP) test, selecting the bandwidth automatically in accordance with the Newey-West procedure using Bartlett kernel; and third the Kwiatkowski-Test (KPSS) with equivalent bandwidth selection procedures (Hamilton 1994; Kirchgässner/Wolters 2006; Kwiatkowski et al. 1992). The tests differ with respect to their null hypotheses: The null hypothesis of the ADF and the PP tests is the existence of a unit root in the time series, whereas the null hypothesis of the KPSS test is trend stationarity of the time series.

Since unit roots in fiscal data imply that economic shocks have a sustaining effect on the data over time, the identification of a unit root denotes a non-stationary (unsustainable) time series. All tests are applied in levels allowing for a constant and a constant with trend, respectively, and in first differences. In the presence of structural breaks, the power of standard unit root tests is decreased, e.g., the ADF test is biased towards a non-rejection of the null hypothesis. In order to take a possible distortion of structural breaks into account, we follow a twofold approach: First, we conduct the unit root and stationarity tests on the entire sample (1872-2010) and on the two sub-samples (1872-1913 and 1950-2010). Second, we additionally apply a fourth test suggested by Zivot and Andrews (1992). It tests the null hypothesis of a unit root against the break-stationarity alternative using the Akaike Information Criterion (AIC) in order to determine the optimal number of lags. The break date is chosen where the t-statistics from the ADF test is most negative, i.e., the evidence is “least favourable for the unit root null” (Glynn et al. 2007: 68). The Zivot and Andrews test (ZA) is applied in levels allowing for a structural break in the intercept and in the intercept and trend, respectively.

In a second step we perform Johansen cointegration tests to examine whether current debt equals discounted future primary budget surpluses over time (see first term of the right hand side of eq. (1) in section 2). If variables are integrated of order one $I(1)$, there may be a linear combination of a lower order of integration, such that a cointegration relation exists. This procedure allows for analysing whether the time series share a common stochastic drift, and to detect the rank of a cointegration matrix (r) for a VECM analysis. Hence, a long-term relation, a cointegration vector, and a short term adjustment may be detected once we identify a cointegrated system. Cointegration tests allow for a further analysis of the data beyond standard regressions: If, for example, debt and surpluses are cointegrated, the necessary condition for the sustainability of the intertemporal budget constraint holds (Afonso 2005). Two statistical tests are able to determine the number of cointegration vectors: the Trace test and the Maximum Eigenvalue test. The former tests the null hypothesis that there are at most r cointegration vectors against an unrestricted alternative. The latter tests the null hypothesis that there are r cointegration vectors against the alternative of $r+1$ cointegration vectors.

In a third step, we consider standard VAR tests for those variables that are not $I(1)$. In a VAR the endogenous variables are explained by their own lagged values and the lags of the other variables in the model. In addition, the impact of shocks on the adjustment path is modelled with impulse response functions. This procedure allows for estimating the adjustment processes on increasing public debt ratios, as suggested by Bohn (1995, 1998). Furthermore, a VAR can disclose the assumed positive reaction patterns between primary surpluses and debt (Greiner/Kauermann 2007).

In a fourth step, we test for a simultaneous equilibrium in the dataset and estimate a VECM to further explore the relation between debt, yields and inflation. Impulse response and tests for Granger causality further explore this relation.

4.2 Results of the unit root tests

4.2.1 1872-2010 unit roots tests results

The stationarity tests on the period from 1872-2010 are only indicative, as the whole period is characterized by large scale events and structural breaks. The positively skewed distribution of total debt supports this introductory remark.

Regarding expenditures and revenues, the tests indicate that both are stationary in differences while the results for their levels are ambiguous: Revenues tend to be stationary in levels with trend, as the ADF test statistic allows for rejecting the hypothesis of a unit root on the one percent significance level. In contrast, the KPSS test rejects the null hypothesis of stationarity if we allow for a constant. If we also include a trend in the estimation, we fail to reject the hypothesis of trend stationarity. Hence, revenues seem to be trend stationary in levels if we consider the ADF and KPSS tests. The results of the PP test contradict these findings. To further explore this puzzle, we supplement a ZA unit root test that is sensitive to structural breaks in the intercept and trend. If we allow for a structural break in the intercept, we cannot reject the hypothesis that revenues have a unit root. If we also allow for a structural break in the trend, the hypothesis is retained. Both tests indicate a break point in 1918 and support non-stationarity of revenues.

Expenditures in levels appear to be non-stationary over the whole period and stationary in first differences – which suggests $I(1)$ series – if we consider ADF and PP test results. The hypothesis of stationarity can be rejected by the KPSS tests allowing for a constant. Since KPSS neither rejects stationarity in expenditure levels with trend nor in first differ-

Table 6 Tests for unit roots and stationarity, 1872-2010

Variables	ADF test			PP test			KPSS test			ZA test		
	Level	Level with trend	First differences	Level	Level with trend	First differences	Level	Level with trend	First differences	Intercept	Intercept and trend	
Public Debt (in % GDP)	-0.126	-0.100	-2.011	0.174	0.212	-8.892***	0.096	0.079	0.075	-0.828 (1945)	-0.469 (1956)	
Gross Surplus/Deficit (in % GDP)	3.673	3.712	0.515	3.243	3.184	-10.455***	0.135	0.107	0.150	2.784 (1945)	2.283 (1955)	
Expenditures (in % GDP)	-1.652	-2.347	-5.045***	-1.247	-1.839	-10.360***	1.062***	0.027	0.113	-2.714 (1939)	-2.395 (1918)	
Revenues (in % GDP)	-2.206	-4.369***	-6.095***	-1.524	-2.856	-11.561***	1.170***	0.048	0.060	-4.304 (1918)	4.423 (1918)	

Note: The values are the estimated t-statistics. '***', '**', or '*' indicates that the corresponding null hypothesis of a unit root can be rejected (KPSS: null hypothesis: no unit root) at the 1, 5, or 10 percent level, respectively. ADF lag length is automatically selected at a maximum lag length of 12 based on the Hannan-Quinn criterion. PP and KPSS bandwidth is automatically selected using Bartlett kernel. ZA uses AIC max lag length of 8. Lag length criteria tests are available in the workfile. '(yyyy)' indicates the year for the ZA break point. ZA graphs are reported in the Online Appendix.

ences, the results are, again, puzzling: With a ZA test allowing for a structural break in the intercept, we cannot reject the hypothesis that expenditures have a unit root. Also, the null hypothesis of a unit root with a structural break in both the intercept and trend cannot be rejected. Break points are 1939 with respect to the intercept and 1918 regarding a break in intercept and trend. Comparing expenditure and revenue break points, the ZA results suggest that fiscal policy of the 19th century is significantly different from that of the 20th century. The significant breakpoint in 1939 is due to the sharp increase of expenditure growth to finance WWII.

With respect to surpluses, the ADF and PP tests suggest a unit root in levels with and without a trend. They differ with regard to in first differences: The PP test rejects the hypothesis of a unit root in first differences, while ADF test does not. Trend stationarity is rejected neither in levels nor in differences by the KPSS test. The ZA test statistic does not allow for a rejection of the hypothesis of a unit root in deficits while choosing 1945 as a break point in the intercept. If we allow for a break in the trend as well, the ZA retains the hypothesis of a unit root with 1955 as a break point – the year also well known for its peak growth performance of the German “economic miracle” (Richter 1998: 32). The latter surplus coincides with its maximum value of the second period (1950-2010), as reported in Table 5 at 1.4 percent. Surpluses appear to be non-stationary in line with the ADF and the PP tests in levels.

The ADF and PP tests suggest a unit root in levels with and without a trend for public debt. They differ with regard to their test results in first differences: While ADF does not reject the hypothesis of a unit root in first differences, the PP test does so. Trend stationarity is neither rejected in levels nor in differences by the KPSS test. The ZA test statistic does not allow for a rejection of the hypothesis of a unit root in debt while choosing 1945 as a break point in the intercept. If we allow for a break in the trend and intercept, the ZA retains the hypothesis of a unit root with 1956 as a break point. Public debt appears to be non-stationary in support of the ADF and the PP tests in levels.

Given these ambiguous results, we conclude that continuing the analysis with the whole time series is not meaningful. Moreover, the power of standard unit root tests decreases substantially if there are significant structural breaks in the time series. The ZA tests indicate a multiplicity of structural breaks, which reaffirms the results from the anecdotal evidence. Therefore, we divide the sample into two sub-periods as discussed above.

4.2.2 1872-1913 unit roots tests results

With regard to public debt during the first sub-period of the dataset (1872-1913), the PP unit root tests and the KPSS tests indicate a non-stationary debt time series in levels. The ADF, however, rejects the hypothesis of a unit root in levels, without a trend on a ten percent significance level. If we allow for a constant and a trend in the estimation, the ADF retains the null hypothesis. In addition, the ZA rejects neither the hypothesis for a unit root with a structural break in the intercept (1882), nor the hypothesis of a unit root with a structural break in the intercept and trend (1883). Both dates coincide with the start of the depression in Germany (i. e., the Gründerkrach) and the United States. ADF and PP tests on first differences reject unit roots on the one percent level. Also rejecting stationarity in first differences on the ten percent significance level, the KPSS questions whether the debt series is truly I(1).

The annual budget surplus is stationary during this period with regard to the ADF and PP tests. For levels – either with a constant or with a constant and a trend – both unit root

Table 7 Tests for unit roots and stationarity, 1872-1913

Variables	ADF test			PP test			KPSS test			ZA test		
	Level	Level with trend	First differences	Level	Level with trend	First differences	Level	Level with trend	First differences	Intercept	Intercept and trend	
Public Debt (in % GDP)	-2.740*	-1.782	-4.186***	-2.183	-1.019	-4.760***	0.603**	0.191**	0.352*	-2.780 (1882)	-3.571 (1883)	
Gross Surplus/Deficit (in % GDP)	-6.665***	-5.861***	-6.484***	-7.477***	-5.603***	-6.514***	0.529**	0.214**	0.510**	-11.820*** (1880)	NA (1880)	
Expenditures (in % GDP)	-0.256	-2.359	-3.107**	0.292	-2.362	-2.978**	0.697**	0.121*	0.231	-3.801 (1880)	-3.964 (1880)	
Revenues (in % GDP)	-0.955	-2.118	-3.088**	-0.219	-2.101	-3.244**	0.682**	0.172**	0.150	-4.556 (1880)	-4.527 (1880)	

Note: The values are the estimated t-statistics. '***', '**', or '*' indicate that the corresponding null hypothesis of a unit root can be rejected (KPSS: null hypothesis: no unit root) at the 1, 5, or 10 percent level, respectively. '(yyyy)' indicates the year for the ZA break point. For further information please see the Note to Table 6 and the EViews workfile, respectively.

tests reject the existence of a unit root at the 1 percent level. This is also reflected by the ZA test that rejects a unit root allowing for a structural break in 1880 for the intercept, but fails to estimate the results allowing for a break in the intercept and the trend as regressors may be perfectly collinear. However, the KPSS test rejects the null hypotheses of trend stationarity in first differences and levels on the five percent level. Hence, the results for budget surplus ratios are not unambiguous.

ADF and PP tests do not reject the hypothesis of a unit root in the data series of expenditures and revenues in levels. The ZA supports these results, reaffirming the structural break in 1880. The hypothesis of trend stationarity (KPSS) is rejected in levels without trend. Therefore, expenditures and revenues are $I(1)$. The hypothesis of a unit root in differences can be rejected at the 5 percent level according to the ADF and PP test. Similar results are obtained for revenues.

4.2.3 1950-2010 unit roots test results

For the second sub-period (1950-2010), the officially reported annual budget (gross) surplus and primary surplus are available.²⁰ Public debt is non-stationary in levels as ADF and PP indicate. This is validated by the rejection of the hypothesis of trend stationarity in debt levels by the KPSS test. Unit roots can be rejected in first differences on the five percent significance level. In contrast to this finding, stationarity of the debt ratio in first differences can be rejected on the 5 percent level. Allowing for a trend in the difference estimation solves this ambiguity by not rejecting stationarity ($0.036t_i < 0.119t_{crit,10\%}$). A linear trend in differences corresponds with a deterministic trend in levels. An economic explanation for this empirical result could be found in the ever increasing sovereign debt ratios since 1950. Structural breaks are found in 1968, allowing for a break in the intercept and 1972, allowing for an additional break in the trend. Both dates coincide with the paradigm shift in post-war German fiscal policy (see section 2). As unit roots cannot be rejected in levels, the ZA test supports the empirical evidence that public debt is integrated of order one.

Gross and primary deficits are, in contrast, not $I(1)$. ADF and PP tests conjointly reject a unit root in levels and first differences. The KPSS tests confirm these results for stationarity of both time series in first differences. The hypothesis of stationary primary deficits in levels without trend cannot be rejected, in contrast to gross surplus. Considering a trend in both tests allows for the rejection of the hypothesis of trend stationary deficits in both cases. If we allow for a structural break in the regression, however, we can reject the hypothesis of a unit root in gross and primary deficits at least on the five percent level. The break is significant in 1997 for gross deficits and in 1985 for primary deficits, and for 1975 and 1984, respectively, if we also allow for a trend in the estimation. Supporting the results of the ADF and PP test in levels, the ZA test provides further evidence that we cannot treat the series as $I(1)$.

The ADF and PP tests in levels reflect the results from the first period, with regard to government expenditures and revenues. The KPSS null hypothesis of trend stationarity can be rejected in levels, allowing for a constant with or without a trend at least at the 10

²⁰ We thank Mrs. Ilsemarie Lenz at the Federal Statistical Office of Germany (Statistisches Bundesamt), who has provided us all relevant missing data for interest payments during the years 1950-1962. We could not have conducted this analysis without her help and her instant replies when data related problems occurred.

Table 8 Tests for unit roots and stationarity 1950-2010

Variables	ADF test			PP test			KPSS test			ZA test	
	Level	Level with trend	First differences	Level	Level with trend	First differences	Level	Level with trend	First differences	Intercept	Intercept and trend
Public Debt (in % GDP)	1.529	-1.168	-3.403**	1.678	-1.133	-3.573**	0.911***	0.225***	0.717**	-2.315 (1968)	-4.270 (1972)
Gross Surplus/ Deficit (in % GDP)	-3.558***	-3.943**	-7.161***	-3.426**	-3.892**	-13.434***	0.485**	0.191**	0.247	-5.595*** (1997)	-6.449*** (1975)
Primary Deficit (in % GDP)	-3.766***	-4.211***	-6.767***	-3.615***	-3.501**	-9.494***	0.213	0.135*	0.233	-5.207** (1985)	-5.408** (1984)
Expenditures (in % GDP)	-1.481	-1.792	-7.427***	-1.500	-1.863	-7.370***	0.729**	0.166**	0.096	-8.927*** (1974)	-8.850*** (1974)
Revenue (in % GDP)	-1.545	-1.745	-8.688***	-1.512	-1.806	-8.622***	0.745***	0.143*	0.124	-9.380*** (1974)	-9.309*** (1974)

Note: The values are the estimated t-statistics. '***', '**', or '*' indicate that the corresponding null hypothesis of a unit root can be rejected (KPSS: null hypothesis: no unit root) at the 1, 5, or 10 percent level, respectively. '(yyyy)' indicates the year for the ZA break point. For further information please consult the Note of Table 6 and the EViews workfile, respectively.

percent level, but must be retained in first differences. The two variables therefore appear to be $I(1)$. Following the ZA test results, revenues and expenditures do not have unit roots if we allow for a break in the intercept, or both intercept and trend, while choosing 1974 as a break point. The frequent appearance of structural breaks in the 1970s underpins the fiscal implications of the reforms during this period, as mentioned in the anecdotal analysis.

Given the results of the unit root and trend stationarity tests of the period from 1950-2010, we conclude that the necessary condition for the sustainability of the intertemporal budget constraint is not met, as the transversality condition does not hold due to the non-stationarity of public debt. The determinants of public debt of this period will be further discussed in Section 4.5. In addition, we find evidence for a stationary deficit variable (see Section 4.4) and – as far as unit root and stationarity tests are concerned – evidence that revenues and expenditures are $I(1)$, which will be further explored in Section 4.3 comparing both periods.

4.3 Sustainability test of expenditures and revenues

In order to determine the number of cointegrating vectors in the system, we perform Johansen cointegration tests for the time periods of 1872-1913 and 1950-2010. The lag lengths are selected from two VAR models. The first model (1872-1913) retrieves the following lag lengths: 2 Akaike Information Criterion (AIC); 1 Schwarz Criterion (SC); 2 Hannan Quinn Criterion (HQ). The second model (1950-2010) retrieves the same lag structure [2 AIC; 1 SCO; 2 HQ]. Subtracting one lag length for the application of the Johansen cointegration test, which is tested in first differences, we obtain the test results as reported in Table 9a if we assume a stochastic trend in the two periods, and the test results as reported in Table 9b if we assume a trend in the series as well as in the cointegration relation.

With regard to Table 9a, we can reject the hypothesis of no cointegration at the 5 percent significance level for revenues and expenditures in both periods: Trace and Maximum Eigenvalue tests indicate one cointegration vector at the same significance level for the rank of one. Table 9b shows the values for the Johansen test assuming a trend in the data series and allowing for an intercept and trend in the cointegration relation. We reject the hypothesis of no cointegration at the 5 percent significance level for revenues and expenditures in the first period. Trace and Maximum Eigenvalue tests differ with regard to their results for the second period: The Trace test statistic does not allow for rejecting the hypothesis of no cointegration in contrast to the Maximum Eigenvalue test. Cheung and Lai (1995) show that the Trace test is more robust than the Maximum Eigenvalue test with regard to skewness and excess kurtosis of residuals of the estimation. Based on this, we reject a cointegration in the second period (1950-2010) if we assume a trend in the cointegration relation. Nevertheless, we will report a test on the above mentioned sustainability vector of $[1, -1]$ to double-check Cheung and Lai (1995).

In line with the second step of our procedure as outlined above, we now estimate VECM models for the two sub-periods and both trend assumptions, respectively. Our main objective is to check whether the hypothesis that a one percentage point increase in revenues leads to a one percentage point increase in expenditures (and vice versa) can be rejected within the four systems: Econometrically, we analyse whether the cointegrating vector of rank 1 is $[1, -1]$. This vector is associated with fiscal sustainability of expenditures and revenues (Afonso 2005). Afonso (2005) assumes that sustainability

Table 9a Johansen test on expenditures and revenues for both sub-periods with intercept in cointegration

	Null Hypothesis	Eigenvalue	Trace Statistic	5 % critical value
1872-1913	None	0.469	26.370**	15.495
	At most 1	0.010	0.413	3.843
			Max Eigenvalue	
	0	0.469	25.956**	14.265
	1	0.010	0.414	3.843
1950-2010	None	0.273	21.343**	15.495
	At most 1	0.036	2.222	3.843
			Max Eigenvalue	
	0	0.273	19.121**	14.265
	1	0.036	2.222	3.842

Note: *** indicates that the null hypothesis of no cointegration can be rejected on the 5 percent level. The null hypothesis is the hypothesized number of cointegration relations, i.e. the rank of the matrix (r). The number of cointegration relations (No. of CIR) is smaller than 1, i.e., „None“, following Trace test's null hypothesis. If the statistic is higher than the critical value, the null hypothesis is rejected. Hence, the null of „None“ is rejected as shown above. The hypothesis of „At most 1“ cannot be rejected by the Trace test. The Eigenvalue test has a slightly different null hypothesis: Null is „No. of CIR = r“ which is zero „0“ which is rejected at the 5 percent significance level. The critical values for both tests are derived from the Trace and Maximum Eigenvalue of the stochastic matrix.

Table 9b Johansen test on expenditures and revenues for both sub-periods with intercept and trend in cointegration

	Null Hypothesis	Eigenvalue	Trace Statistic	5 % critical value
1872-1913	None	0.500	34.183**	25.872
	At most 1	0.130	5.7512	12.518
			Max Eigenvalue	
	0	0.500	28.432**	19.387
	1	0.130	5.751	12.518
1950-2010	None	0.278	22.985	25.872
	At most 1	0.056	3.345	12.518
			Max Eigenvalue	
	0	0.278	19.538**	19.387
	1	0.056	3.446	12.518

Note: *** indicates that the null hypothesis of no cointegration can be rejected at the 5 percent level. The null hypothesis is the hypothesized number of cointegration equations, i.e., the rank of the matrix. (See also: Note Table 9a)

in fiscal policy is given, if the time series of expenditures and revenues are cointegrated and if the hypothesis of a “normality vector” of [1, -1] holds. Vice versa, fiscal unsustainability is the case if a cointegration relation [1, -1] can be rejected. Due to this, the vector, and its corresponding Chi-Square test, is used in recent contributions to detect whether revenues and expenditures have followed a sustainable path (e.g., Kirchgässner/Prohl 2008).

1872-1913 Results

The 1872-1913 VAR suggests a lag length of zero for the VECM of the cointegrated time series. Assuming a deterministic trend in the dataset and allowing for a constant in the cointegration relation provides the following system:

Table 10 Test for sustainability vector [1, -1] without trend in cointegration relation between expenditures and revenues, 1872-1913

Chi-Square(1)	2.168
Probability	0.141
Revenues(-1)	1.000
Expenditures(-1)	-1.000
Constant	0.004

Note: The null hypothesis of the Chi-Square [1, -1] test is that a one percentage point increase in revenues leads to a one percentage point increase in expenditures.

The null hypothesis that the cointegrating vector is [1, -1] cannot be rejected by the Chi-Square on the underlying system (Table 10): The p-value of the Chi-Square statistic is higher than the five percent critical value (0.141). This is evidence that revenues and expenditures are cointegrated with a sustainability vector. Given the test result, fiscal policy has been sustainable over the period from 1872-1913, assuming a constant GDP growth rate of and allowing for a Wagnerian trend in the dataset of fiscal policy (see also Feld/Schaltegger 2010).

Table 11 Test for sustainability vector [1, -1] with trend in cointegration relation between expenditures and revenues, 1872-1913

Chi-Square(1)	4.546**
Probability	0.033
Revenues(-1)	1.000
Expenditures(-1)	-1.000
@TREND(71)	-0.0001 (0.0003)
	[-0.390]
Constant	0.007

Note: '**' indicates that the hypothesis of the Chi-Square test [1, -1] can be rejected on the 5 percent significance level.

We repeat the Chi-Square test, allowing for a trend in the cointegration relation (Table 11). The Johansen procedure allows for an identical variation, due to the Trace and Eigenvalue test results that conjointly indicate one cointegration equation, assuming a trend in the dataset as well as in the cointegration equation (Table 9b). As shown in Table 11, the hypothesis of a cointegrating vector of [1, -1] is rejected at least on the five percent significance level with a Chi-Square value of 4.546. Sustainability of fiscal policy could thus be doubted if we allow for a trend in the cointegration relation.

1950-2010 Results

Applying the same restrictions on the VECM for the second period reveals a different result compared to the fiscal policy in the German Empire before WWI.

Table 12 Test for sustainability vector [1, -1] without trend in cointegration relation between expenditures and revenues, 1950-2010

Chi-Square(1)	7.128***
Probability	0.008
Revenues(-1)	1.000
Expenditures(-1)	-1.000
Constant	0.019

Note: '***' indicates that the hypothesis of the Chi-Square test [1, -1] can be rejected on the 1 percent significance level.

The null hypothesis of a cointegrating vector of [1, -1] is rejected on the 1 percent significance level (Table 12). In contrast to the first period, the fiscal sustainability vector does not hold for the period between 1950 and 2010. A variation of the test with regard to a trend in the cointegration equation is supplemented (Table 13): Note that the trend is significant on the 10 percent level. However, the negative coefficient is very small, at 4 basis points.

We conclude that revenues and expenditures have not followed a sustainable path since 1950. If we allow for trends in the cointegration, neither period is associated with fiscal sustainability in revenues and expenditures. It therefore appears that unsustainability is robust even considering a GDP trend over the long run. If the series are $I(1)$, cointegrated and if a corresponding VECM does not reject the vector [1,-1], a trend in the cointegration equation should be minded – particularly for long time series. If the hypothesis of a normality vector is still rejected, one can assume that revenues and expenditures are unsustainable.

Table 13 Test for sustainability vector [1, -1] with trend in cointegration relation between expenditures and revenues, 1950-2010

Chi-Square(1)	4.566**
Probability	0.033
Revenues(-1)	1.000
Expenditures(-1)	-1.000
@TREND(71)	-0.0004 (0.0002) [1.868]
Constant	0.008

Note: '**' indicates that the hypothesis of the Chi-Square test can [1, -1] be rejected on the 5 percent significance level.

4.4 Multivariate analysis of budget deficits and debt ratios

The third step of our procedure is to estimate a VAR to further explore the determinants of gross and primary budget deficits that have been stationary in levels over each sub-period. This allows for a re-discussion of the existing empirical results on German fiscal

policy and general reaction patterns in fiscal policy with regard to the primary surplus. Bohn (1998, 2008) finds evidence for a positive conditional response of primary surpluses to increases in the debt ratio. A positive and significant reaction coefficient is commonly viewed as a condition for fiscal sustainability, following Bohn's Model-Based Sustainability (MBS) test. Even if the response is non-linear or time varying, a positive fiscal reaction to increasing public debt ratios by increasing the surplus is considered to be a necessary condition.

Mendoza and Ostry (2008) find such a reaction pattern for Germany and other countries during 1990-2005. Greiner and Kauermann (2008) find evidence for a positive reaction coefficient, however, "with a declining tendency" in a dataset from 1960 to 2003 (Greiner/Kauermann 2008: 1152). Fincke and Greiner (2009) repeat the analysis with a dataset from 1971 to 2006 that is later (2011) expanded to a period from 1950 to 2007. Their results reaffirm the positive reaction function on the one hand and the conclusion of public debt sustainability on the other hand (Fincke/Greiner 2011: 211). However they point out, that a rising debt ratio is not "compatible with sustainability in the long-run", admitting that German debt may "exceed a certain critical value beyond which sustainability is excluded" (*ibid.*). Due to these results, we ask whether there is such a positive and significant coefficient for the debt-to-GDP ratio in our data set. We are furthermore interested in the reaction of fiscal policy to changes in interest rates and inflation. Thus, we conduct this empirical analysis with two VARs, one for the primary surpluses, the other for gross surpluses.

At first, we retrieve the lag lengths for the two VARs. For the primary surpluses VAR we detect the following lags: AIC: 2 SC: 1 HQ: 1. These lengths coincide with the results for gross surpluses. Both VARs should thus be tested with one and two lags, which is also meaningful from the perspective of political economy: Fiscal path dependency on the one hand and the observation that democracies plan each fiscal year in advance on the other hand. Our objective is to analyse whether the lagged values have a significant effect on the two budget ratios. Annual yields and CPI inflation are included as controls. The results of the VARs with two lags are shown in Table 14 (and in Table A2.1 (one lag) in the Online Appendix).

With regard to Table 14, lagged debt ratios and the cost of debt (yields) are not significant for primary surpluses, while both, own lagged values and the lagged CPI, are significant at least at the five percent level. These results are supported by the gross surplus VAR. A constant is, however, only significant in the gross surplus VAR at the five percent level. Contrary to the findings mentioned above, both VARs do neither indicate a positive nor a significant coefficient for total debt. The gross surplus VAR has normally distributed residuals: We cannot reject the hypothesis of normality with a Jarque-Bera test value of 8.34. The residuals of the primary surplus VAR are however not normally distributed: With a Jarque-Bera of 65.10 we can reject the hypothesis that the residuals are multivariate normal. Therefore, the following analysis focuses on the gross surplus VAR only.

The next step is to continue the analysis with a VAR Granger causality and block exogeneity Wald Tests, which investigate and examine the causal relation of the variables in the model. This is important because the test results inform about the direction of causality among the variables, which can be unidirectional, bi-directional or neutral. The results are reported in Table 15. The Chi-Square statistic of 13.866 for debt with reference to gross surplus tests the hypothesis that lagged coefficients of debt in the regression equation of gross surplus are equal to zero. In accordance, the lagged coefficients of yields and CPI as well as the block of all coefficients are equal to zero. This is empirical

Table 14 Results from VAR estimates of budget surpluses, 1950-2010

Variables	Primary Surplus in % of GDP	Variables	Gross Surplus in % of GDP
Primary Surplus Ratio t – 1	0.478 (0.155) [3.11]	Surplus Ratio t – 1	0.384 (0.161) [2.39]
Primary Surplus Ratio t – 2	-0.506 (0.140) [-3.60]	Surplus Ratio t – 2	-0.280 (0.118) [-2.38]
Yield t – 1	-0.001 (0.199) [-0.003]	Yield t – 1	-0.242 (0.169) [-1.43]
Yield t – 2	-0.042 (0.210) [-0.20]	Yield t – 2	-0.146 (0.190) [-0.77]
Debt Ratio t – 1	-0.031 (0.106) [-0.29]	Debt Ratio t – 1	-0.073 (0.093) [-0.78]
Debt Ratio t – 2	0.049 (0.111) [0.44]	Debt Ratio t – 2	0.030 (0.092) [0.322]
CPI t – 1	-0.331 (0.122) [-2.70]	CPI t – 1	-0.205 (0.101) [-2.04]
CPI t – 2	-0.174 (0.094) [-1.85]	CPI t – 2	-0.116 (0.078) [-1.45]
Constant	0.005 (0.011) [0.382]	Constant	0.032 (0.01) [2.83]
R-squared	0.548	R-squared	0.631
Adj. R-squared	0.476	Adj. R-squared	0.572
Sum sq. resids	0.007	Sum sq. resids	0.005
S. E. equation	0.012	S. E. equation	0.010
F-statistic	7.586	F-statistic	10.697
Log likelihood	182.852	Log likelihood	192.199
AIC	-5.894	AIC	-6.210
SC	-5.577	SC	-5.893
Mean dependent	-0.0004	Mean dependent	-0.019
S. D. dependent	0.016	S. D. dependent	0.015

Note: The numbers in parentheses indicate the standard error. The numbers in square brackets are absolute values of the estimated t-statistics.

evidence that gross surplus is influenced by yields, debt and CPI and by all three variables together. Debt, yields and CPI are Granger causal at least at the 5 percent significance levels. They are conjointly Granger causal for surplus at the 1 percent significance level. block exogeneity is, however, accepted when yields and debt are taken as dependent variables. Debt and yield are therefore not jointly influenced by the other variables. The hypothesis of block exogeneity is rejected for CPI. Surplus and yields are not Granger causal. Yields and surplus are unidirectional. Yields are Granger causal for surplus, but

Table 15 VAR Granger causality and block exogeneity Wald Test results for budget surpluses and yields, 1950-2010

Dependent variable: Gross Surplus				Dependent variable: Yield			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
Yield	5.993799	2	0.0499	Gross Surplus	2.029176	2	0.3626
Debt Ratio	13.86591	2	0.0010	Debt Ratio	4.356628	2	0.1132
CPI	6.442257	2	0.0399	CPI	0.130706	2	0.9367
All	28.11551	6	0.0001	All	9.051684	6	0.1707
Dependent variable: Debt Ratio				Dependent variable: CPI			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
Gross Surplus	3.856132	2	0.1454	Gross Surplus	0.356698	2	0.8367
Yield	1.150911	2	0.5624	Yield	15.61314	2	0.0004
CPI	6.018748	2	0.0493	Debt Ratio	0.338673	2	0.8442
All	10.96006	6	0.0896	All	18.73896	6	0.0046

not vice versa. This is exactly the same with debt and CPI. Debt and CPI are Granger causal for surplus, but not vice versa.

The most common way to analyse VAR models is the use of impulse response functions. An impulse response analysis examines the effect of current and past shocks on the time series. We consider shocks to each residual in the system and the effects on all variables of the VAR. The impulse responses are shown in Figure 5 as solid lines. The dotted lines define confidence intervals of two standard deviations. If these confidence intervals include zero, it can be concluded that the impulse response is not significantly different from zero.

The first column of the graph shows the effect of a one standard deviation shock to the gross surplus residuals. The first of these four graphs illustrates the effect of the shock of gross surplus on itself. It rapidly disappears with a sustaining positive effect at the first lag and a small negative impact on its second lagged value as shown above in the VAR. The second, third and fourth graph of this first column show the effects of the shock on yields, debt ratios and CPI, respectively. The only evidence is that an unforeseen standard deviation increase in primary surpluses decreases CPI. With regard to the confidence intervals, CPI (yields) include zero, i. e., the impulse response is not significantly different from zero. Taking into account the complexity of determinants of CPI (and yields) this is not surprising. The confidence intervals of gross surplus and public debt do not include zero until the second and fourth year respectively. Though Granger causing surplus, debt is neither positive nor significant which is why we cast doubt on the empirical findings of the above mentioned papers. Again, primary surplus did not even pass the normality test, which is why we discarded a further analysis.

4.5 Vector error correction model for government debt ratios

The fourth step is to identify a simultaneous equilibrium in the dataset with respect to government debt. Since we have not discussed debt ratios so far, we estimate a VECM to further explore the relation between yields and debt. The unit root and stationarity tests

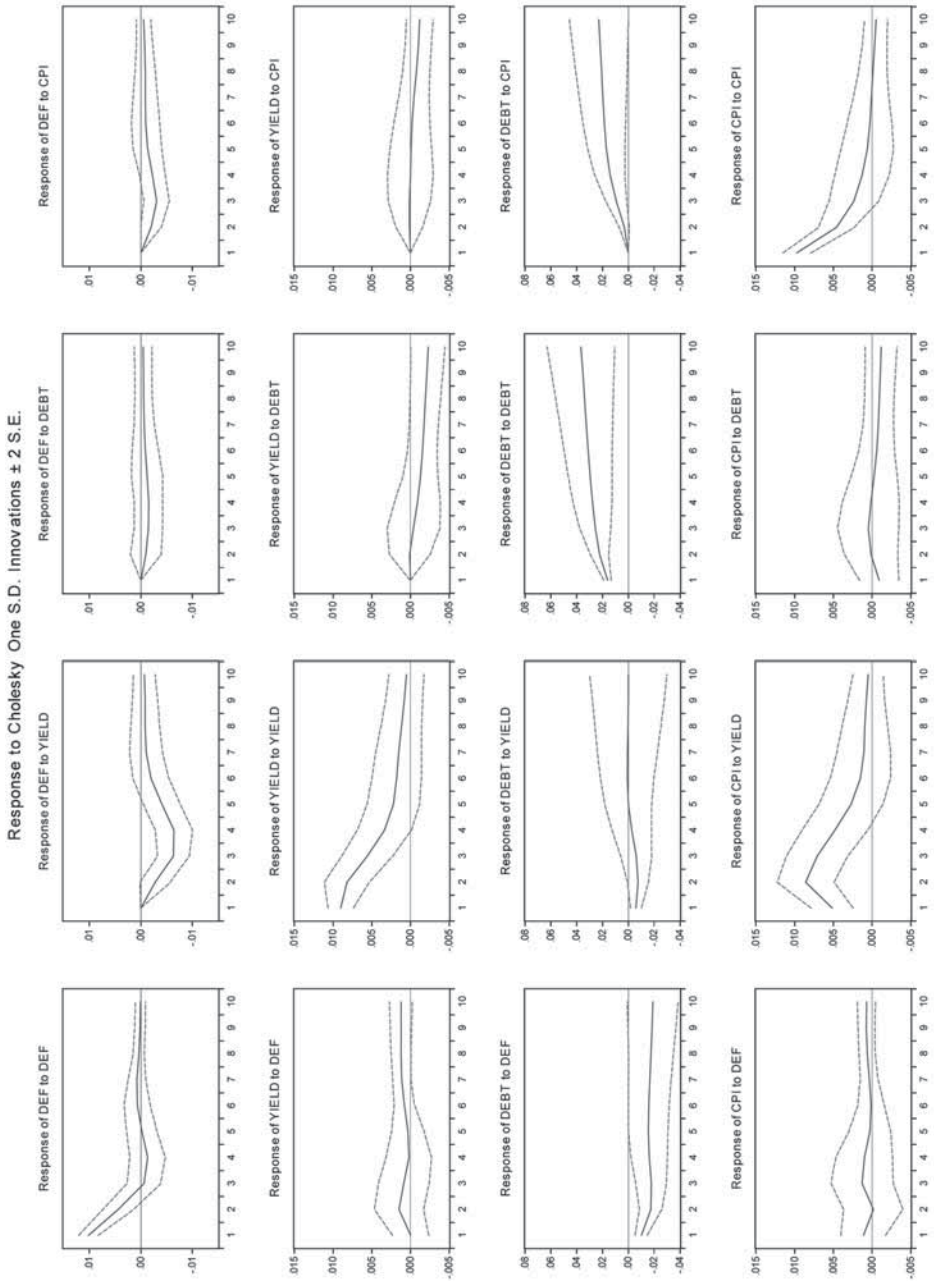


Figure 6 Impulse response tests for the gross surplus VAR, 1950-2010

Table 16 Johansen test on yields and debt

	Null Hypothesis	Eigenvalue	Trace Statistic	5 % critical value
1950-2010	None	0.362	39.710**	29.797
	At most 1	0.196	13.235	15.495
			Max Eigenvalue	
	None	0.362	26.476**	21.132
	1	0.196	12.893	14.265

Note: *** indicates that the null hypothesis of no cointegration can be rejected at the 5 percent level. See also: Notes of Table 9a.

have shown that debt is I(1). A VAR is tested to retrieve the lag length for the procedure on CPI, yields and the debt ratio and throughout the procedure. The cointegration test indicates one cointegration equation at the five percent level as reported in Table 16.

Allowing for a deterministic linear trend in the dataset, and a constant in the cointegration equation, the VECM results are shown in the eq. (2) to (4) below. The resulting residuals are tested for normality: The null hypothesis of normal distribution of the residuals cannot be rejected (the Jarque-Bera test statistic is 9.067). According to the KPSS test, the cointegration vector is stationary (0.112 in levels with a constant and 0.100 with trend). The following system provides robust evidence on the long and short run relation between the debt-to-GDP ratio, government bond yields and the CPI. While the long run relation is significant for yields and the debt-to-GDP ratio, it is not for the CPI. Looking at the debt equation (3), all three lagged coefficients are significant in the short run. Block exogeneity can be rejected for the debt equation at a significance level of 1 percent. CPI Granger causes debt but not vice versa. Similarly, yields Granger cause debt at a 1 percent significance level but not vice versa. This is evidence for a unidirectional relation. Block exogeneity cannot be rejected for equations (2) and (4). Yields and CPI are not jointly influenced by the other variables.

$$D(\text{YIELD}) = -0.445 * (\text{YIELD}(-1)) + 0.004 * \text{DEBRATIO}(-1) - 0.001 * \text{CPI2005}(-1) - 0.080 \quad (2)$$

[-3.040] [5.479] [-4.172]

$$+ 0.260 * D(\text{YIELD}(-1)) + 9.966e-05 * D(\text{DEBRATIO}(-1)) - 0.001 * D(\text{CPI2005}(-1)) + 0.002$$

[1.706] [0.161] [-1.118] [0.727]

$$D(\text{DEBRATIO}) = -83.946 * (\text{YIELD}(-1)) + 0.004 * \text{DEBRATIO}(-1) - 0.001 * \text{CPI2005}(-1) - 0.080 \quad (3)$$

[-2.582] [5.479] [-4.172]

$$+ 56.140 * D(\text{YIELD}(-1)) + 0.641 * D(\text{DEBRATIO}(-1)) + 0.905 * D(\text{CPI2005}(-1)) - 0.763$$

[4.663] [4.662] [3.237] [-1.583]

$$D(\text{CPI2005}) = 7.452 (\text{YIELD}(-1)) + 0.004 * \text{DEBRATIO}(-1) - 0.001 * \text{CPI2005}(-1) - 0.080 \quad (4)$$

[0.754] [5.479] [-4.172]

$$+ 23.790 * D(\text{YIELD}(-1)) + 0.034 * D(\text{DEBRATIO}(-1)) + 0.745 * D(\text{CPI2005}(-1)) + 0.335$$

[2.323] [0.811] [8.758] [2.283]

Due to the insignificance of the cointegration equation for CPI at the five percent level for the error correction model, we test whether it has a weak exogenous influence on the system by restricting the coefficient of the cointegration equation of CPI to be zero. The Chi-Square test does not allow for rejecting the hypothesis that the cointegration coefficient is zero at a p-value of 0.513. The residuals of this model are, too, normally distributed with a Jarque-Bera value of 9.686. The cointegration vector is, again, sta-

tionary (0.059 in levels with a constant and 0.058 with a constant and trend). We therefore have empirical evidence to conclude that yields have a negative influence, whereas CPI has a positive influence on debt.

A concluding remark of the test series of the unique data set in this section is straightforward: We have found econometric evidence, that Germany's fiscal policy has not been sustainable since 1950 (section 4.2). Sustainability of fiscal policy can only be assumed for the German Empire before 1913, but only if we do not allow for trends in the cointegration relation. In addition, we could not find any empirical evidence for a positive reaction of debt to primary surpluses (section 4.3). Instead, we report evidence that contradicts Fincke and Greiner (2011). The VECM (section 4.4) showed a simultaneous equilibrium. Granger causality and Block exogeneity tests showed that debt is influenced by yields and CPI, but not vice versa.

5 Conclusion

Public debt in Germany has continuously attracted attention. After the experience of the two World Wars, the German population is quickly alarmed when debt levels appear to be rising to unsustainable levels. This holds particularly for recent years, as Germany's debt-to-GDP ratio has never been higher in peacetime than today.

In this paper, we analyse sustainability of German public finances from 1872 to 2010. Given the breaks in the data series, in particular those induced by the two World Wars, the main analysis is conducted for the sub-periods 1872-1913 and 1950-2010. In addition to anecdotal historical evidence on the basis of studies published in the JNS, we conduct more formal tests on fiscal sustainability. While we cannot reject the hypothesis that fiscal policy was sustainable in the period before the First World War, this only holds if we do not allow for trends in the cointegration relation. The hypothesis of fiscal sustainability for the years 1950 to 2010, on the other hand, must be rejected. After the Second World War, German public finances have become unsustainable.

This evidence leads to the conclusion that public finances in Germany are in dire need of consolidation. In fact, the introduction of the debt brake in the year 2009 is a much needed reaction to this development. Although such fiscal rules always have their loopholes and are necessarily incomplete, they usually have some success in restricting public deficits and debt (Feld/Kirchgässner 2008; Feld/Baskaran 2010). The incompleteness of the German debt brake will have to be addressed in the coming years in order to ensure that fiscal consolidation actually takes place. One shortcoming of the new debt rule requires a wider ranging reform, however: The Länder (including their local jurisdictions) not only have huge consolidation requirements, they also do not have the tax autonomy to balance the spending demands on their budgets. The next major reform of the German fiscal constitution should thus allow for more tax autonomy at the sub-federal level.

Appendix

A1 Data

Variable	Name	Description	Source
CPI	cpi1913	consumer price index (1913/14=100).	1877-1944: Deutsche Bundesbank (1976)
	cpi2005	consumer price index (2005=100).	1949-2010: Deutsche Bundesbank (2012)
General government debt	debtgen	total public debt in million Mark/Euro. Including Reich/Bundesrepublik, states/Bundesländer, municipalities (where available), most public funds.	1850-1949: Own calculations (federal debt + regional debt + municipal debt) 1950-2010: Statistisches Bundesamt (2011a)
	Federal debt	debtfc debt of the Reich/Bundesrepublik in million Mark/Euro. Fiscal year until 1945: 31 st March, afterwards 31 st December. 1914-1944 including Mefo bills. 1949 including equalisation claims (Ausgleichsforderungen).	1850-1913: Hoffmann (1965) 1914-1944: Deutsche Bundesbank (1976) 1949: Bank deutscher Länder (1950) 1950-2010: Statistisches Bundesamt (2011a)
Regional debt	debtl	Debt of the states/Bundesländer in million Mark/Euro. Fiscal year until 1945: 31 st March, afterwards 31 st December.	1850-1913: Hoffmann (1965) 1914-1944: Deutsche Bundesbank (1976) 1950-2010: Statistisches Bundesamt (2011a)
Municipal debt	debtm	Municipal debt in million Mark/Euro. Fiscal year until 1945: 31 st March, afterwards 31 st December. 1850-1913 including debt with Sparkassen and other local authority obligations.	1850-1913: Hoffmann (1965) 1914: Schremmer (1994) 1928-1940: Deutsche Bundesbank (1976) 1950-2010: Statistisches Bundesamt (2011a)
Debt service	dservice	Interest service on total public debt in million Mark/Euro. 1880-1913 for Reich and Prussia, Württemberg, Baden, Bavaria, Saxony and Hamburg.	1880-1913: Accominotti et al. (2011) 1950-2010: inquired at Statistisches Bundesamt
Fiscal deficit	deficit	Public deficit in million Mark/Euro	1871-1913: own calculation: $debtgen(t) - debtgen(t-1)$ 1950-2010: inquired at Statistisches Bundesamt
Public expenditures	exp	General ordinary and extraordinary expenditures (in million Mark/Euro). 1871-1879, 1919-1925, 1933-1944 without states. 1920-1923 only current expenditures of the Reich.	1871-1879, 1924: Mitchell (2007) 1880-1913: Accominotti et al. (2011) 1914-1919: Roesler (1967) 1920-1923: Haller (1976) 1925-1932: Ritschl (2002) 1933-1944: Länderrat des Amerikanischen Besatzungsgebiets (1949) 1950: Statistisches Bundesamt (2011b) 1951-2010: Statistisches Bundesamt (2011c)

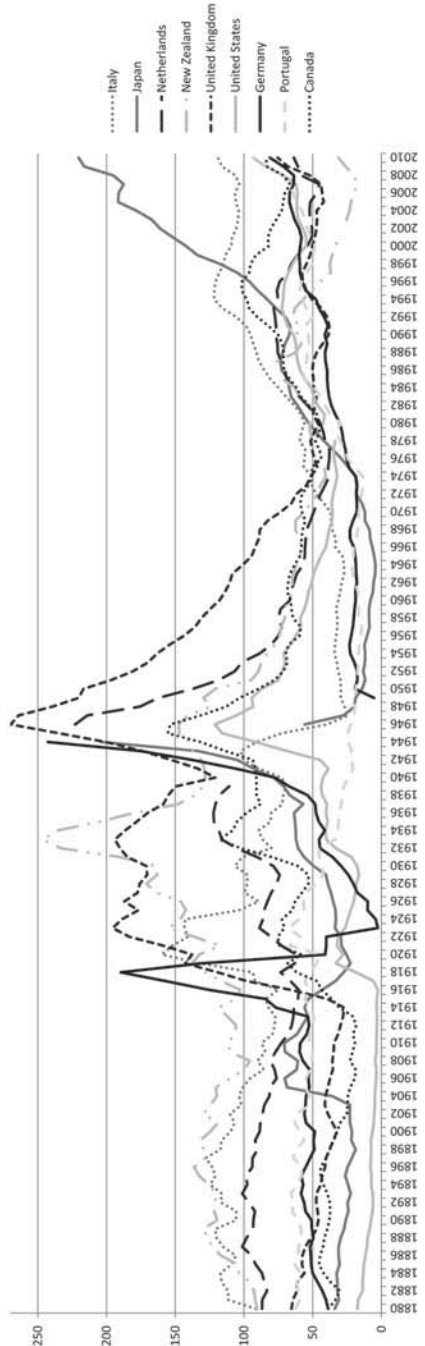
Variable	Name	Description	Source
Nominal GDP	nomgdp	in local currency, current prices.	1851-1913: Burhop and Wolff (2005), kindly made available by Schularick.
		Nominal GDP in local currency, current prices. 1914-1924: Real GDP 1924-1939: Schularick and Taylor (2012) (in 1913 prices) estimated by Ritschl and Spoerer (1997), GDP deflator as measured by CPI1913.	1914-1924: Own calculations 1924-1939: Schularick and Taylor (2012) 1940-1944, 1946-1950: Ritschl and Spoerer (1997) 1950-2010: Statistisches Bundesamt (2012)
Public revenues	rev	General ordinary and extraordinary revenue (in million Mark/Euro). 1871-1879, 1919-1925, 1933-1949 without states; 1920-1923 only current expenditures.	1871-1879, 1946-1949: Mitchell (2007) 1880-1913: Accominotti et al. (2011) 1914-1919: Roesler (1967) 1920-1923: Haller (1976) 1925-1932: Ritschl (2002) 1933-1944: Länderrat des Amerikanischen Besatzungsgebiets (1949) 1950: Statistisches Bundesamt (2011b) 1951-2010: Statistisches Bundesamt (2011c)
			1950-2010: deficit – dservice
Primary deficit	pdeficit	Primary deficit, i.e. budget deficit or surplus after deducting interest payments (in million Mark/Euro). constant prices of 1990, Int. GK\$	1950-2010: deficit – dservice
Real GDP	rgdp		1850-2008: Maddison (2010) 2009-2010: Schularick and Taylor (2012)
Bond yields	yield	Long term government bond yields, 5 year or 10 year maturity. 1850-1869: computed as average of two Prussian and one Bavarian bond yields	1850-1869: Homer (1963/77) 1870-2008: Schularick and Taylor (2012) 2009-2010: IMF International Financial Statistics

A2 Comparison of estimated debt ratios (% of GDP), 1914-1924

	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
Our estimates*	80.50	88.70	105.68	124.81	132.78	110.84	58.30	57.39	91.35	2.86	4.39
Holtfrerich (1996)	–	–	–	–	180	127	–	–	–	–	–
Schularick**	47.92	61.82	98.11	128.94	160.4	133.13	43.41	42.44	10.31	–	–

*Our estimates include the Bundesländer until 1919. **Data kindly made available by Schularick, referring to Niall Ferguson.

A3 Public debt as percentage of GDP in nine OECD countries, 1880-2010



Sources: For Germany refer to Figure 1, for the rest refer to Abbas et al. (2010).

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Dipl.-Vw. Heiko T. Burret, Walter Eucken Institut e.V., Goethestrasse 10, 79100 Freiburg, Germany.
burret@eucken.de

Prof. Dr. Lars P. Feld, Walter Eucken Institut e.V. and Albert-Ludwigs-University Freiburg, Goethestrasse 10, 79100 Freiburg, Germany.
feld@eucken.de

Dipl.-Vw. Ekkehard A. Köhler, Walter Eucken Institut e.V., Goethestrasse 10, 79100 Freiburg, Germany.
koehler@eucken.de