Foreign Debt and Secondary Markets: Lessons from Interwar Germany*

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February 20, 2014
Preliminary and incomplete

Abstract

Recent advances in sovereign risk theory suggest that secondary markets can act as an enforcement mechanism for foreign debt and help advert defaults. We show this mechanism in action by revisiting a little-explored aspect of German economic history in the Interwar period: the large repurchases of foreign debt carried out by German citizens and companies between 1931 and 1939. In support of our theoretical framework and interpretation, we carry out an econometric analysis based on a unique dataset of weekly prices of German bonds traded in New York between 1930 and 1940. By identifying structural breaks in these series, we show that German and foreign investors faced different probabilities of repayment, which were decisively influenced by the possibility of trading on secondary markets. We also conclude that, far from encouraging the buyback activity, the German authorities kept it under strict control in order to enjoy some of its benefits, while avoiding detrimental macro effects for the German economy and their policy objectives.

JEL: E65 F340 F510 G12 G150 H630 N240 N440
Keywords: Germany, Debt Crisis, Foreign Debt, Sovereign Risk, Government Bonds, Financial Repression , Structural Breaks

*Acknowledgments: - We thank Albrecht Ritschl for his support throughout the writing of this paper. We are also grateful to Fernando Broner, Alberto Martin, Jaume Ventura, Thilo Albers, Youssef Cassis, Rui Esteves, Joshua Hausman, Kim Oosterlinck and the participants to the 2013 EHES Conference in London, the 2013 EHA Annual Meeting in Washington DC and the 2013 FRESH Meeting in Florence for their insightful comments. We also thank Ben White and Lorna Williams at the Bank of England Archive and the staff of the LSE Library for their patience and help. Any mistakes remain ours.

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[. . .] the Schachtian policy of buying back un-serviced loans below par contributed to crushing Germany's moral standing with the creditors.

Hermann Josef Abs, 1953[1]

He [Hermann Josef Abs] bought back some of the external German debt (Kreuger loan) and made a large arbitrage profit (the difference between the very low price of German debt abroad, and its face value price within Germany) on the deal on his own account.

Harold James, 2004[2]

1 Introduction

The European debt crisis has rekindled interest in issues relating to sovereign debt. By exposing the fact that advanced countries are not immune to runs on their debts - a lesson taught by history, but forgotten by many (Reinhart and Rogoff, 2013) - the crisis has led economists to develop new theoretical frameworks and revisit established models.[3] One strand of this literature has emerged from the work of Broner, Martin, and Ventura (2008, 2010), which has led to a number of recent empirical and theoretical contributions investigating the role of secondary markets for debt.[4] Our paper contributes to this literature. To our knowledge, this is the first detailed case-study documenting the importance of secondary markets in influencing the default probability and other macroeconomic outcomes in a heavily indebted country.[5] In order to do this, we look at one of the best known debt crises in

[1] Klug (1993) page 54, from Schwarz (1982) page 60. Herman Josef Abs was the German negotiator at the 1953 London Agreement on German Debt.

[2] James (2004) page 59. During the 1930s, when these transactions took place, Abs was a director at Deutsche Bank

[3] See Panizza, Sturzenegger, and Zettelmeyer (2009), Aguiar and Amador (2013) and Tomz and Wright (2013) for excellent pre and post crisis reviews of the literature on sovereign debt.

[4] See Broner, Erce, Martin, and Ventura (Forthcoming) and therein contained references for excellent examples of this literature

[5] Brutti and Sauré (2013) have recently provided evidence for one of the testable predictions of the Broner, Martin and Ventura framework, namely that when a crisis raises the temptation to default (in this case the

history: the German debt crisis of the 1930s. In particular, we concentrate on secondary markets for German debt both within Germany and in the most important financial center at the time - New York - revisiting the relatively obscure debt repurchases carried out by Germans during the decade. We, therefore, also contribute to the literature on this particular historical episode. Our approach consists in building a theoretical model expanding on the framework of Broner, Martin and Ventura along political economy and informational asymmetries dimensions, and supporting it with empirical evidence which exploits a unique weekly dataset of German bond prices traded on the New York Stock Exchange.

The Secondary Market Hypothesis, as it has been dubbed, relies on the idea that changes in debt ownership can play a fundamental role. Broner, Martin and Ventura argue that, whenever a sovereign crisis ensues and a country's debts are traded on well-functioning secondary markets, citizens of the debtor country have an incentive to repurchase them, while foreign creditors have an incentive to sell them. The reason is that the debtor government's incentive to default or repudiate the country's obligations disappears - or weakens substantially - when the debt is owned by domestic citizens, which translates into a high probability of full repayment for domestic creditors.

The government's incentive to default changes with debt ownership because, when the debt is held internally, a default only implies a redistribution of income, whereas when the debt is owned by foreigners, instead, not enforcing payments leads to a net welfare gain in terms of foregone transfers abroad. In fact, the conventional wisdom has been for some time that when a country's sovereign debt is held by its own citizens, the perceived risk of default is generally low. That of Japan has often been cited as an example of a large public debt made sustainable by the fact that it is mostly owned by the countries' citizens (Horioka, Nomoto, and Terada-Hagiwara, 2013). As a result of the mechanism described, domestic and foreign investors value the debt differently and well-functioning secondary markets allow asset trade, thus lowering the probability of default. The possibility of carrying out debt buybacks is beneficial ex-ante because it allows for the existence of borrowing and lending between countries. However, it is inefficient ex-post for the debtor country, since it implies

recent Financial Crisis), a country's debt securities tend to be repatriated beyond what would be expected based on optimal portfolio allocation considerations. Our approach, allows us to investigate a wider set of testable predictions, although, of course, not in a cross-sectional setting like theirs.

forfeiting the possibility of imposing a loss on foreign creditors and increasing overall welfare. For this reason, debtor governments might try and interfere with the functioning of secondary markets and make buybacks difficult. Even in case of a default actually materializing, the presence of secondary markets can increase international borrowing ex ante by reducing restructuring costs ex post. This happens because trading on secondary markets reveals the reservation value of creditors to the defaulting government (Bai and Zhang, 2011).

As Germany's debt crisis became acute in the early 1930s - due to both political instability and economic woes - a differential opened up between the price of German bonds (both public and private) traded in Germany and in financial centers abroad (Figure 1). The spread indicates that the value of the German debt was different depending on the domicile of the creditor. The price differential, in turn, fueled the practice of debt repurchases, often by individuals and entities different from the original issuer (Klug, 1993). The debt purchased abroad at a discount could then be sold at home for a much higher price. In other words, there was room for large, risk-less arbitrage profits.

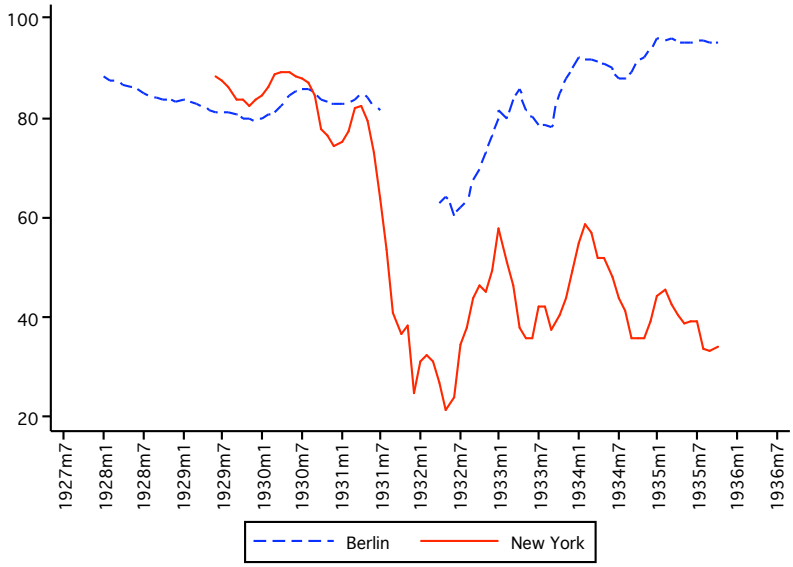


Figure 1: The index price of German bonds in Berlin and New York.[6]

[6]Source: IFK, Jahrstatistiches Handbuch 1933 & 1936. In 1931, the Berlin stock exchange was only open between the 1st of January and the 12th of July and from the 3rd to the 18th of August. The trading started again in April 1932. In March 1935, the interest rate of the 6% bonds traded in Berlin was reduced to 4.5%.

However, as foreseen in Broner, Martin and Ventura's framework, the practice of repurchasing foreign debt was soon put under strict control by the German authorities. Between July and August 1931, Germany's central bank - the Reichsbank - introduced exchange controls with the intention of curbing all forms of capital flight (Bonnel, 1940; Child, 1958; James, 1985), including debt repurchases. This meant that the authorities made foreign exchange available to private individuals and companies in limited amounts and for purposes approved by the authorities themselves. The Reichsbank did allocate some foreign exchange for the repurchase of German foreign debt abroad in the form of bonds and blocked accounts and some authors interpreted this as an encouragement by the authorities to engage in the practice. As highlighted by Child (1958), however, given the large price differentials of German bonds and the potential arbitrage profits to be made, this encouragement was hardly necessary. The rationing of foreign exchange and the strict control of its use by the German authorities were, instead, stumbling blocks for the activity which, in turn, led to the persistence of the price differential.

At the same time, there is substantial evidence that the German authorities used debt buybacks as a policy tool. Eventually the repurchases amounted to around 4 billion Reichsmarks, making the episode one of the largest documented in history. Contemporaries discussed these events widely, but were unable to fully grasp their size.[7] More recently, they have been revisited in the broader context of German foreign economic policy in the 1930s, most notably by James (1985). Klug (1993) is the only author to have dedicated a detailed economic analysis to the episode. He interpreted it as a mixed policy of debt overhang reduction and export promotion. While the latter interpretation has a long history dating back to contemporary commentators, the former was previously only briefly discussed by James. This view of the episode rests on the interpretation of buybacks as a coordinated action by a country aimed at reducing its debt burden, which gained popularity among economists during the Latin American debt crisis of the 1980s.[8] Klug compellingly argued that the subsidization of exports was not likely to be a strong enough motif for the involvement of the German authorities in such an extensive buyback practice. However, if any reduction

[7]See for example Balogh (1938); Bonnel (1940); Ellis (1941); Einzig (1934); Harris (1935); Heuser (1934)

[8]Some examples of this literature are: Bulow and Rogoff (1988, 1991); Froot (1989); Kenen (1991); Krugman (1988, 1989); Sachs (1988a,b)

in the market value of German debt was achieved, it was minimal, as Klug himself shows. This is because, as highlighted by Bulow and Rogoff (1988) in a seminal paper, debt repurchases raise the market value of residual debt, thus offsetting the decrease in its face value. We present some preliminary, mostly qualitative, evidence that the German authorities exploited the possibility of repurchasing debt securities at a discount abroad to accrue benefits to specific individuals and organizations. This interpretation is fully compatible with the Broner, Martin and Ventura framework. While unrestrained debt repurchases would have been detrimental to Germany, tightly controlled ones could benefit influential supporters of the political party in charge.

Providing empirical evidence for our interpretation of the episode is not trivial. The motivations that pushed German citizens to repurchase the debt cannot be observed. The same is true for the incentives of foreign investors and German authorities. Although a wealth of historical documents exists, these need to be treated with great care: secrecy, lack of cooperation and double-dealing were defining characteristics of international relations during the interwar period. The internal political situation in Germany was no better, especially after the rise to power of the Nazis. For these reasons, we carry out an econometric analysis based on the prices of German debt traded on the New York Stock Exchange. These data are informative, available at relatively high frequency (weekly) and likely to be free from direct manipulation. Our approach is to compute point estimates for structural breaks in the price series and constructing asymmetric confidence intervals around them. We then associate these breaks to significant political or economic events. Our results show that the estimated breaks are associated to economic events that restricted the access of German citizens to secondary markets, adverserly affecting bond prices, and on the same footing as momentous events such as the beginning of World War II. The analysis of the price of German government bonds thus supports our theoretical framework and historical reconstruction.

To sum up, the framework presented in this paper is able to explain why the buybacks started in Germany in 1931 as a private initiative as well as the behavior of the German government who was only apparently promoting them, but *de facto* restricting them in order to pursue its policy objectives. Moreover, it explains the reason for the appearance and persistence of the price differential between German bonds traded at home and abroad.

We therefore contribute to both the literature on this specific episode and to the growing literature highlighting the importance of secondary markets and debt ownership for sovereign risk.

The rest of the paper is organized as follows. Part 2 provides some brief historical context. Part 3 introduces the theoretical model through which we interpret the buyback episode and Part 4 presents the data, our econometric strategy and the results of the analysis. Part 5 summarizes our arguments by connecting theory and evidence. Part 6 concludes.

2 Historical Context

2.1 The debt stockpile: reparations and borrowing in the 1920s

In the aftermath of World War I, the winning powers imposed a heavy reparation payments burden on defeated Germany. However, the exact amount was not established by the Treaty of Versailles and even after the protocol prepared by the Inter-Allied Reparations Commission (the London Schedule of Payments) was signed in 1921 - this document formally established Germany's obligations for the first time - uncertainty remained as to how much Germany would eventually really have to pay. Schuker (1988) recounts how reparation payments were divided into three tranches: A, B and C. While it was fairly clear that the first two tranches - amounting to 50 Million gold Marks - would constitute part of the final reparation burden, the C tranche - amounting to around 82 millions gold Marks. was never effectively billed to Germany, but still hovered around for most of the interwar period. Germany's external debt was further increased by the heavy borrowing of all sectors of the economy on international capital markets throughout the 1920s.

Data collected from archival sources gives us a snapshot of the nature and composition of German foreign commercial debts at the end of November 1931 (Table 1 and 2). The USA was Germany's principal creditor, with holdings of over 40% of the total foreign commercial debt.[9]

[9]Although America's lending to Germany has been often highlighted as exceptional and at least partially politically motivated - Schucker called it "American reparations to Germany" - the USA was porbably the principal lender of the 1920s for a good number of countries. Accominotti and Eichengreen (2013) have recently shown that around 66% of all European bond issues between 1924 and 1928 took place in New

Creditor country	Debt share
USA	41.72%
Netherlands	16.96%
Switzerland	12.96%
England	12.94%
France	4.79%
Bank for International Settlements	3.49%
Italy	0.69%

(a) by creditor country

Debtor sector	Debt share
Industry	61.68%
Public bodies	16.38%
Banks	15.35%
Reichsbank and Goldiskontbank	3.67%
Private citizens	2.41%
Insurance companies	0.40%
School, churches etc.	0.11%

(b) by debtor sector

Table 1: Total German foreign commercial debt, November 1931[10]

England, The Netherlands, Switzerland, France and the Bank for International Settlements also had significant holdings. Germany's industry was the principal debtor in the country, accounting for almost 62% of total foreign debts. The Public Sector and the Banks accounted for around 16% and 15% respectively. A large share - around 46% - of German foreign commercial debt was short term (with a maturity of less than a year) with the rest divided between medium term - around 4% - and long term - around 50%. The geographical distribution of this short-term debt was quite different from the long term one, with the USA playing a less important role and the debt more evenly distributed across the other principal creditors. The industrial sector played a slightly smaller role in short-term borrowing while the banks' share was higher than that of overall debt.

German commercial foreign debt was issued in a variety of currencies, but the US Dollar was the principal currency of denomination (Table 3). Around 50% of the debt was issued in the US currency, 12% in British Pounds, 11% in Reichsmarks, 10% in Swiss Francs and 9% in Dutch Florins. Ritschl (2012) argues that the Dawes Plan signed in 1924 was one of the triggers for Germany's heavy borrowing during the course of the decade. The plan was intended to provide relief to a country that was slowly coming out of an economic and political crisis epitomized by the hyperinflation. This international agreement featured the issue of bonds with maturity in 1949, the proceeds of which went to Germany in order to help it keep

York. This dominant position was then reversed after the 1929 crash with Paris taking over as the principal financial center for new bond issues.

[10]Source: Bank of England Archive OV34/69 - Die Auslandsverschuldung Deutschlands nach dem Stande von 30. November 1931.

Creditor country	Debt share
USA	27.02%
Netherlands	17.26%
Switzerland	16.30%
England	14.04%
Bank for International Settlements	7.52%
France	5.41%
Italy	0.76%
Other countries	11.69%

(a) by creditor country

Debtor sector	Debt share
Industry	53.00%
Public bodies	25.97%
Banks	8.34%
Reichsbank and Goldiskontbank	7.52%
Private citizens	4.58%
Insurance companies	0.47%
School, churches etc.	0.12%

(b) by debtor sector

Table 2: German foreign short-term commercial debt, November 1931 [11]

Currency	Debt share
US Dollar	50.0%
Pound Sterling	11.8%
Reichsmark	10.7%
Swiss Franc	9.7%
Dutch Florint	9.2%
French Franc	3.6%
Other currencies	4.9%

Table 3: German foreign commercial debt by currency of issue, November 1931 [11]

monetary stability and meet reparation payments (Piet, 2004). More importantly, the Dawes Plan made reparation payments *de facto* junior with respect to commercial debts. According to Ritschl, this created a moral hazard issue, which incentivised international markets to lend to German companies and public bodies, confident that their claims would be senior to reparations. At the same time, the moral hazard applied to the German counterparts, who found it very convenient to borrow abroad. Ritschl further argues that this regime was eventually reversed by the Young Plan, drafted and adopted between 1929 and 1930, which re-established the seniority of reparations with respect to commercial debts. This regime switch contributed to plunging Germany in economic chaos by causing a sudden stop as commercial creditors saw their claims endangered. By that time, foreign commercial debts had reached the astronomical level of 32.6 billion Reichsmarks (Table 4). With the inclusion of reparations, Germany's foreign debt amounted to 67.6 billion Reichsmarks, or 81.5% of

[11] Source: Bank of England Archive OV34/69 - Die Auslandsverschuldung Deutschlands nach dem Stande von 30. November 1931

GDP. Mainly due to a sharp fall in GDP, the foreign debt to GDP ratio reached its peak at the end of 1931 exceeding 100% (Ritschl, 2012b).

Table 4 also reports estimates painstakingly reconstructed by Klug (1993) of the debt buybacks carried out by Germans between 1932 and 1938. The buyback figure for 1931 is an estimate we have calculated using archival sources. Klug believed that the buybacks had started in earnest in 1932, but the evidence shows that the practice was widespread already in 1931.[12]

Year	GDP	Commercial	Reparations	Total	Buybacks	Debt/GDP
1928	89.05	27	40	67	-	75.2%
1929	89.25	31	46	77	-	86.3%
1930	82.93	32.6	35	67.6	-	81.5%
1931	69.15	33.6	34	67.6	0.3	97.8%
1932	56.44	25.9		25.9	0.86	45.9%
1933	57.72	23.2		23.2	1.18	40.2%
1934	64.38	18.1		18.1	0.58	28.1%
1935	71.75	N/A		N/A	0.54	N/A
1936	79.65	16.4		16.4	0.3	20.6%
1937	89.11	14.8		14.8	0.15	16.6%
1938	99.19	13.9		13.9	0.19	14.0%

Table 4: German GDP, foreign debt and debt buybacks, billions of Reichsmarks [13]

2.2 The many guises of default: German economic policy in the 1930s

In the summer of 1931, the Reichsbank ratified exchange controls, in order to curb all forms of capital flight (Bonnel, 1940; Child, 1958; James, 1985).[14] The principal feature of this

[12]Germany Country File, Bank of England Archive; OV34/148: Special advisory Committee Basel 1931 and OV34/179. As the author himself notes, however, some buybacks also took place in the 1920s.

[13]Source: the debt series is from Bundesbank (1976), the GDP series is from Ritschl (2012b), the buyback series is from Klug (1993) for 1932-38 and the buyback figure for 1931 is a lower bound estimate calculated from Germany Country File, Bank of England Archive; OV34/179: Germany Moratorium. Report of the committee appointed to examine and interpret the figures submitted by the Reichsbank, May 30th 1933.

[14]The matter was intricate from the start, and exchange controls regulations were changed countless times. Following their informal adoption in July 1931, they led to "three general exchange-control laws, upwards of 50 separate decrees of amendment and adaptation, and something in the neighborhood of 500 administrative rulings, to say nothing of clearing, compensation, and payment agreements with partner countries",Ellis (1940), page 9.

legislation was that the German authorities restricted the availability of foreign exchange for individuals and companies. Moreover, the use of the foreign exchange allocated had to be approved by the authorities themselves. The allocation of foreign currency was at first established based on the requirements of the previous year.[15] This arrangement lasted until 1934 (James, 1985), when even stricter controls on the use of foreign exchange were established (Klug, 1993).

At the international level, Germany's economic, financial and political chaos was reflected in a series measures aimed at giving temporary relief to German debtors. On the 21st of June 1931, US president Hoover introduced a one-year moratorium on German intergovernmental debts and reparations. Moreover, the Reichsbank was given a $100 million emergency loan from the Bank of International Settlements, the Bank of England, the Bank of France and the Federal Reserve Bank of New York. In addition, the first Standstill Agreement - signed in August 1931 - meant that approximately 6.3 billions Reichsmarks of German short-term debts were frozen.[16] Finally, the Lausanne Conference of July 1932 virtually put an end to reparation payments, while maintaining and protecting the service of the Dawes and Young loans (Piet, 2004). Germany was by no means unique in this pattern of events, but its default was the largest of the interwar era (Reinhart and Rogoff, 2013)

The march towards default accelerated after the rise to power of the Nazis in January 1933 and the reinstitution of Hjalmar Schacht as president of the Reichsbank on the 17th of March of the same year. In August 1934, the head of the German central bank was also given the command of the *Wirtschaftsministerium* (Ministry of Economics). Schacht was a prominent figure in German and international economic and financial circles and was generally considered responsible for ending Germany's hyperinflation in the first half of the 1920s. He was also a strenuous opposer of the war reparations imposed on Germany. At the same time, he was generally seen as a friendly figure by the international community, at least until the initial phases of his second stint as President of the Reichsbank. International creditors were soon up for disappointments. James (1985) recounts the steps taken by

[15] In particular, in November 1931, it was established that 75% of previous year's requirements of foreign exchange would be allocated. In March 1932, the share was lowered to 35% and successively raised to 50% (Klug, 1993).

[16] The agreement was renewed until 1939 with German debtors directly repaying part of the debts every year.

Schacht, shortly after his reinstitution. A new Law on Payments Abroad was approved in May 1933, which forced all foreign debts not covered by the Standstill Agreements - including the Dawes and Young loans - to be repaid through a *Konversionskasse* (Conversion Bank) and which reduced the service of the debts to 75% of the level of June 1933.[17] By the end of the same year, the amount transferred was reduced to 30%. In January 1934, the Reichsbank declared that scrip would be exchanged with foreign currency for 67% of the nominal value. This meant that 77% of the debt service could be met. In the spring of 1934, however, Germany instituted a complete transfer moratorium (Ellis, 1941), which formalised its default on all foreign obligations. The Germans introduced aggressive measures even with regard to the Dawes and Young loans, which had previously commanded a privileged status. In May 1933, notwithstanding the protests of the Bank for International Settlements who was the guarantor of these loans, Germany unilaterally revoked the *Gold Clause* (Piet, 2004). This meant that the loans would now be serviced in nominal rather than in real terms.

Ellis (1940) convincingly argues that the striking aspect of the exchange control system that came to life in Germany during the 1930s was that, while it had all the characteristics of an emergency measure and was so perceived by most contemporaries, it ended up becoming the defining feature of German foreign economic policy during the decade. Holders of German securities abroad followed the unfolding of events closely and with growing anxiety.[18] As will be shown in Part 4, these events were reflected powerfully in the price of German bonds traded in the most important financial center at the time: New York.

2.3 The aftermath: the London Debt Agreement of 1953

In the aftermath of World War II, the question of Germany's interwar debts loomed large. Eventually, the issue was tackled through London Debt Agreement signed in February 1953. The Federal Republic of Germany (West Germany) accepted responsibility for all public debts issued between the world wars. It also obliged to put in place a mechanism that would

[17]Debtors could pay up to 50% of the debts service, provided that this did not exceed 4% of the principal. The remaining service was to be paid in scrip Reichsmarks (i.e. currency with no legal tender) with a discount of 50%. The Reichsbank, in turn, promised to exchange the scrip with foreign currency.

[18]Contemporary commentators such as Einzig (1934), for example, identified the Reichsbank's measures as a severe blow to creditors' hope of ever seeing full repayment.

guarantee the fulfillment of private obligations issued by debtors living in the Republic (Guinnane, 2004).[19]

It was agreed that part of the debt would be repaid after the reunification of West and East Germany, but many other issues were on the table including interest payments, currency of denomination and the share of debt to be assigned to East Germany. As could be expected from the complex events recounted so far, estimating how much Germany would have to repay if it was to repay the full amount of its interwar debts is extremely difficult. Given the Debt agreement, however, it can be safely stated that Germany repaid *at most* 50% of its obligations (Guinnane, 2004) (check what Albrecht said in The Economist article!). For example the Gold Clauses written in many of the loan agreements were explicitly ignored reducing the debt burden (in the cases where they existed) by 40% on their own (the clause was substituted by a Dollar Clause to avoid the excessive penalization of countries whose currencies had devalued even more severely than the Dollar against gold). Germany was also given a very long time frame to repay its debt, which became ever lighter as its economy took off during the *Wirtschaftswunder*. The last payment relating to the original agreement was made in 1983. The reunification then triggered additional payments which wen on until 2010. Part of these were interest payments on the Young and Dawes loans. Fundamentally, the repayment plan was tied to Germany's ability to pay and thus its ability to generate hard currency through exports. This meant, however, that instances at single creditor and debtor level were ignored, benefitting some and harming others (for example, on the benefit side, companies that would have been able to start repaying debts immediately, were allowed to wait for Germany to get its economy and export sector on its feet again).

3 A model of debt buybacks

In this section, we present a model outlining the theoretical framework through which we interpret the German buyback episode. Our baseline model is based on Broner, Martin, and Ventura (2010) and highlights the role of secondary markets in influencing default risk by

[19]West Germany also took responsibility for debt issued by the Austrian government during the war for repayment of advances relating to the the Marshall Plan and other post-war recovery schemes. The agreement reached, instead, left out other types of obligations, including claims fordamages arising out of the Second World War (Guinnane, 2004).

allowing asset trade between creditors and debtors. The authors present a wide range of examples showing the result of relaxing the assumptions of the model.

We follow this approach and explore how the model changes when the set up is modified along two lines. Firstly we introduce debtor heterogeneity. This serves the purpose of making the redistribution of income within the debtor country non-neutral and thus introducing Political Economy considerations in the model. Secondly, we introduce heterogeneity among creditors. This allows us to take into account the information held by different categories of foreign creditors. We thus show how Political Economy considerations on the part of the debtor government and frictions in financial markets can separately affect the outcomes of the model; the main message is, however, unchanged. Details can be found in Appendix A. The objective of this section is, in essence, to add formality and clarity to our arguments and provide empirically testable predictions.

3.1 Related Literature

Broner, Martin, and Ventura (2008) show that in the presence of weak enforcement institutions in primary markets, the presence of secondary markets restores efficiency. In secondary markets, assets are re-traded leading to the optimal amount of ex-ante asset trade. Secondary markets can thus help mitigate the particular form of the fundamental problem of exchange that arises due to sovereign risk, which is the inability of a debtor government to credibly commit to enforce foreign payments. Bai and Zhang (2011) show another way in which secondary markets can facilitate borrowing ex-ante, that is by reducing the duration of debt restructuring ex-post. This happens because trading in secondary markets reveals the reservation value of creditors, which instead cannot be observed in the case of bank loans. Crucially, the Broner, Martin and Ventura demonstrate that the role of secondary markets holds both when the debtor government acts opportunistically by not enforcing foreign debts and when the government is unable to enforce them due to a weak institutional environment. This framework is extremely relevant for many historical episodes (Dixit, 2004), as well as current ones (European debt crisis?). It also has a bearing for the case discussed here. The Weimar Republic was a weak political entity and creditors were as preoccupied with German ability to pay as well as its willingness. For simplicity, however, we will only treat the first

instance formally in this paper.

Recent research on default episodes finds large variations in the treatment of sovereign debt creditors, without a systematic discrimination in favor of domestic or foreign creditors (Sturzenegger and Zettelmeyer, 2008). Erce (2012) provides an explanation of why this might be. He argues that selective defaults depend on three elements: the origin of the liquidity pressure (i.e. is the government having difficulty in rolling over the internal or external debt?), the size of the internal debt and the health of the banking sector (due to the consequences a default would have on the domestic financial system), the dependence on domestic versus foreign borrowing of the private sector. In Section 5 we explain how this framework clearly points towards the "advantages" of an external rather than internal default in the German case.

3.2 Baseline model

The gist of the Broner, Martin, and Ventura (2010) model is the following. When a sovereign crisis ensues and the debtor government cannot credibly commit to enforce payments, creditors will be willing to sell their assets on secondary market at any positive price. Citizens of the debtor country, instead, will be willing to repurchase them at any price up to face value, since the government is expected to enforce payments between domestic citizens. If the debt is held internally in its entirety, not enforcing payments will only lead to a redistribution of income, not a net gain resulting from foregone payments to foreigners. An essential assumption for this result is that governments cannot discriminate among debtors when they decide to enforce payments. This outcome resembles an ex-post prisoner's dilemma: if debtors could collude and decide not to repurchase foreign debt, the country as a whole would be better off. Each single citizen of the debtor country, however, has an incentive to repurchase the debt since she can make a large riskless profit. As a result, if the debtor government had the chance, it would put sand in the wheels of private investors and interfere with the functioning of secondary markets .

The set up of the model is as follows (we denote all variables at the individual level with lower case letters and country aggregates with upper case letters). There are two countries: Debtor populated by the agents $i \in I^D$ and Creditor populated by $i \in I^C$. There are two

time periods Today ($t = 0$) and Tomorrow ($t = 1$). Preferences are described by:

$$u_i(c_{i0}, c_{i1}) = u(c_{i0}) + u(c_{i1}) \tag{1}$$

c_{i0} and c_{i1} denote consumption Today and Tomorrow, which means there is no time discount. The utility function $u(.)$ is monotonic, increasing and concave.

Representative agent endowments (2)

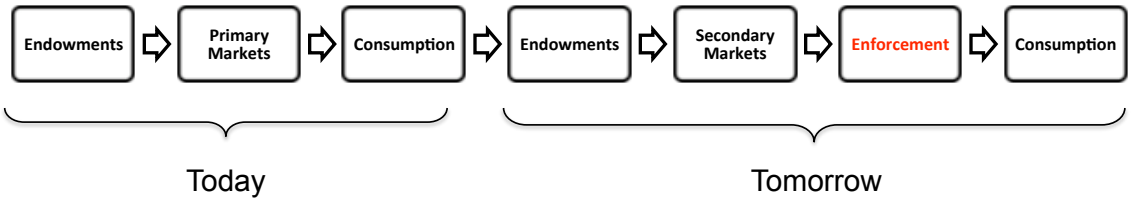
$$(y_{i0}, y_{i1}) = \begin{cases} (y - \varepsilon, y + \varepsilon) & \text{for } i \in I^D \\ (y + \varepsilon, y - \varepsilon) & \text{for } i \in I^C \end{cases}$$

Creditors and Debtors, therefore, have idiosyncratic shocks ε with probability 1 to their endowment y, and by trading internationally in assets they can increase their utility. The governments of the two countries only care about their own citizens and their only role is to decide whether to enforce payments. Their objective functions are:

$$W^j = \int u(c_{i1}) \text{ for } i \in I^j \text{ and } j \in D, C \tag{3}$$

In the absence of secondary markets, there will be no international trade in assets. The Debtor government will never enforce payments Tomorrow and, knowing this, Creditor citizens will never lend Today. If the debtor government, instead, only cared about enforcing payments, creditors would purchase ε bonds at price 1 from Debtor citizens and there would be perfect consumption smoothing between the two countries: each agent would consume y in both periods.

Now assume the presence and frictionless functioning of secondary markets and the following timing of asset trade, endowments and enforcement decisions:
In case of full enforcement, there is no need to trade in secondary markets and bond holdings Tomorrow will equal bond holdings Today, $x^D_{i1} = x^D_{i0}$. When the governments' objective function described by equations 3 holds, instead, enforcement by the Debtor government will only take place towards the citizens of Debtor and not those of Creditor: $e^D_j \in \{0, 1\}$ with $e^D_C = 0$ and $e^D_D = 1$. In this situation, Creditors will have an incentive to re-trade their



bonds in the secondary markets and sell them for any positive price since, if they hold them, payments will not be enforced by the Debtor government and the debt will have a value of zero. Debtor citizens will have an incentive to purchase the bonds for any price up to their face value since any lower price translates into a riskless arbitrage profit. Eventually, all bonds will be bought back at face value by the citizens of Debtor. The intuition here is that if the bonds trade at face value, Debtors are indifferent to purchasing them, but if they trade even at a fractional discount, there will be untapped arbitrage opportunities. The equilibrium will be:

$$\text{Bond prices: } q_0^D = 1; \quad q_1^D = 1; \quad q_0^C = 1; \quad q_1^C = 1 \tag{4}$$

$$\text{Consumption: } c_{i0} = c_{i1} = y \text{ for } i \in I^D \cup I^C \tag{5}$$

$$\text{Primary market bond holdings:} \tag{6}$$

$$x_{i0}^D = \begin{cases} -\varepsilon & \text{for } i \in I^D \\ \varepsilon & \text{for } i \in I^C \end{cases}$$

$$\text{Secondary market bond holdings:} \tag{7}$$

$$x_{i1}^D = \begin{cases} \delta_i & \text{for } i \in I^D \\ 0 & \text{for } i \in I^C \end{cases}$$

$$\text{where: } \int \delta_i = 0 \text{ and } \delta_i =< y \text{ for } i \in I^D \tag{8}$$

Equations 7 and 8 say that Creditor citizens will sell all their bonds to Debtor citizens. The quantity bought by each Debtor citizen, δ_i, is not fixed; some can buy more, some less, some none at all. The final net bond holding position of both countries as a whole will be equal

to 0.

This equilibrium is inefficient ex-post for the Debtor country. The efficient solution would be to collude Tomorrow and not repurchase the debt on secondary markets. However, each individual can make large capital gains by buying the bonds. Ex-ante, the presence and frictionless functioning of secondary markets are beneficial to both countries since they allow the existence of asset trade. Secondary markets ensure that assets are transferred from those who value them less (Creditors) to those who value them more (Debtors) and asset holdings are aligned with the preferences of the government who makes the enforcement decision.

The model has an alternative equilibrium, which arises when agents are pessimistic and believe the government will not enforce debts even when they are held by domestic citizens, i.e $e_D^D = 0$. In this equilibrium asset prices in the Secondary market are equal to zero since Debtor citizens have no incentive to buy the bonds back and, as a result, there is no asset trade in primary markets either. However, the optimistic equilibrium is more robust. This is because if the domestic enforcement decision e_D^D entails a cost $\gamma(e_D^D)$ (e.g. internal disruption of economic activity, political repercussions, uncertainty etc.), which is positive only in case of non-enforcement the Debtor government will not be indifferent anymore between enforcement and non-enforcement, no matter how small this cost is.

$$W^D = \int u(c_{i1}) - \gamma(e_D^D) \text{ for } i \in I^D \text{ where } \gamma(0) > 0 \text{ and } \gamma(1) = 0 \tag{9}$$

It is essential to clarify the assumptions this equilibrium rests on. First of all, as already anticipated, secondary markets work perfectly. In the presence of frictions (e.g. transaction costs) asset trade will be lower, but the main result will not change, unless the costs are large. Secondly, agents behave competitively and there is no (or limited) collusion among Debtor country citizens. Finally, the government's enforcement decision happens after the trade in Secondary Markets is concluded. If it takes place before, the government will not enforce payments and asset trade will be destroyed. As Broner, Martin, and Ventura (2010) show, these results also hold when there are many countries, time periods, shocks, sources of market incompleteness, and sources of heterogeneity within and between regions.

It follows from this model that, since the government cannot default outright by shutting down secondary markets unless it is willing to destroy international asset trade, it might try

to put sand in the wheels of private investors in order to make the debt repurchases difficult.

3.3 Extensions

In Appendix A, we show how some reasonable extensions of the model can affect its outcomes. In doing this, we follow the example of Broner, Martin and Ventura by relaxing key assumptions and exploring the repercussions.

Firstly, we introduce debtor heterogeneity. The assumption that internal redistributions of income arising from the decision to enforce or not enforce internal payments are neutral is clearly a strong one. In the context of the German case, we know that both Weimar Republic and Nazi Governments were supported by very influential groups. It follows from this that a government's objective function will weigh the welfare of different groups of citizens differently. We illustrate the case in which there are two groups of citizens: a share of the population of Debtor is composed by influential agents supporting the government in charge, which we call "Supporters", while the rest of the population is either opposed or not influential enough to have any leverage on the party (or coalition of parties) in charge. We call this group of people "Others". Under reasonable assumptions, the results illustrated in the baseline model hold, with the crucial difference that now the Debtor Government will enforce payments in a more limited range of scenarios. The shares of debt issued and repurchased by the two groups of debtors become key parameters in determining the existence of international borrowing and lending and no default. In the words, the good equilibrium becomes more fragile. A natural further extension would be to further assume that the Debtor government cannot observe precisely its citizens portfolios as in Bai and Zhang (2011).

Secondly we show what happens if we introduce heterogeneity on the creditors' side. Assuming that all creditors have equal and perfect information about the economy and policies in the debtor country is a strong assumption as well. We introduce two classes of creditors: "Informed" and "Uninformed". The latter has perfect information when making the initial lending decision, but is not informed about changes after the lending decision is taken. Informed creditors, instead, are in the know and react to policy changes and changes in economic conditions. We show that, when the Debtor country is hit by an exogenous shock which limits the ability of its citizens to repurchase securities on secondary markets (this

could be the outcome of a sudden stop limiting access to foreign currency or the unforeseen introduction of financial repression measures such as capital controls; Germany experienced both), informed creditors will scramble to sell the securities in their possession below face value while the uninformed ones, unwilling to accept a discounted price, will eventually be defaulted on. This set up manages to reproduce a number of features of the German episode. In particular, it captures the fact that a number of creditors managed to exit their investments in German bonds at a relatively small discount through sales on secondary markets, thus limiting their losses, while other stuck with the bonds and eventually accepted either huge discounts on the bond prices or a long and difficult restructuring which was protracted until the first decade 21st century (Guinnane, 2004).

4 Empirical application

The main conclusion of the models presented in Part 3 is that when secondary markets function well they contribute to avert default by allowing the re-trading of assets. When their working is disrupted, instead, the risk of default persists, trading in secondary markets is restricted and debt securities trade at a discount abroad, while commanding a higher price domestically. In this section we show that these predictions fit very well with the German data, by identifying structural breaks in the Young and Dawes bond series, thus using a similar empirical strategy to that of Brown and Burdekin (2002). Contrary to Brown and Burdekin (2002) and Frey and Kucher (2001), however, we identify the number of breaks at the 99% confidence level and provide asymmetric confidence intervals around break dates; moreover, the events associated with the breaks always match the predictions of our theoretical framework.

4.1 Empirical Strategy

Our empirical strategy consists in studying the price of German debt securities traded on the New York Stock Exchange between 1930 and 1940. More precisely, we look for structural breaks in the weekly price series of Dawes and Young bonds. These bonds were the direct results of the Dawes and Young Agreements described in section 2 and were essentially

German Government debt commanding a somewhat privileged status compared to other bond issues (Piet, 2004). Working with asset price data has at least two advantages: high frequency and reliability. High frequency in our case translates into weekly data, while the reliability is due to the fact that stock market data is less prone to direct manipulation, especially given that we look at German debt securities traded on the New York Stock Exchange.

Figure 2 presents the weekly price data for the Dawes and Young bonds traded on the New York Stock Exchange between December 1929 (June 1930 for the Young series) and June 1940, manually collected from the New York Times publication *The Annalist*, as well as quotations of German Mortgage bonds on the Berlin Stock Exchange available from Global Financial Data. Mortgage bonds are chosen as representatives of German bonds traded in Berlin for reasons that will become apparent in the next paragraphs. At the time, New York was already the most important financial center in the world together with London, and German debt was held disproportionately more by residents of the United States than of any other country in the world, as shown in Part 2.

Figure 2: Young and Dawes bonds traded in New York and Mortgage bonds traded in Berlin[20]

[20]Source: The Annalist: A Journal of Finance, Commerce and Economics, Vol. 35 - 56, published by - The

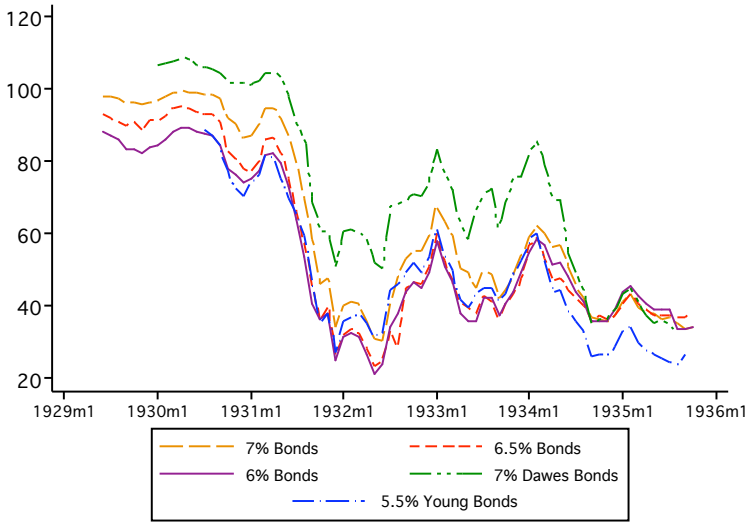
Bond price data provides us with a variety of information. First of all, it gives an indication of the perceived risk of default for foreign creditors of German debt. Secondly, we exploit the fact that the price of assets such as government bonds tends to reflect key economic and historical events connected to the debtor country. For example, Brown and Burdekin (2002) and Frey and Kucher (2001) have used a similar empirical strategy to ours to study the influence of World War II on German bonds traded in London and Zürich respectively. [21] By connecting structural breaks in the price series of German bonds traded in New York to key events, we can identify what foreign investors perceived as important developments for their chances to be repaid. Specifically, we can test the predictions of our theoretical model by investigating what effect trading on secondary markets had on the perceived risk of default. Ideally, we would study the spread between the price of German bonds traded within Germany and abroad. Unfortunately, the closure of the Berlin Stock Exchange for almost a year in 1931/32 precludes us from performing such an econometric analysis. However, the prices of a number of German bonds traded in Berlin reported in Figure 3 show that, indeed, these followed a very different path from similar bonds traded abroad. First of all, their price recovered much faster after the crash of 1931. Secondly, the apparent correlation between German bonds traded in Germany and in Berlin breaks down in the first half of 1934, with bonds in Berlin trading at stable price close to face value, whereas in New York prices of German bonds were more volatile and trending downwards.

The mechanisms described in the model in section 3 hold for both public and private debt, but our analysis will look at public debt only due to issues of data availability. However, looking at only two of bond issues does not appear to be a major shortcoming. Figure 3 shows that a German bond was highly correlated with another German bond traded in the same exchange, not across categories. In fact, while the German government was very keen to claim a difference between "political" and other debts, the treatment was not significantly different (Guinnane, 2004). Moreover, as highlighted in our theoretical framework, the decision to repay foreign debts, whether public or private or public eventually rests with a country's authorities. This was recognized also by the parties involved in the London Debt Agreement

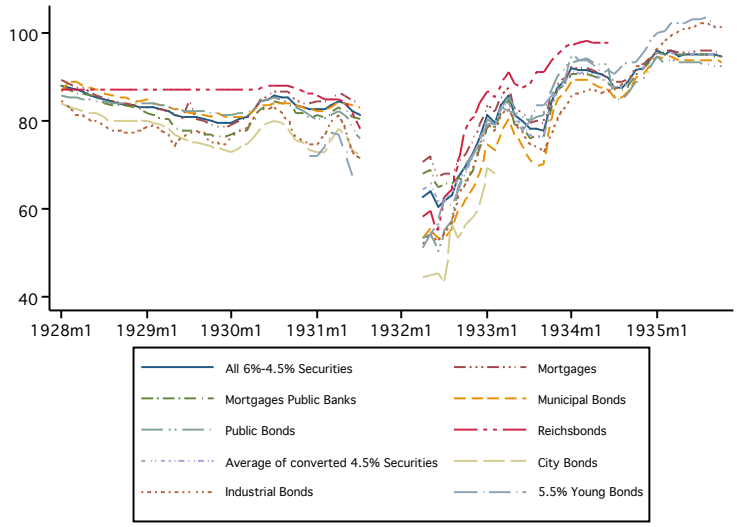
New York Times Company, January 1930 to October 1940.

[21] There is a substantial literature using bond markets to study historical and economic events. See for example Oosterlinck and Landon-Lane (2006); Oosterlinck and Ureche-Rangau (2008).

of 1953, where both private and public German debts from the interwar period were discussed and repayment negotiated together. In any case, the privileged status of Young and Dawes loans, which gave them a certain degree of seniority over other debts (Piet, 2004), means that the bonds were less prone to fluctuation due to temporary shifts in economic conditions, policy and creditor expectations, which serves the purpose of our analysis well.



(a) New York



(b) Berlin

Figure 3: German bonds traded in New York and Berlin[22]

[22]Source: IFK, Jahrstatistiches Handbuch 1933 & 1936

Another key aspect that allows us to work confidently with asset price data is the fact that financial markets in the 1930s had already reached a high level of sophistication. By comparing the debt crises of the 1930s and 1980s, Eichengreen and Portes (1990a) have shown that financial markets in the two periods were equally able to process information.[23] Specifically with regard to sovereign risk, the authors showed that there is no evidence that the main creditors of the 1980s - banks - possessed an advantage over the main creditors of the 30s - bond markets. The authors also note that sovereign bonds were traded widely in secondary markets, a finding confirmed by Stone (1991). Eichengreen and Portes finally showed that bond markets were, not surprisingly, heavily influenced by political events.[24]

4.2 The Econometric Model

Our goal is to estimate the dates of multiple structural breaks in the time series of Dawes and Young bond prices. The idea is that these breaks reflect significant historical events. Thus, finding a correspondence between the breaks and episodes limiting the access of German citizens to secondary markets (whether due to Government intervention or other causes) would lend strong support to our theoretical framework and historical reconstruction. We treat both the dates and number of breaks as unknown a priori, to be endogenously determined from the data.[25] In this respect, we rely on two different estimation procedures: a simultaneous estimation procedure, following Bai and Perron (1998, 2003) and a sequential procedure based on Bai (1997a,b) and Chong (1995). This is done to test the robustness of the estimations of the break dates. The two estimation procedures also imply different ways to select the number of breaks. While the location and confidence intervals of the breaks are estimated, one should speak instead of selection of the number of breaks. This distinction is important for the interpretation of the results, e.g. we find that the number of breaks is identified at the 99% confidence level, but that does not have a direct implication onthe

[23] Interestingly, Flandreau, Gaillard, and Packer (2011) find that at the time rating agencies performed very poorly, similarly to today.

[24] Eichengreen and Portes also argue that creditor government involvement was common, but its importance varied greatly from country to county.

[25] It is important to note that allowing for more than one break requires different, and more complex, statistical procedures than in the well-known case of a single break. For an overview of the literature, the interested reader can refer to Hansen (2001) and Perron (2005).

confidence interval around one of the estimated break dates. We present in the next paragraphs only the simultaneous estimation procedure; the sequential procedure is described and applied to an example in appendix C.

The estimation procedure of Bai and Perron (1998, 2003) allows us to test for the number of breaks and estimate consistently the dates of multiple breaks in a partial structural change linear model. It estimates simultaneously the break dates, but it requires knowledge of the number of breaks present in the data, which in turn is selected through a series of statistical tests. Following their notation, we consider the following univariate model for each of the bond series independently:

$$y_t = \alpha_j + \rho_j y_{t-1} + \beta z_t + e_t \qquad t = T_{j-1} + 1, ..., T_j \tag{10}$$

for regimes $j = 1, ..., m+1$ (with $T_0 = 0$ and $T_{m+1} = T$), where m is the number of breaks, y_t is the natural logarithm of the bond price at time t, z_t is the natural logarithm of a measure of market performance and e_t is white noise. Parameters α_j and ρ_j are allowed to change across regimes, whereas β is estimated for the whole sample. We assume the variance of the error term to be constant across regimes, in order to focus on the main features of the model. The main objective is to estimate the unknown break dates $T_1, ..., T_m$ and, to a much lesser extent, to estimate the model parameters.[26] For each set of break dates $(T_1, ..., T_m)$, the estimates of the parameters α_j, ρ_j and β are obtained by minimizing the sum of squared residuals (SSR) for the whole sample, i.e. spanning all regimes:

$$SSR = \sum_{j=1}^{m+1} \sum_{t=T_{j-1}+1}^{T_j} [y_t - \alpha_j - \rho_j y_{t-1} - \beta z_t] \tag{11}$$

[26]The choice of a first-order autoregressive model permits us to use a reasonably flexible, yet easily tractable model. Bond prices are usually modeled in the literature as unit root processes, but other than this there would be no other reason for choosing a unit root process to analyze the data. Unit root tests typically found in the literature cannot be applied in this case, as we are considering possible multiple breaks: the appropriate test would be one which tests the null of a unit root with multiple breaks against the alternative of a stationary process with multiple breaks. To our knowledge, such a test exists only for cases with two breaks (Lee and Strazicich, 2003) but not for an arbitrary number of breaks. We therefore assume stationarity of the series under each regime and will use standard methods to identify potential explosive behavior of the series after structural breaks have been accounted for.

Parameter estimates are therefore a function of the set of break dates: different partitions of the time line in $m+1$ regimes will generally lead to different parameter estimates. The estimated set of break dates is such that:

$$(\hat{T}_1, ..., \hat{T}_m) = argmin_{T_1,...,T_m} \sum_{j=1}^{m+1} \sum_{t=T_{j-1}+1}^{T_j} [y_t - \hat{\alpha}_{j[T_j]} - \hat{\rho}_{j[T_j]} y_{t-1} - \hat{\beta}_{[T_j]} z_t] \tag{12}$$

where the hat denotes sample estimates and the subscript $[T_j]$ represents the dependence of the parameter estimates on the date of the breaks. This estimation method looks for the global minimizers of the SSR, a task that requires a number of operations by least squares of order $O(T^m)$ if performed by standard grid search. When the number of breaks m is greater than two the procedure becomes computationally challenging. Bai and Perron (2003) propose an algorithm that is able to find the global minimizers of the SSR by using a number of least squares operations of order $O(T^2)$. Their dynamic programming approach achieves this reduction in operations by efficiently selecting only the feasible partitions[27] of the time line before starting the grid search. When a partial structural change model is estimated the global minimization algorithm is modified to include an iterative procedure whereby the parameter not affected by the structural change is estimated from the full sample[28].

The estimation procedure above requires knowledge on the number of breaks m. In practice, it is possible to repeat the simultaneous estimation procedure for each desired number of breaks. However, the results of the estimation will not contain any element that would help us decide between, say, l or $l+1$ breaks: it is not appropriate to simply compare the SSR of different models which differ only in the number of breaks allowed, as the SSR will not increase if an extra break is added to the model. For this reason, formal statistical tests are required. A number of test statistics can be used to infer m from the data, and we use three of them in particular: i) a $supF_T$ test similar to that of Andrews (1993) and

[27] Given a number of breaks m, only a limited number of segments exist that can fit simultaneously on the time line. Other requirements are added, such as minimum length of each regime, minimum distance between regimes and other conditions at the beginning and end of the sample.

[28] This procedure demands some care in the choice of the starting value of β, due to the fact that in the case of a partial structural change model the algorithm does not necessarily converge to the global minimum for β. However, this an issue mainly for the estimation of the value of the optimal $\hat{\beta}$, as the estimated break dates are generally only slightly affected by this.

generalized by Bai and Perron (1998), which tests the null of no breaks against a fixed number of breaks l; ii) two double maximum tests (Bai and Perron (1998)) that test the null of no break against an unknown number breaks; iii) a test of the null of l breaks (corresponding to the global minimizers of the simultaneous estimation) against $l+1$ breaks (Bai and Perron (1998)), denoted $supF_T(l+1|l)$, which tests if each of the $l+1$ regimes can be broken down in two (i.e a single break test for each regime) by observing if the decrease in the *global* SSR is statistically significant.

The three tests outlined above yield different information about the number of breaks in the model. We use the first two tests to confirm our assumption that at least one break is present is present and to get some intuition on whether there might be"few" breaks (up to three) or "many" (more than three). The last test, $supF_T(l+1|l)$, is applied sequentially, starting from $l=1$, to formally determine the precise number of breaks for a chosen significance level.

We perform robustness checks by changing the trimming parameter from 0.05 to 0.15 (for its definition, see Bai and Perron (1998)), by estimating different orders of the autoregressive part of the model and by allowing for heteroskedasticity of the errors across regimes: results do not differ substantially. The model with heteroskedasticity performs particularly well, but it is not presented here as we do not include change in volatility in our theoretical framework; therefore, we prefer to focus on the main features of the model only. We also included in the model a measure of market performance of the NYSE but it was discarded as it was not found to be significant.

4.3 Results

We will now report the main results of the estimation procedures applied to (10).[29] For the Dawes bond series there is strong evidence against the hypothesis of no break: both versions of the double maximum test are highly significant, and so is the $supF$ test, repeated for a number of breaks up to 8. The $supF(l+1|l)$ test is significant at the 1% level for an additional break up to the sixth, turning to not significant after that point. The repartition

[29] All calculations are obtained with modified versions of the Gauss and Matlab codes accompanying Hansen (2001) and Bai and Perron (2003).

procedure (appendix C) at the 2.5% significance level also estimates 6 breaks, and for this reason we select for the Dawes series a number of breaks $m = 6$. Both the simultaneous and refined sequential estimation yield the same estimates of the break dates. The simultaneous estimation procedure with the selected number of breaks quickly converges (4 iterations) to a model with a SSR of 1.825; the fixed parameter that reflects the influence of the stock market on the bond series is not found to be significant.

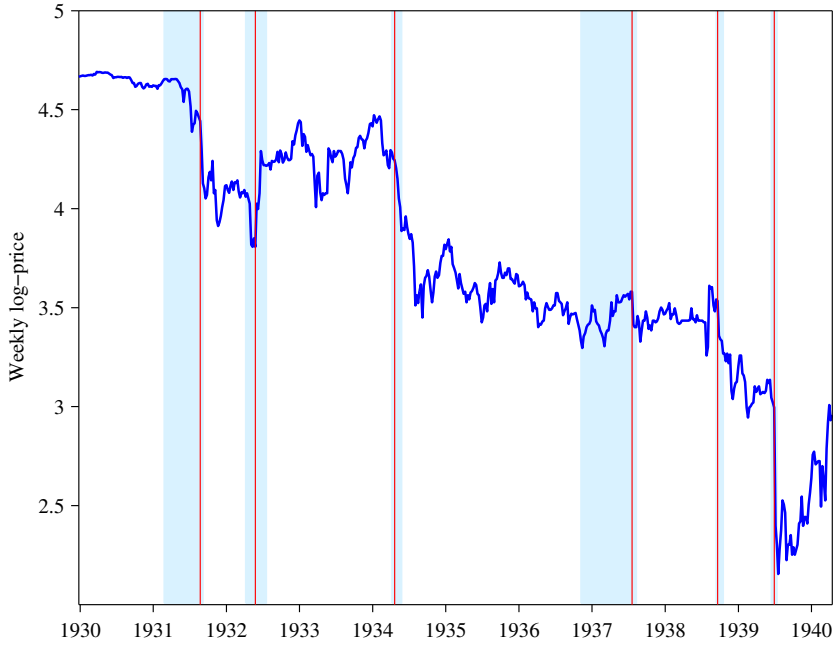


Figure 4: Dawes bond log-price with estimated break dates; shaded areas are 90% confidence intervals

Also for the Young bond series the statistical tests provide evidence of the presence of at least one break. The $supF(l+1|l)$ test is significant at the 1% significance level for an additional break up to the fifth one; it remains significant, although at the 2.5% level, for a sixth break and then turns not significant. The repartition procedure finds $m = 5$ breaks at the 10% level and $m = 4$ at the 5% level. We select $m = 5$ breaks as a compromise choice. The dates selected by the simultaneous and repartition estimation are the same only for two dates. The simultaneous estimation, however, ends up selecting the same dates as the repartition procedure only for a model with 7 breaks. This indicates that the dates arising as the outcome of the repartition procedure can still be considered as very plausible break

dates. In tables 5 and 6 we associate to every date identified statistically to an event likely to have had an impact on the series.

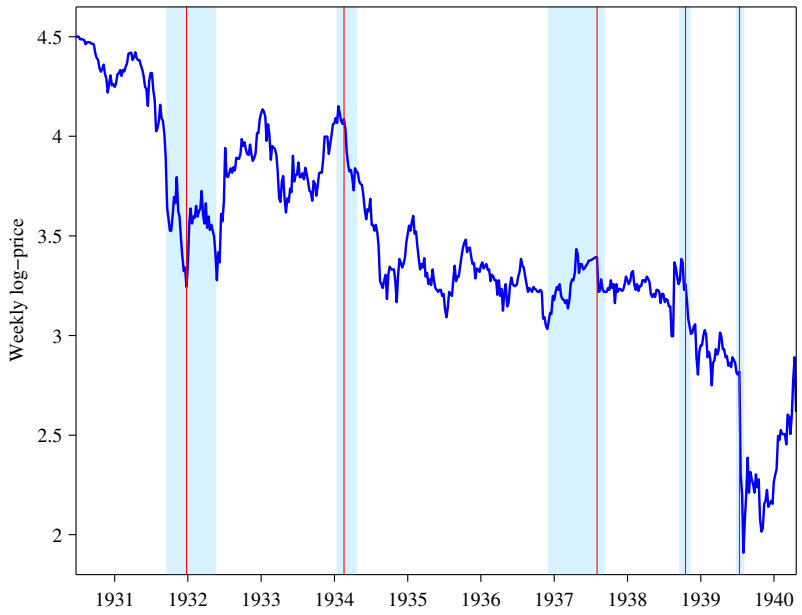


Figure 5: Young bond log-price with estimated break dates; shaded areas are 90% confidence intervals

What emerges from our empirical exercise is that, indeed, restrictions on the possibility for German citizens to trade on secondary markets had strongly adverse effects on the price of German bonds traded in New York. We interpret this as an indication that the perceived probability of default for foreign creditors was strongly influenced by the possibility of asset trade on secondary markets. Our results are also peculiar for what they do not find. The service of German foreign debt was modified a number of times - for example, in 1933 the the German government unilaterally revoked the *Gold Clause*, which meant that the Dawes and Young bonds started being serviced in nominal rather than real terms - however, we do not find breaks in correspondence to such events. What sets the breaks we find apart from other key historical events is that they correspond to instances of German citizens and companies being restricted from accessing secondary markets abroad.

Break date	90% confidence interval	Mean	Event
05/9/1931	07/3/1931 - 19/9/1931	51.4	At the end of July 1931 exchange controls were introduced amid political and economic turmoil (Ellis (1941)). August 1931 also saw the signing of the first Standstill Agreement, which froze 6.3bn Reichsmark of German short-term debt (Piet (2004)).
11/6/1932	23/4/1932 - 06/8/1932	67.3	The Lausanne conference was held from June 16 to July 9, 1932 and virtually put an end to reparations payments, while maintaining the service of the Dawes and Young bonds (Piet (2004)).
19/5/1934	05/5/1934 - 23/6/1934	28.1*	In July 1934 a complete transfer moratorium on foreign payments was enforced, which established the complete control of the Reichsbank on all foreign exchange operations.
04/9/1937	19/12/1936 - 25/9/1937	23.8	In May and September new capital controls are introduced.
12/11/1938	05/11/1938 - 10/12/1938	19.3	Foreign exchange controls announced and implemented in November and December.
26/8/1939	12/8/1939 - 09/9/1939	10.8	September 1st 1939: Germany invades Poland

Table 5: Break dates with 90% asymmetric confidence bands and corresponding events for the Dawes bond price series. The reported mean is the expected long-run value of the estimated stationary $AR(1)$ process for the regime *starting* at the respective break date. An asterisk denotes that one of the parameters was not found to be significant in that regime.

In Table 5 we can see that the introduction of exchange controls in 1931 was accompanied by a 50% decease in the mean of the estimated stationary $AR(1)$ process for the regime (see the Mean column in the table), which can be interpreted as an equally large decrease in the price of the bonds. Exchange controls made the repurchase of securities abroad very difficult for German investors and companies given that, following the introduction of this measure, foreign exchange availability and its use were tightly controlled by the Reichsbank. Conversely, the second break we identify is connected with an increase in the price of German bonds. This is not surprising since we associate the break to the Lausanne Conference of July 1932, which essentially put an end to reparation payments, thus raising the expected value of residual claims, including Dawes and Young bonds. The introduction of a complete

Break date	90% confidence interval	Event
26/12/1931	19/9/1931 - 21/5/1932	Dates in between the introduction of capital controls by the end of July 1931 and the Lausanne conference starting in June 1932.
03/3/1934	27/1/1934 - 05/5/1934	In July 1934 a complete transfer moratorium on foreign payments was enforced, which established the complete control of the Reichsbank on all foreign exchange operations.
04/9/1937	02/1/1937 - 09/10/1937	In May and September new capital controls are introduced.
26/11/1938	29/10/1938 - 17/12/1938	Foreign exchange controls announced and implemented in November and December.
26/8/1939	12/8/1939 - 16/9/1939	September 1st 1939: Germany invades Poland

Table 6: Break dates with 90% asymmetric confidence bands and corresponding events for the Young bond price series. Means of the estimated $AR(1)$ process are not reported as many of the parameters are not found to be significant.

transfer moratorium and even tougher exchange controls in 1934, is connected to a further collapse in the price of Dawes bonds. This legislation made debt repurchases extremely difficult due to the complete monopoly of the Reichsbank over foreign exchange operations. As shown in Table 4, debt buybacks grew in volumes over time, peaking at over a billion Reichsmarks in 1933, only to dwindle after the policy tightening of 1934, notwithstanding the enormous increase in the spread between bonds traded in Germany and abroad around the same period and the equally large riskless arbitrage profits which could be made from this state of things. We are also able to pick up the further tightening of exchange controls in May and September 1937[30], as well as the announcement and implementation of the foreign exchange law in November and December 1938. [31]

The breaks we find thus correspond to complex and multifaceted episodes accompanied by partial or total defaults or restructurings. We argue that the financial repression that

[30]More precisely: (1) on May 27th, see Deutsches Reichsgesetzblatt, Jahrgang 1937, Teil I, Nr. 65, p. 600-601 and (2) on September 16th see: Deutsches Reichsgesetzblatt, Jahrgang 1937, Teil I, Nr. 105, p. 1018-19.

[31]November 8th: Anträge auf Zuteilung von Devisen. December 12th: Bekanntmachung des Gesetzes über die Devisenbewirtschaftung, source: Deutsches Reichsgesetzblatt Jahrgang 1938, Teil I, Nr. 211, p. 1733-48. Exchange banks were also involved in the confiscation of Jewish securities.

accompanied them was a key element of these episodes. The exchange controls which limited the access of Germans to secondary markets closed the channel through which the effects of limited debt services to foreigners could be offset. In fact, in the face of a purely external default such as the one we observe, debt repatriation would have represented a natural way for creditors to dismiss unwanted assets and for German citizens to profit on their higher probability of repayment.

The last break we pick up is not an episode of financial repression but the outbreak of World War II itself, represented by Molotov-Ribbentrop pact and the German invasion of Poland on the 1st of September 1939, which is reflected by a 50% hit to the prices of Dawes bonds. This result suggests that, for investors on the New York stock exchange, exchange controls and the connected restriction of trading on secondary markets were expected to further increase, significantly reducing their chances of repayment, as a consequence of an event such as the beginning of World War II.

Table 6 presents the results for the Young bonds. The breaks identified are the same except for the first. In this case, the model picks up an extended period of turbulence between the introduction of the exchange controls in 1931 and the Lausanne Conference of 1932 resulting in a single break instead of two separate ones. the message is, however, unchanged.

The comparison of our results with the break dates obtained by Brown and Burdekin (2002) is illustrative of the usefulness of our empirical approach[32]. One break we share in common is the outbreak of WWII. They also find two breaks in 1935 and two in 1937; however, they are associated with events of political nature, such as the reintroduction of conscription, and not with financial repression events. The importance of providing confidence intervals in our work also becomes apparent when comparing the two breaks they find in 1937, that according to our identification correspond to a single break situated in period of turbulence due to the introduction of multiple layers of capital controls.

[32]The samples differ and overlap only for the period 1933-1940, which is the period we will be comparing.

5 Discussion

In this section, we use our theoretical framework and empirical results to argue that the German debt crisis and the debt repurchases carried out in the 1930s are best interpreted in the light of the key role of secondary markets for foreign debt we have described. Any interpretation of the German buyback episode must be able to explain why the buybacks started in earnest in 1931, the reason for the appearance and persistence of the price differential between German bonds at home and abroad and the behavior of the German authorities. We provide a coherent framework through which we address all these points.

Why did the buyback start in earnest in 1931?

The fundamental mechanism was outlined in Part 3. During sovereign debt crises, domestic investors value the debt more because they have a higher chance of repayment. Why? When the debt is held internally the gains from default and repudiation in terms of foregone transfers to foreigners disappear. Moreover, domestic citizens are in a privileged position to obtain repayment due to, among other things, the ease with which they can interact with the local legal system, for example through bankruptcy procedures (Eaton, Gersovitz, and Stiglitz, 1986). Between 1929 and 1931, Germany spiraled into political and economic chaos Germany. Commercial debtors saw their credits endangered by the Young Plan, which made their claims junior with respect to reparations (Ritschl, 2012), and this spurred foreign investors to sell their holdings and domestic ones to purchase them. Indeed, although foreign bondholders in the interwar period publicly deprecated debt buybacks, their private stance was quite favorable, and interferences in the functioning of secondary markets were seen with hostility. Eichengreen and Portes (1990a) report a statement by the Council of Foreign Bondholders from 1937 which declared that restraints of bond repurchases would be met with "strong and ... effective criticism on the ground that, by limiting the market in such bonds, it would act detrimentally to the bondholders".

The previous literature on episode provided two explanations for the debt repurchases: export subsidization and debt overhang reduction.[33] The first explanation was popular among contemporaries (Einzig, 1934; Heuser, 1934), but has been contested by Ellis (1941),

[33] see Appendix B for a more detailed discussion

Balogh (1938) and Klug (1993). Klug, in particular, cites evidence from the German Economic Ministry, which highlights that German authorities did not believe the differential between debt prices in Germany and abroad to be high enough, at least until 1934, for the buybacks to be an efficient tool of export subsidization in a foreign-exchange-strapped country such as Germany. To the extent that the exports subsidized were genuinely additional, however, this argument should not apply. In any case, this interpretation does not explain why the buybacks started as a spontaneous private initiative. Balogh (1938), Child (1958) and Ellis (1940) claim that the buybacks became a real policy tool only during the course 1932, and that the Reichsbank managed to impose its complete monopoly on the practice only after the complete transfer moratorium of 1934. In fact, the Reichsbank president prior to Schacht, Hans Luther, expressed disappointment for the failure of the German authorities to curb debt repurchases more effectively while the Economics Ministry, although viewing the practice with more favor, was also eager to keep it under strict control (James, 1985).

Klug saw the buybacks as a tool for reducing Germany's debt overhang. The author cited the fact that the German authorities were always on the lookout for ways to reduce Germany's external debt, including unconventional ones (to use an euphemism) like the swap of German Jews for debt relief. German foreign debt did indeed fall sharply during the 1930s. Commercial debt was more than halved, going from 32.6 billions in 1930 to 13.9 in 1938. However, buybacks were a small part of this debt reduction. The departure of the USA and Great Britain - and eventually all countries - from the Gold Standard led to sizable devaluations of German debt denominated in foreign currency. The rapid growth of German GDP in the second half of the 1930s, also meant that the debt burden became lighter. In this context, the use of buybacks for the purpose of debt overhang reduction does not appear likely, especially for a country heading for political and economic isolationism and marching in rapid steps towards war. Buybacks, especially of Austrian debt, took place until 1944, in the full swing of the war (Klug, 1993). The reasons why the German government would want to reduce the debt overhang of Austria in the midst of a world war is unclear. Debt buybacks imply a mechanism that, although formalized by Bulow and Rogoff only in the 1980s, must have been known to the German authorities: as foreign debt is bought back, the residual debt will increase in value, everything else equal. This means that the reduction in

face value of the debt will be offset partially or entirely by the increase in its market value. Indeed, Klug himself calculated that if the buybacks led to any reduction in the market value of the debt at all, then this was minimal. A government-coordinated mobilization of thousands of individuals and companies, as well as billions of Reichsmarks to bring about a minimal reduction in the value of the foreign debt does not appear realistic.

Our view of events could be contested don the basis of the fact that, just a decade earlier, Germany underwent a massive default on its domestic rather than foreign creditors in the form of the hyperinflation. How - it could be inquired - can the radical difference in policy response between the two episodes be explained? Apart from the clear political differences between Germany in the early 1920s and in the early 1930s, we can also identify economic rationale. Following Erce (2012), we can frame the selective default decision based on the following elements: 1) source of liquidity pressure 2) size of internal debt and health of banking system 3) source of financing for the economy. As shown in Section 2, almost half of Germany's foreign commercial debt was short term. Towards the end of the 20s rolling over these debts became increasingly difficult, mainly due to deteriorating financial circumstances in the United States, which started already n 1928. This points to the main source of liquidity pressure coming from abroad. Regarding the health of the banking sector, Germany underwent a devastating banking crisis in 1931 making it very unpalatable to impose further pressure on a crippled financial sector in the form of an internal default. Finally, regarding the source of financing of the economy, after the deluge in foreign borrowing of 1925-28, the German economy started moving towards trade and financial autarky towards the end of the decade. International financial markets were essentially shut for German borrowers starting from 1929, with the exception of the Young loan of 1930 (Ritschl, 2012). During the 1920s, Germany relied on foreign borrowing to finance reparations payments as well as its its public and private sectors and although this borrowing really kicked off after the Dawes Plan signed in 1924, the German authorities could have expected the opening up of foreign credit markets already in the early post-war years, which would mean a lower reliance on domestic financial institutions. Finally, due to the composition of debt in the aftermath of WWI, internal default was - essentially - the only option given that most debts were internal as opposed to those of the Allies which had borrowed heavily from the United States (Guinnane, 2004).

In sum, Germany in 1931 was a very different political and economic entity from that of a decade earlier.

What explains the price differential between German bonds traded at home and abroad?

Some contemporaries attributed the price differential to an "irrational panic" (TheAnnalist, 1932). Klug hypothesized that the price differential was due to a different valuation of debt between creditors and debtors. According to the author, this could be the result of asymmetric information between creditors and debtors regarding Germany's desire to repudiate its foreign debt. An alternative explanation is that default had a higher cost for debtors compared to creditors. The explanation entailed in our framework is much simpler. Creditors abroad valued German debt less than German citizens because debts held domestically had a much higher probability of repayment. Both the willingness and ability to enforce payments on the part of the German government concerned foreign bondholders disproportionately more than domestic ones. The financial repression introduced in Germany in the early 1930s - epitomized by the exchange controls[34] - meant that the the different valuation could not be exploited by German and foreign investors.

In the presence of frictionless markets, we can expect investors to seize riskless arbitrage opportunities immediately. In the presence of disruptions to the functioning of these markets, instead, arbitrage opportunities will not be exploited and price differentials between the same securities traded in different locations, for example, can persist. The sudden stop of 1929/30, exchange controls, Schacht's transfer moratorium, growing political isolationism and the threat of war dealt successive blows to the chances of repayment for foreign bondholders and the price differential between German securities traded abroad and domestically became ever larger. The strict control of the German authorities on debt repurchases meant that the differential could not be offset. As argued by Ellis (1940), the exchange control system was the principal reason why the price differential between German bonds abroad and at home persisted, and thus also the principal reason for the perpetuation of the system itself.

[34]Ellis (1941) recounts some of the other measures enacted by the German authorities. Apart from what has already been discussed in Part 2, on the 3rd of October 1931 the German authorities suppressed the free publication of foreign quotations of German securities and on the 2nd of November of the same year, the trading of German securities issued abroad was put under the strict direct control of the *Devisen* (Foreign Exchange) Office

How is the behavior of the German authorities explained?

The behavior of the German government represents, perhaps, the most puzzling part of the story. If, as argued in this paper, debt buybacks can be detrimental for a highly indebted country, the German government was aware of this and macro objectives such as systematic export subsidization and debt reduction were not the ultimate goals of this practice, why did the German government not completely suppress them? Why were some resources put aside for debt repurchases?

We argue that limited and tightly controlled buybacks were a useful policy tool. By limiting the availability of foreign exchange and controlling its use, the German authorities were able to extract some benefits from the buybacks, without any major detrimental effects. First of all, genuinely additional exports - which would not have taken place without the possibility of buybacks - were a source of foreign exchange, rather than a leakage. Foreign exchange was of essential importance to Germany, both to meet its debt service and to acquire raw materials and capital goods abroad. Secondly, James (1985) argues that key industries benefited significantly on export markets thanks to this hidden subsidies. Thirdly, buybacks might have played a role as a debt reduction tool and source of riskless arbitrage profits for specific industries, individuals and companies. It is well known that there were strong connections between the Nazi party and groups of industrialists - these have been recently documented, together with their economic implications by Ferguson and Voth (2008) - and previous German governments had strong connections with interest groups such as the Junkers. It is not outlandish to imagine that granting the possibility of repurchasing foreign debt could be another mean of favoring supporters and strengthening alliances.

Klug documents how the company Miag Muhlebau Industriegesellschaft was granted foreign currency in order to buy back some of its own debt securities abroad that bore a particularly heavy interest burden. The repurchase of foreign debt for the gain of influential individuals and organizations has also been widely documented. Hermann Josef Abs, an important figure in post-war Germany and a Deutsche Bank director in the 1930s, made large personal profits by purchasing German debt abroad and selling it for higher prices in Germany (James, 2004). The finance Minister Lutz Graf Schwerin, tried to carry out a similar operation in November 1933, but was only granted around half of the foreign exchange

he requested (Klug, 1993). Klug also recounts how the Nazi party itself, in a period when it was particularly cash-strapped (precisely between autumn 1933 and spring 1934), employed some intermediaries to buy German debt in Europe and make profits by selling it at home.

6 Conclusion

We have studied a relatively little-explored aspect of German economic history in the interwar period: the large repurchases of foreign debt, carried out by Germans between 1931 and 1939. The poisonous economic and political climate - both within Germany and worldwide have made the study of this episode both interesting and challenging. The considerations of contemporaries who observed and studied the episode[35] were critically assessed together with more recent studies by historians and economists, including Child (1958), James (1985) and Klug (1993). Recent advances in economic theory - particularly the work by Broner, Martin, and Ventura (2008, 2010) on the role of secondary markets in mitigating sovereign risk - were employed in combination with econometric analysis based on primary sources. These different tools were used to disentangle this complex historical and economic event. Published and unpublished historical documents and archival sources were used to add depth and consistency to the arguments made. To our knowledge, this paper is the first detailed case study demonstrating the importance of secondary markets for foreign debt.

The theoretical model presented in Part 3 described the framework used to think about debt buybacks in this paper. Contrary to the literature that emerged as a result of the 1980s debt crisis[36], buybacks were not treated as the result of a planned government intervention, but rather as the natural outcome of market activity given the incentives of investors in the debtor and creditor countries. We showed that, in the event of a sovereign debt crisis, citizens of the debtor country have an incentive to repurchase the foreign debt, while creditors are willing to sell it. The framework also coherently explained the behavior of the government of the debtor country. Given that that debt repurchases are inefficient ex-post for the debtor

[35]Prominent examples are Balogh (1938), Bonnel (1940), Ellis (1941), Einzig (1934), Harris (1935) and Heuser (1934)

[36]For example Bulow and Rogoff (1988, 1991); Froot (1989); Kenen (1991); Krugman (1988, 1989); Sachs (1988a,b)

country, the government has an incentive to make trading in secondary markets, and therefore debt repurchases, difficult. This intervention can lead to the foreign debt not being bought back in its entirety and to debt securities trading at a strong discount abroad, while trading at face value at home.

We demonstrated throughout the paper that this framework applies extremely well to the German episode. Soon after buybacks began as a private initiative in the economic and political chaos of 1931, they were put under strict control by the German authorities. In the summer of 1931, the introduction of exchange controls, which gave the German central bank a virtual monopoly over all operations in foreign exchange, made debt repurchases dependent on the will of the Reichsbank. With the rise to power of the Nazis and the introduction of a complete Transfer Moratorium in the late spring of 1934, the control over the allocation and use of foreign exchange, and thus debt repurchases, by the German authorities became complete.

These events were reflected on the price of German bonds at home and abroad. The empirical analysis of Part 4, studied in detail the behavior of the price of German bonds in New York by identifying structural breaks in the series. The breaks identified econometrically were assigned a precise time horizon based on asymmetric confidence intervals and connected to key political and economic events. The results support the arguments made. Government interventions and other events which hampered the functioning of secondary markets and made buybacks difficult had sharply negative effects on the price of bonds. Other episodes, such as the unilateral elimination of the gold clause by the German government and various other reductions in the debt service, instead, did not lead to any break, hinting that well-functioning secondary markets were regarded as an element of foremost importance by foreign creditors. The price of German bonds in Germany followed a different path: after the tumult of 1931 and the closure of the Berlin stock exchange for almost a year until April 1932, bonds in Berlin recovered their value rapidly, trading close to face value for the rest of the decade. This indicates an extremely different valuation of the securities depending on where they were held, confirming that foreign and domestic bondholders faced a different probability of repayment.

The buybacks, however, were not suppressed altogether because they allowed the pur-

suit of specific micro-objectives for the German authorities. Key industries, companies and influential individuals benefited from the repurchases in several ways. Buybacks were used as a hidden subsidy to promote exports, as a tool to reduce debt exposure and a s a way to make large arbitrage profits. At the same time, their use as a systematic macro-tool was ruled out by the fact that it would have led to excessive debt repayment and welfare losses for the German economy as a whole.

This paper suffers from the shortcomings common to many studies of the interwar period. The issue of data availability has been partly mitigated by the reliance on primary sources and a dataset put together directly by the authors. The exceptional political and economic climate of the interwar years made the use of both official and private statements and other documents problematic. A number of these were used to corroborate the arguments made, but have to be taken with more than a grain of salt. Given that the motivations behind the decisions of German and foreign investors as well as the German authorities cannot not be observed directly, economic theory and econometric analysis were deemed to be the most effective tools of investigation.

This study of the German buyback episode has not exhausted all research possibilities. These could evolve in at least two directions. Firstly, a more precise breakdown of the buybacks both geographically and temporally could open the way to a detailed analysis of the effect of buybacks on bond prices. Secondly, studying the evolution of the price of German bonds in creditor countries other than the US would probably strengthen the case made in this paper, due to the similar evolution of German bond prices in all creditor countries.

In sum, this study contributes to both a better understanding of the episode of German buybacks in the interwar period and to the growing literature investigating the influence of secondary markets on sovereign risk. Recent work by Broner, Erce, Martin, and Ventura (Forthcoming) shows that this literature can help explain some puzzling features of the current European debt crisis. The interwar period may also yet yield some lessons for today.

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A Model extensions

A.1 Introducing Debtor Heterogeneity

This section introduces heterogeneity among the citizens of the debtor country, leaving all other assumptions unchanged. We show that, under certain conditions, introducing heterogeneity does not change the equilibrium of the model while in others it does.

Assume that the a share of the population of Debtor is composed of some influential agents supporting the government in charge, which we call "Supporters". The rest of the population is either opposed or not influential enough to have any leverage on the party (or coalition of parties) in charge. We call this group of people "Others". So we have $I^D = I^{DS} + I^{DO}$ where I^{DS} is the population of Supporters and I^{DO} are the others. We denote the proportion of Supporters and Others in the population as μ^{DS} and μ^{DO} respectively. We assume these proportions to be constant over time.

What sets Supporters apart from the Others is their greater ability to influence the Governments decisions. We model this feature by modifying the objective function of the Debtor Government as such (we have assumed $\gamma(e_D^D)$ arbitrarily small so that we can safely omit it once we have established the greater robustness of the optimistic equilibrium): (need to fix the funxtional form, this does not work if one group's utility becomes tiny it brings everything down!)

$$W^D = \left[\int u(c_{i1})\right]^{\alpha}\left[\int u(c_{j1})\right]^{1-\alpha} \text{ for } i \in I^{DO} \text{ and } j \in I^{DS} \text{ with } \alpha < \frac{1}{2} \tag{13}$$

Equation 13 tells us that the utilities of Supporters and Others enter the objective function of the Government multiplicatively and with a weight of $1-\alpha$ and α respectively. The assumption that α is smaller than $\frac{1}{2}$ insures that the utility of the Supporters receives a bigger weight than that of the Others relative to the sizes of the two groups. If we were to assume that the Supporters were as many or more than the Others, then the Supporters' utility would weigh more in the governments decision than that of the Others for any $\alpha < \frac{1}{2}$ also in absolute terms. Another way to obtain this result is for α to be small. How small depends on the relative sizes of the two groups.

The functional form chosen is the conventional Cobb Douglas, which satisfies the usual INADA conditions. This is very convenient for a variety of reason. First of all, concavity insures the presence of a maximum. Moreover, the limit of the partial derivative of the function with respect to the utility of a group goes to infinity as the utility of the group goes to zero. This means that as the utility of one group goes to zero, the welfare gain for the Government of transferring resources to it from the other group goes infinity. This is useful in our circumstances because it forces the government not to neglect either group completely. This is reasonable because even if Supporters have more leverage with the Government, it is intuitive to assume that the Others could eventually put it out of power if excessively vexed.

Before we proceed we rewrite equation 13 in aggregate terms to make the notation less burdensome. Capital letters denote country (C, D) and within country (DS, DO) aggregates.

$$W^D = \left[u(C_1^{DO})\right]^{\alpha}\left[u(C_1^{DS})\right]^{1-\alpha} \text{ with } \alpha < \frac{1}{2} \tag{14}$$

We have so far implicitly assumed that agents consume all their income after asset trade and debt repayment. We thus substitute C_1 for the income available for consumption Y_1.

$$W^D = \alpha\left[u(Y_1^{DO})\right]^{\alpha}\left[u(Y_1^{DS})\right]^{1-\alpha} \text{ with } \alpha < \frac{1}{2} \tag{15}$$

In the case of full enforcement, leaving all other assumptions unchanged implies that each Supporter and Other emits ε bonds Today, which are then repurchased by citizens of Debtor Tomorrow. The Debtor government enforces payments Tomorrow and we reproduce the optimistic equilibrium of the baseline case. We still have the assumption that when the government enforces domestic payments, it cannot discriminate among domestic debtors.

In the case of strategic enforcement we have a number of scenarios based on who in debtor country repurchases the debt from abroad. We first explore the extreme scenarios (only Supporters or Others repurchase debt) and then turn to the scenario in which both Supporters and Debtors repurchase a share of the debt.

A.1.1 Only Supporters repurchase debt from foreigners

1. *Only Supporters repurchase debt from foreign creditors*

   In this scenario the debtor government's objective function will be:

$$W^{D(1)} = \left[u\left(Y_1^{DO} + E^{DO} - e_D^D E^{DO}\right)\right]^{\alpha}\left[u\left(Y_1^{DS} + E^{DS} - (E^{DO} + E^{DS}) + (e_D^D)E^{DO}\right)\right]^{1-\alpha}$$
$$\text{with } \alpha < \frac{1}{2} \tag{16}$$

   where E is the aggregate of individual $\varepsilon' s$ so that the debtor Government's enforcement decision will be given by

$$\arg\max_{e_D^D} W^{D(1)}$$

   Given that e_D^D can take value either 1 or 0, the debtor government will enforce payments if

$$\left[u(Y_1^{DO})\right]^{\alpha}\left[u(Y_1^{DS})\right]^{1-\alpha} \geq \left[u(Y_1^{DO} + E^{DO})\right]^{\alpha}\left[u(Y_1^{DS} - E^{DO})\right]^{1-\alpha} \tag{17}$$

which implies that the gain to Others from non enforcement must be larger than the loss to the Supporters, valued through the utility function. The enforcement decision thus depends on a a number of parameters and namely

(a) α the weight given to the utility of Others and $1-\alpha$ the weight given to the utility of supporters. The smaller alpha, the more likely it is that the government will decide not enforce payments.

(b) The relative size of the two groups as expressed by their income Y_1.

(c) The size of the aggregate shock E. This depends on the size of the shocks ε to individual incomes relative to the size of the incomes, but also, again, the relative size of the two groups.

The important result here is that for some parameters values, the government will enforce payments ex-post and asset trade will therefore exist ex-ante.

Proposition 1

2. *Only Others repurchase debt from foreign creditors*

In this scenario the debtor government's objective function will be:

$$W^{D(2)} = \left[u\left(Y_1^{DO} + E^{DO} - (E^{DO} + E^{DS}) + e_D^D E^{DS}\right)\right]^{\alpha}\left[u\left(Y_1^{DS} + E^{DS} - (e_D^D)E^{DS}\right)\right]^{1-\alpha}$$
$$\text{with } \alpha < \frac{1}{2} \tag{18}$$

where E is the aggregate of individual $\varepsilon's$ so that the debtor Government's enforcement decision will be given by

$$\arg\max_{e_D^D} W^{D(2)}$$

Given that e_D^D can take value either 1 or 0, the debtor government will enforce payments if

$$\left[u(Y_1^{DO})\right]^{\alpha}\left[u(Y_1^{DS})\right]^{1-\alpha} \geq \left[u(Y_1^{DO} + E^{DS})\right]^{\alpha}\left[u(Y_1^{DS} - E^{DS})\right]^{1-\alpha} \tag{19}$$

which implies that the gain to Supporters from non enforcement must be larger than the loss to the Others, valued through the utility function. The enforcement decision thus depends on a a number of parameters and namely

(a) α the weight given to the utility of Others and $1-\alpha$ the weight given to the utility of Supporters. The smaller alpha, the more likely it is that the government will decide not enforce payments.

(b) The relative size of the two groups as expressed by their income Y_1.

(c) The size of the aggregate shock E. This depends on the size of the shocks ε to individual incomes relative to the size of the incomes, but also, again, the relative size of the two groups.

Again, t important result here is that for some parameters values, the government will enforce payments ex-post and asset trade will therefore exist ex-ante.

3. *Both Supporters and Others repurchase debt from foreign creditors*

In this scenario the debtor government's objective function will be:

$$W^{D(2)} = \left[u\left(Y_1^{DO} + E^{DO} - (E^{DO} + E^{DS}) + e_D^D E^{DS}\right)\right]^{\alpha}\left[u\left(Y_1^{DS} + E^{DS} - (e_D^D)E^{DS}\right)\right]^{1-\alpha}$$
$$\text{with } \alpha < \frac{1}{2} \tag{20}$$

where E is the aggregate of individual $\varepsilon' s$ so that the debtor Government's enforcement decision will be given by

$$\arg\max_{e_D^D} W^{D(2)}$$

Given that e_D^D can take value either 1 or 0, the debtor government will enforce payments if

$$\left[u(Y_1^{DO})\right]^{\alpha}\left[u(Y_1^{DS})\right]^{1-\alpha} \geq \left[u(Y_1^{DO} + E^{DS})\right]^{\alpha}\left[u(Y_1^{DS} - E^{DS})\right]^{1-\alpha} \tag{21}$$

which implies that the gain to Supporters from non enforcement must be larger than the loss to the Others, valued through the utility function. The enforcement decision thus depends on a a number of parameters and namely

(a) α the weight given to the utility of Others and $1-\alpha$ the weight given to the utility of Supporters. The smaller alpha, the more likely it is that the government will decide not enforce payments.

(b) The relative size of the two groups as expressed by their income Y_1.

(c) The size of the aggregate shock E. This depends on the size of the shocks ε to individual incomes relative to the size of the incomes, but also, again, the relative size of the two groups.

Again, t important result here is that for some parameters values, the government will enforce payments ex-post and asset trade will therefore exist ex-ante.

In Part 3.2 we assumed that the amount purchased by each debtor is δ_i changes from debtor to debtor. In this section we use this this to draw some Political Economy implications.

We first of all explore the case in which only Supporters repurchase debt securities from Creditors. In this instance the Government wil

We rewrite the government objective function as such

If we were to assume that Supporters can collude, however we would have a different outcome:

Supporters colluding means that they will not repurchase their debt back. However, in case of full enforcement Others might repurchase some of this debt. Since Others cannot collude we assume that they repurchase debt proportionally to the amount issued by each group of debtors. Since the resources at Others deisposal are not enough to repurchase all the debt we have as BMV Example 9.

But now imagine enforcement decision follows equation 11. Then enforcement will take place if increase in Others utility weighted is greater than loss of Supporters welfare weighted. So in case there are a lot of supporters or the weigh a lot, the government might not enforce and therefore there would be non secondary market or primary market. Internmational lending breaks down. If enorcement takes place we are again in example 9 of BMV.

If we imagined that the Supporters are richer and emit more debt. More to lose. Might want to explore this.

Show game thoeretic payoffs!

A.2 Introducing Creditor Heterogeneity

We now go back to the set up of the Baseline model. Hetereogeneity in both groups will be explored in the next subsection.

We now have that the population of the Creditor country is made of inofrmed and Uninformed creditors. So we have $I^C = I^{CI} + I^{CU}$ where I^{CI} is the population of Informed Creditors and I^{CU} are the Uninformed Creditors. We denote the proportion of Informed and Uninformed in the population as μ^{CI} and μ^{CU} respectively. We assume these proportions to be constant over time.

Informed creditors differ from Uninformed ones in their ability to acquire information from the Debtor country. Both groups have full information about Today, but any change in circumstances in the debtor country Tomorrow is only known to Informed creditors. This introduces a further time window in which the government or the debtors can make decisions. This matters if Debtors' access to secondary markets is restricted. This can be due to an

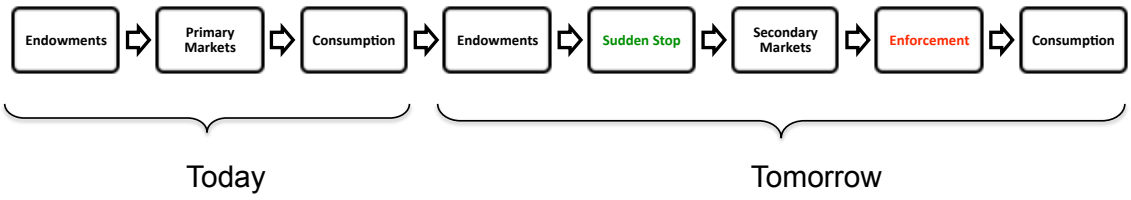
exogenous shock such as a sudden stop which limits the availability of foreign currency or as the result of a surprise Government intervention not internalized by domestic and foreign agents in period 0. This means that Today everything is the same as in the baseline.

So to explore the consequences of this heterogeneity in creditors let us assume that foreign exchange shortage in the debtor country leads to the debtor citizens having restricted access to secondary markets for debt. This is what Germany experienced as a consequence of the sudden stop of 1929/30. As discussed,however, the limited access to secondary markets was not only the outcome of this event, but also the product of deliberate government intervention. The conclusions from this section's model can thus be applied to the case when the government explicitly limits the access of debtors to secondary markets.

The set up is as follows. Now debtors can only use part of their resources to trade on secondary markets:

$$\psi_{i1}^{D} = \varphi_{i1}(y + \varepsilon) \text{ where } \varphi_{i1} \in [0, 1] \text{ for } i \in I^{D} \tag{22}$$

Equation 22 says that the resources to trade on secondary markets - ψ_{i1}^{D} - depend on the share of Tomorrow's income - φ_{i1} - which can be used to buy back bonds. For the time being, we assume that φ_{i1} takes a unique value between 0 and 1. Assume further that this restriction to market access takes place at the the start of period 1, so that in period 0 everything is the same as the optimistic equilibrium above:



Assume further that this change is not known to all creditors. There are two different types of creditors, a share μ_1^C is "informed" about evolutions in the debtor country while the rest is not.

Given this set-up two main scenarios are possible. In the first scenario, the resources available to debtors to trade in secondary markets are insufficient to repurchase all the primary markets debt holdings of all informed creditors at face value. In equations:

$$\int \psi_{i1}^{D} < \mu_1^C \int \chi_{j0}^{D} \text{ for } i \in I^{D} \text{ and } j \in I^{C} \tag{23}$$

Given that informed creditors are willing to sell their bonds at any positive price and that debtors are willing to repurchase any bond up to face value, but are limited to their foreign

exchange endowments, the secondary market price of the bonds will be:

$$\frac{\int \psi_{i1}^D}{\mu_1^C \int \chi_{j0}^D} < 1 \text{ for } i \in I^D \text{ and } j \in I^C \tag{24}$$

So that the secondary market of bonds depends on the resources of debtors and the share of informed creditors. The full equilibrium will be:

$$\text{Bond prices: } q_0^D = 1; \quad q_1^D = \frac{\int \psi_{i1}^D}{\mu_1^C \int \chi_{j0}^D}; \quad q_0^C = 1; \tag{25}$$

$$q_1^{CI} = \frac{\int \psi_{i1}^D}{\mu_1^C \int \chi_{j0}^D}; \quad q_1^{CU} = 0; \text{ for } i \in I^D \text{ and } j \in I^C \tag{26}$$

Consumption of Debtor Citizens (27)

$$c_{it} = \begin{cases} y & \text{at } t = 0 \\ y + \varepsilon - \underbrace{\varepsilon \mu_1^{CI}}_{\text{Debt to be repaid}} + \underbrace{\left(1 - \frac{\int \psi_{i1}^D}{\mu_1^C \int \chi_{j0}^D}\right)}_{\text{Arbitrage profit}} \underbrace{\delta_i}_{\text{Debt bought back}} & \text{at } t = 1 \text{ for } i \in I^D \text{ and } j \in I^C \end{cases}$$

Consumption of Informed Creditor Citizens (28)

$$c_{kt} = \begin{cases} y & \text{at } t = 0 \\ y - \varepsilon + \underbrace{\chi_{i0}^D \left(\frac{\int \psi_{i1}^D}{\mu_1^C \int \chi_{j0}^D}\right)}_{\text{Debt sold back}} & \text{at } t = 1 \text{ for } i \in I^D,\ j \in I^C \text{ and } k \in I^{CI} \end{cases}$$

Consumption of Uninformed Creditor Citizens (29)

$$c_{jt} = \begin{cases} y & \text{at } t = 0 \\ y - \varepsilon & \text{for } t = 1 \text{ and } j \in I^{CU} \end{cases}$$

Primary market bond holdings: (30)

$$\chi_{i0}^D = \begin{cases} -\varepsilon & \text{for } i \in I^D \\ \varepsilon & \text{for } i \in I^C \end{cases}$$

Secondary market bond holdings of Debtor citizens: $\chi_{i1}^D = \delta_i$ for $i \in I^D$ (31)

$$\text{where: } \int \delta_i = 0 - \int \psi_{i1}^D \text{ for } i \in I^D \tag{32}$$

Secondary market bond holdings of Creditor citizens at market value: (33)

$$\chi_{i1}^{D} = \begin{cases} 0 & \text{for } i \in I^{CI} \\ 0 & \text{for } i \in I^{CU} \end{cases}$$

Secondary market bond holdings of Creditor citizens at face value: (34)

$$\beta_{i1}^{D} = \begin{cases} 0 & \text{for } i \in I^{CI} \\ \varepsilon & \text{for } i \in I^{CU} \end{cases}$$

In Broner Martin and Ventura (2010, example 9, page 22)) and in our set up in Section A.1, creditors know in advance that debtors do not have enough resources to repurchase all the debt that would be issued in the case of full enforcement. This set-up translates into lower trading in primary markets and lower consumption and welfare in both countries, as well as a discount price of bonds in secondary markets. Here, instead, this comes as complete surprise; this is why bonds in circulation are the same as in the baseline case. Uninformed Creditors also do not know of which type other Creditors are and, therefore, there cannot be a signalling of informed creditors to uninformed ones. Moreover, informed creditors have no incentive to signal uninformed ones since this would reduce the value of the debt they hold as uniformed Creditors would scramble to sell their bonds to the Debtors left in the market. We also assume that debtors repurchase a fixed share of each debtors' bonds.

The value of the debt for Debtors remains $q_1^D = 1$, since the Debtor Government enforces payments between domestic citizens as in the baseline case. Therefore, they will be willing to repurchase the bonds at the market price $q_1^D = q_1^{CI}$, since it guarantees riskless arbitrage profits. Being this price lower than the face value of the debt (i.e. 1), and unaware of the disruption in the functioning of secondary markets, uninformed Creditors will not be willing to sell their holdings. In other words, while informed Creditors' reservation value has been updated based on changes in the debtor country, uninformed creditors reservation value has not changed.

As Debtors run out of resources, totally unexpectedly for the uninformed Creditors, the latter are left with their bonds unsold. At this point, they would be willing to sell at any positive price, but the resources at debtors disposal have been exhausted.

B The debt buybacks: alternative interpretations

In this appendix we survey in more detail alternative explanations for the debt repurchases carried out by German individuals and companies in the 1930s. We also briefly discuss some key papers from the first wave of research into debt buybacks which originated from the Latin American debt crisis of the 1980s.

B.1 Debt buybacks as export subsidies

Heuser (1934), together with many contemporaries, saw the buybacks as a way to subsidize German exports. The mechanism worked as follows. Due to the devaluation of the Pound and the Dollar following the departure from the Gold Standard of England and the United States, many German exports ceased to be competitive on world markets. If a company could demonstrate that its production costs exceeded world prices, the Reichsbank had the option of granting it the possibility of repurchasing German debt (blocked accounts or bonds) on foreign markets with part of the export proceeds and selling it back in Germany for much higher prices.[37] These exports were additional (in German: *Zusatzausfuhr*), in the sense that they would not have been possible without this disguised subsidy. The German government declared that, for this reason, they represented a source of foreign exchange, rather than a leakage.[38] On average only 50% of the export proceeds were used to repurchase bonds (at least officially), while the rest was handed over to the Reichsbank. Heuser argues that, for various reasons, Germany did not have at its disposal the policies normally employed to stimulate exports and reduce imports, an idea also supported by Child (1958). Devaluation, for example, was ruled out for both political reason and the large size of the foreign currency denominated debt, which would have increased dramatically in real value. Further deflationary policies in an already depressed economy, moreover, might have caused violent social unrest and additional capital flight. Finally, exchange controls limited imports, but, as a consequence, also increased the price of essential imported raw material and investment goods. The additional export system that exploited debt repurchases was, according to the author, one of the few options left to Germany to increase exports and maintain the debt service. This system was a essentially a way to depreciate the Reichsmark on export markets, while avoiding a depreciation in the exchange rate which would have led to an increase in the real value of foreign debt. More prosaically, Einzig (1934) wrote that Germany had found a way of "eating [its] cake and keeping it".

However, a number of authors have contested this view. Ellis (1941) expressed doubts as to whether the repurchase of bonds and blocked accounts could be directly linked to additional exports. He and other authors (Balogh, 1938; Child, 1958) also argued that the role of exchange controls and debt repurchases in trade policy gained some importance only in the middle of 1932, while the buybacks started already in 1931. Additionally, by tapping archival evidence from the *Wirtschaftsministerium*, Klug (1993) showed that the price differential between New York and Berlin was not considered high enough for the additional export practice to be beneficial, given the foreign exchange shortage faced by Germany. Klug also claims that the fact that German exports expanded most between 1934 and 1936, when buybacks were low, is a sign that these were not instrumental in Germany's foreign economic policy.[39]

[37] A detailed description of the mechanism can be found in Heuser (1934), page 212-214.

[38] FOLIO FHG/3, London School of Economics and Political Science Archive: The Repurchase of German Foreign Bonds, Berlin January 26 1934 (copy of a memorandum prepared in English by the German Government).

[39] This argument of course does not consider the fact that buybacks might have been low exactly because

B.2 Debt buybacks as a tool to reduce debt overhang

Klug (1993) argued that debt buybacks were an instrument to reduce Germany's debt overhang. This interpretation has its roots in the theoretical literature on debt buybacks which originated as a consequence of the 1980s debt crisis in Latin America. An intense debate arose among economists as they discussed different forms of debt reduction, including market-based ones such as debt repurchases. Opinions on the practice varied widely, with some authors considering buybacks a useful instrument within the toolkit of developing countries attempting to lower their debt, and others considering them outright harmful for both debtors and creditors.[40]

The main rationale for voluntary, market-based initiatives aimed at reducing the debt overhang is that they can help overcome the free rider problem among creditors (Froot, 1989). Each creditor has no interest in reducing her claims, especially if the debtor is believed to be on the wrong side of the debt Laffer curve. The reason is that, in this scenario, debt relief raises the value of expected repayment and thus of residual claims, benefiting creditors. So, although, as Krugman (1988), page 2 put it, "there is no magic in market-based debt reduction, as opposed to more straightforward approaches" such an approach might be chosen by the debtor country in order to overcome the creditor free rider problem. Another interpretation is that buybacks can be used as a signal of the willingness to reform (Fernandez-Ruiz, 2000). Froot, however, concludes that buybacks are difficult to work in practice, mainly due to the fact that finding the necessary resources is not trivial and that the exact dynamics behind the debt Laffer curve are difficult to measure.

Bulow and Rogoff make the classic case against buybacks. In Bulow and Rogoff (1988) the authors define buybacks schemes as boondoggles and argue that debtors cannot gain by unilaterally repurchasing their foreign debts if they do not receive concessions from creditors at the same time. This is because the buybacks simply translate into a subsidization of creditors with the use of scarce resources, which have a high opportunity cost. Moreover, by turning to the market, debtor countries pay a price corresponding to the average value of the debt, while the reduction of debt reflects its marginal value, which for highly indebted countries is lower. In other words, a debt repurchase reduces the market value of the debt minimally because the price of the residual debt increases. The authors cite the example of Bolivia, where a $34 million operation reduced the market value of the debt by a mere $400,000.[41] In Bulow and Rogoff (1991), the authors build on the insights of their previous paper. They formally show that when a country owes more than it can repay, even if

they were not needed to subsidize exports. Furthermore, the introduction of Schacht's New Plan in 1934, meant that Germany started engaging heavily in bilateral trade agreements. These often comprised clearing agreements and the direct exchange of goods which increased German exports considerably without the need of explicit or disguised subsidies.

[40] Although the systematic study of buybacks is relatively recent, their practice has a long history. While they were almost unknown in the 19th century, as the German episode demonstrates, they were widespread already in the 1930s (Klug, 1993).

[41] However, the authors argue that, in this case, the buybacks were a signaling strategy that allowed Bolivia to have access to IMF lending.

buybacks do reduce overhang and stimulate investment this does not translate into gains for the debtor country. The reason is that the resulting improvements in the economic outlook are foreseen by the creditors who demand higher prices to sell their debt. The authors show that creditors are able to extract more than 100% of the efficiency gains resulting from the reduction in debt overhang. So, as further elaborated by Detragiache (1994) buybacks can be beneficial for both debtors and creditors only when they take place in the context of further concession and the senioritization of existing debts relative to new ones.[42]

A limit of this literature is that it considers buybacks only in the context of a coordinated program by a highly indebted country trying to reduce its debt overhang. However, buybacks can also take place when the citizens and firms of a debtor country value the debt differently from creditors abroad. Classens and Diwan (1989) argue that the difference in valuation can arise in three instances: 1) discount factors differ between creditor and debtors, 2) creditors receive an amount different from that paid by the debtor, 3) the perceived probability of default is different for debtors and creditors. This list, however, does not exhaust the reasons why debt buybacks by private agents can take place. As discussed in Part 3, if the debtor government enforces payments between domestic agents, but not from domestic agents to foreign ones, debt will be valued more by the domestic agents. If a price differential arises due to these considerations, citizens of the debtor country will have an incentive to repurchase the country's foreign debt in order to make riskless arbitrage profits (Broner, Martin, and Ventura, 2010). The same mechanism applies even when the debtor government is unable to enforce payments because of a weak institutional environment. In this case, however, the citizens of the debtor country will repurchase the debt in order to insure themselves against enforcement errors (Broner, Martin, and Ventura, 2008).

In support of Klug's interpretation of the episode stands the wider experience of debtor countries in the 1930s. According to Eichengreen and Portes (1990a), page 4 "[. . .] market-based debt reduction made a useful contribution to resolving the debt crisis of the 1930s by reducing the debt overhang and eliminating marginal creditors". The authors, however, do not mention Germany in their assessment of the role of buybacks in the 1930s, even though it carried out by far the largest of such operations. James (1985) argues that buybacks contributed to restore German credibility abroad, a fact demonstrated, according to him, by the changes in the price of German bonds. In his study, Klug analyzes a large number of German bond issues in New York, finding that buybacks raised secondary market prices, but the effect was not strong. According to the author, this finding demonstrates that the Bulow and Rogoff (1991) framework does not apply to the German case. He therefore concludes that Germany might have marginally benefited from the buybacks due to debt overhang reduction.

Klug (1993) further claimed that the Nazi government was particularly attached to the practice of debt buybacks, even though these began well before it rose to power. Barkai (1990), however, argues that the Nazis had no clear economic ideology. Their method consisted in establishing some goals, and trying to reach them through trial and error and by leaving the technicalities to experts and bureaucrats, often outside the Nazi party, such as

[42]The seniorization of existing debts is necessary to avoid their dilution through excessive new borrowing.

those of the *Wirtschaftsministerium* and the Reichsbank. James (1985) argues that both Luther and Schacht used the pivotal role of the Reichsbank in foreign and economic policy to realise "their economic vision". These elements hardly suggest a harmonious and coherent economic policy in Germany in the first half of the 1930s. Klug mentioned that the large accounting profits, which private companies made through debt repurchases, have been indicated by some commentators as the main cause for the buybacks. He, however, dismissed this instance on the basis that this would not explain the behavior of the Nazi government. As he himself notes, however, the Nazi government eventually imposed its will on private initiatives of buybacks by severely restricting the availability of foreign exchange. Klug finally argues that buybacks took place mostly in countries where the threat to debtors in the form of trade disruption was most damaging to Germany. This consideration is also compatible with the argument in this paper. If credible sanctions increase the probability of repayment towards a country, the government has no reason to interfere with secondary markets since they do not influence the chance of repayment

What can be concluded from previous studies on the German buybacks in light of the framework we present in this paper is that the German governments of the 1930s managed to make the most out of an initiative that started spontaneously. It was not planned or introduced by the authorities. On the contrary, in order to extract some benefits out of it, it was kept under strict control. After all, the huge price differential between German bonds at home and abroad was a more than sufficient driver for investors to engage in debt buybacks. The practice, however, might have eventually led to the repayment of a large chunk - if not all - of the German external debt. Hence, Germany could have lost not only the possibility of repudiating its debt in the future or receiving more debt relief from its creditors, but also accessory benefits such as export subsidization. By restricting debt buybacks, Germany had no reason to repudiate its debt, and, in fact, Hitler himself did not consider this the best option (Klug, 1993). As long as the whole debt was not bought back, Germany could profit from the situation and keep its ties with international markets.

C Simulataneous estimation procedure

Sequential estimation of break dates, i.e. one by one, was developed and refined due its low computational cost and the asymptotic properties of the estimator. The procedure begins by performing a parameter constancy test for the whole sample. If the test indicates the presence of a break, one calculates the SSR as a function of a *single* break for the whole sample. The date T_α that minimizes the SSR is selected as a candidate break date, and the full sample is split in two subsamples at date T_α. The procedure is then repeated for each subsample, until the parameter constancy test suggests that no other breaks are present on any of the subsamples. The key theoretical insight comes from Chong (1995), who proves that even in a misspecified model with an insufficient number of breaks, the estimator described above consistently estimates one of the true breaks, relying only on a number of least squares operations of order T. Bai (1997a) provides limiting distributions for the estimated break dates and shows that the procedure above also consistently estimates the number of breaks

m.

Bai (1997a,b) introduced an improved version of the procedure that is also asymptotically efficient, which is referred to in the literature as iterative refinements or as repartition method. The refinement involves re-estimating all break dates identified by the standard sequential procedure described above: this can be done either at the end, when all break dates have been identified, or when only a number of them have been identified. If two breaks have been identified, say, T_α and T_β, with $1 < T_\alpha < T_\beta < T$, then T_α will be reestimated by applying the sequential procedure over the subsample $[1, T_\beta]$ (including the parameter constancy test) if T_α was the first break to be identified; otherwise T_β will be reestimated over the subsample $[T_\alpha, T]$.

We illustrate the first steps of the repartition method in the following example. Figure 6 graphs the sum of squared residuals for the whole sample of the Dawes bonds as a function of a *single* break date. One can clearly discern a global minimum T_α for the week ending on 19/08/1939, denoted by an asterisk. Local minima are noticeable throughout the sample, denoted by circles. In the first step of the sequential procedure the sample will be split in two at the global minimum on 19/08/1939; we define $T_0 = 28/12/1929$ and $T = 15/06/1940$. In subsample $[T_0, 19/08/1938]$ a break is identified on 24/02/1934; in the subsample $[26/08/1939, T]$ no evidence is found in favor of a break, despite the presence of a local minimum identified in the first step: this is likely due to the closeness to the end of sample, together with the explosive behavior of the series in that short subsample. We can now proceed to a refinement step by reestimating the first break in the subsample $[03/03/1934, T]$.

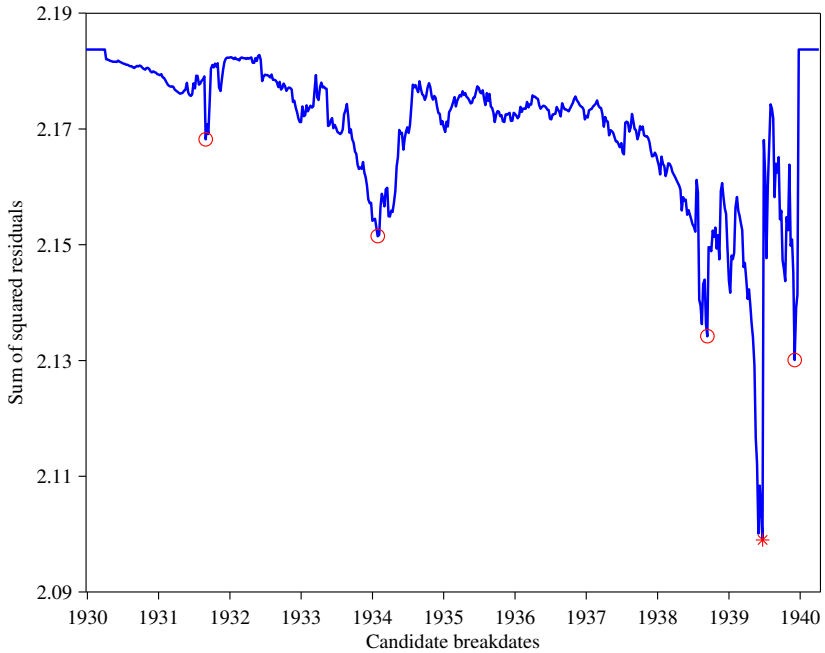


Figure 6: Sum of squared residuals as a function of a single break - Dawes bond series