Chapter 4

Enforcement of sovereign debt under war reparations

4.1. Introduction

Sovereign debt is paid back most of the time, despite creditors not having many remedies to enforce debt contracts. Countries pay back their loans because they want to be able to borrow again, or to avoid financial sanctions. Unlike in corporate bankruptcies, and outside of military intervention, no one can force a country to pay its sovereign liabilities. One such extreme and rare example is that of war reparations, which has often been directly linked to the removal of occupying troops. As a result, sovereigns generally do not directly default on war reparations.[66] The reason that defaults on reparations are rare is that they have political consequences far and above normal sovereign defaults, which themselves are not costless. Recent sovereign defaults in Greece saw political interference in exchange for financing during the Eurozone crisis, and China has taken possession of critical infrastructure from its debtors.[67] The most famous example of reparations is probably that of German World War I reparations. Germany defaulted on its sovereign debt in 1933 but did not default on reparations themselves.[68] Reparations were negotiated to a standstill and effectively ended at the Lausanne Conference in 1932, a year before the sovereign debt default.

This paper shows how episodes of war reparations exhibit many of the same characteristics of sovereign defaults yet were repaid. The literature on sovereign debt defaults has shown that defaults typically occur after a sharp contraction in output, are followed by a devaluation of the currency, and are costly. The devaluation of the currency lowers the

[66] Examples are discussed in section 2.1.
[67] An example is Sri Lanka handing over control of its Hambantota Port to China in 2017 (Abi-Habib 2018).
[68] The 1922 refusal to pay reparations is discussed later in the paper. The sovereign default is dated according to Hjalmar Schacht (1967, p. 137-41), but various debts were defaulted on at different times.

relative price level and real wages. Governments choose to default when it is economically beneficial not to pay interest and principal and instead incur the loss associated with a default and financial autarky. The costs of default are both the inability to smooth consumption, by not being able to borrow again, as well as an explicit output loss that occurs because of the default. To account for these stylised facts, I apply a sovereign debt model by Na, Schmitt-Grohé, Uribe, and Yue (2018) to the Franco-Prussian War indemnity, to German interwar reparations, and to Finnish World War II reparations. This narrow set of reparations cases are the largest transfers (over 20 percent of GDP) where there was agreement to pay in a relatively short time span (less than ten years). I collected data for the output, interest rates, debt stocks, wages, and exchange rates (nominal and real) for each episode. Common for them was that reparations were paid because they were enforced by military or political power, even if the country was situation in the default set of the model.

The case of Franco-Prussian War indemnities features several default-like characteristics (output contraction and high debt levels) but sees no devaluation nor a fall in real wages. Its stock of foreign assets allowed France to borrow money quickly to repay the indemnity, and despite briefly being strictly in the default set, I argue that repayment made sense. Conversely are the cases of German and Finnish reparations. German real output contracted by over 20 percent during the hyperinflation of the Weimar Republic (1921-23), as Germany refused to pay reparations in 1922. It was forced to resume negotiations by military force after the Allied occupation of the Ruhr. Reparations were rescheduled in 1924 and were subsequent paid throughout the 1920s, financed by capital inflows (Feldman 1993, p. 631-69). Once capital flows reversed by the 1930s, austerity replaced debt which translated into output losses and a downward adjustment to real wages, which were too high because of the gold standard (for an overview of this debate, see e.g., James 1986, Borchardt 1990, Holtfrerich 1990, or Ritschl 2002). At this point, the European nations did not have the ability to enforce debt contracts and the U.S. agreed to a de facto cancellation of reparations. Despite no obvious nominal devaluation accompanying the default, once stealth interventions and export subsidies are accounted for, the German default is well explained in the model. Finnish reparations in the 1940s were repaid under great economic strain and the economy exhibited all the characteristics normally associated with a default. Unable to default because of geopolitical considerations, it took Finland longer to grow because large parts of its domestic resources went to produce reparations.

In all three historical episodes, the level of debt and output losses lie within the default set at one point, implying that the optimal economic policy would be to default. Because it

was not possible to default on war reparations because they were enforced, economic policy was suboptimal in the cases of Germany and Finland.

4.2. Related literature

Sovereign defaults are unlike private defaults because creditors generally cannot take control of sovereign assets through enforcement of debt contracts. Commercial assets can be seized, but official foreign assets (such as embassies, military bases, or consulates) tend to be immune from creditor attachment (Buchheit 2013). Despite the limited enforcement mechanism, most sovereign debt is still repaid. Two reasons have generally been offered to explain why: countries want to maintain a good reputation, and they want to avoid facing financial sanction. The reputational explanation originating with Eaton and Gersovitz (1981) explains repayment of sovereign debt as an incentive to borrow again. A default causes an exclusion from capital markets for a period, which means the country cannot borrow to smooth consumption.[69] The incentive to repay sovereign debt is thus not a legal one. In the literature on sanctions, meanwhile, creditors have certain legal remedies to force economic sanctions on the defaulter (Bulow and Rogoff 1989a, 1989b).[70]

Recent sovereign defaults have carried high costs, but countries were nevertheless able to make the decision to default (see e.g., Kuvshinov and Zimmermann 2019). War reparations are different. They are a special case of sovereign debt because the enforcement mechanism is binding, often by military occupation or the threat of occupation. The case of war reparations is thus an extreme version of 'gunboat diplomacy'. Gunboat diplomacy, or imposed fiscal control, was commonly used to ensure repayment after default before World War I. In the period between 1870 and 1913 more than 40 percent of sovereign defaults resulting in sanctions (Mitchener and Weidenmier 2010). Sanctions and enforcement of debt contracts happened either through creditor countries' legal or military power, or because international banks got involved. Banks were able to set conditions on loans because they had legal and military remedies to monitor and enforce their claims, and thus acted as a lender of reputation to ensure payment (Flandreau and Flores 2012).[71] The practice of militarily enforcing sovereign debt became much less common after the Drago Doctrine was adopted

[69] Defaults occur when countries find debt service to be costlier than a default (e.g., Arellano 2008 or Bocola et al. 2019). Most papers specify a time-period where the country is excluded from capital markets.
[70] See e.g., Aguiar and Amador (2014) for a recent contribution. An example of a sovereign asset seizure was when the hedge fund Elliott seized an Argentine navy ship in Ghana in 2012 to collect on defaulted bonds from the 2001 restructuring (Cotterill 2012).
[71] For a list of case studies during the period, see e.g., Tunçer (2015).

by the Hague Conference in 1907. The Drago Doctrine states that military force should not be used to enforce sovereign debt payments.

The reparations studied in the paper were paid under the threat of violence, or after direct occupation. They were inspired by the quick repayment of Napoleonic Wars reparations from 1815, where France was occupied until reparations were repaid (see e.g., Oosterlinck et al. 2014). The withdrawal of Prussian troops from France was directly linked to repayment of the Franco-Prussian War indemnity, which was repaid in three years (Devereux and Smith 2007). German World War I reparations had to be enforced by occupation of the Ruhr in 1923, after Germany refused to pay initially (Ritschl 2012a), while Finnish war reparations following World War II were paid because of its close relationship and dependency on the Soviet Union. Table 4.1 shows the size of each reparation in terms of GDP and in annual cost, as well as Napoleonic Wars reparations for comparison.[72]

	Debt stock before reparations	Reparations	Annual debt service and reparations cost	Reparations and interest costs (percent of government taxes)
1815-19: Napoleonic Wars	15	22	7	70
1871-73: Franco-Prussian War	55	25	9	72
1923-33: WWI (Germany)	72	100	13	44
1945-52: WWII (Finland)	61	20	3	15

Sources: Calculated from Oosterlinck et al. (2014); White (2001, p. 351); Ritschl (1996, 2012); and Pihkala (1999, p. 32-35). Note: Finnish reparations were paid in-kind but converted to money equivalent.

Table 4.1: Comparison of reparations (in percent of GDP).

When estimating Germany's capacity to pay after World War I, diplomats and politicians looked to what amounts France paid fifty years earlier (Marks 2013). German headline reparations were bigger in terms of GDP, but not in terms of the government's capacity to levy taxes. French reparations in the nineteenth century represented 70 percent of government tax revenue, while in Germany it was 44 percent and for Finland as low as 15 percent. All three countries saw steep declines in output around the time that reparations were imposed, with growth shocks bigger than what is normally associated with sovereign defaults. The difference from many other cases of sovereign debt defaults was an inability to default due to military occupation or political pressure. The amounts paid for war reparations in all cases were large, both in an absolute sense and relative to state capacity, with debt stocks already sizeable after each war.

How did the countries manage to pay the transfers under stretched capacity to pay? Was it simply that creditors could enforce reparations, or did market access gains outweigh the cost of repaying the total debt including reparations? To answer the questions, it is worth to

[72] See section 2.1 for a discussion of other war reparations.

understand when countries are normally willing to repay debt. One way is to look at sovereign debt models where the government is in control of both the decision to default and conducts optimal monetary policy. The latter ensures the government can devalue its currency, to lower real wages, while the decision to default is taken when the benefits from continued borrowing no longer outweighs the costs of default. Such a model allows to characterise a default set, which can be compared to the historical episodes of reparations. The combination of default and devaluation is empirically founded as it has been observed in many emerging markets during defaults (Reinhart 2002). The goal is to figure out if reparations are considered payable in terms of a standard sovereign debt analysis. If the macroeconomic conditions lie outside what is normal willingness to pay, the reason for repayment is likely to be found in the political economy.

4.3. A model of optimal default

Sovereign debt models can provide a framework in which the cost of servicing sovereign debt is quantified against the benefits of repayment. In the model on the following pages, a benevolent government can free up domestic balance sheets by defaulting, but it results in an output loss and removes the country's ability to borrow money.[73] In the model, the government chooses to default or repay sovereign debt, based on a value function. The nominal exchange rate is set unilaterally by the government, which can counteract any (potential) distortions from wage rigidities via monetary and exchange rate policies. The predictions of the model can then be used for both the nineteenth century with limited wage rigidities and the twentieth century.[74] In the nineteenth century wages were flexible, while in the twentieth century the nominal exchange rate adjusts real wages lower (see section 4.4.3 for a discussion of how this applies to Germany under the gold standard). Because of the adjustment mechanism, if it makes sense to default in a floating exchange rates regime, it makes even more sense in a world of fixed exchange rates.[75]

The model is the optimal monetary policy version of Na et al. (2018). The point of the analysis is to understand if the macroeconomic conditions, with and without reparations, should lead to default. One complicating factor in the analysis of sovereign debt is that defaults are often endogenous. Defaults can be caused by a series of negative shocks to the

[73] As is standard in the literature and an empirical feature of sovereign debt defaults (see e.g., Borenztein and Panizza 2008, Furceri and Zdzienicka 2012, or Hébert and Schreger 2017).
[74] See Eichengreen (2008) for a general discussion of wage rigidities.
[75] To adjust the relative real wage and the price of non-traded goods in a fixed exchange rate system, unemployment would have to rise. A devaluation would adjust this via the exchange rate instead.

economy *and* defaults can cause a loss of output. Both are common, as shown by Esteves et al. (2021) who use a narrative approach to find that historically exogenous causes of default are more common, but endogenous factors are becoming more frequent. They find that 62 percent of sovereign defaults between 1870 and 2010 can be explained by exogenous factors, with terms of trade shocks and political factors the most regular causes of default. In their sample, they also find evidence that default causes output to fall.[76] The latter evidence is generally, and in this paper, used as a justification for an exogenous cost of default.

The model allows us to observe certain stylised facts around sovereign debt defaults, with the default set a function of the benefits and costs of repaying debt. The value functions allow for a characterisation of what can be considered optimal policy in terms of whether to default or not. The model can then be measured against the historical setting of war reparations and whether the cases lie in the default set. It is calibrated to the French economy in 1870-73, the German economy in 1930-33, and the Finnish economy in 1945-48. The model helps to quantify if the costs of repaying reparations were above a level at which countries normally default. If the answer is yes, it suggests that countries should have defaulted on reparations and entered autarky but were unable to because sovereign debt was enforced by occupation. The next few pages present the model.

4.3.1. Government

The model is of a small open economy where the government borrows on international debt markets. The economy consists of the government, homogeneous firms that are perfectly competitive, and households that have identical preferences. The government can either be in default or not. If the country is repaying its debt, $R_{t-1} = 1$, whereas if the country defaults at the start of the period, then $R_t = 0$. Default implies that the country has lost all access to borrowing on international debt markets. If the country is in default, it exits default in $t + 1$ with probability θ and remains in default with $1 - \theta$ probability. A default is defined as a total default on all external debt.[77] If $R_t = 1$ then households receive a lump-sum payment for the debt tax that the government levies, F_t, which is expressed as $g_t = F_t / P_t^T$ in terms of tradable goods, where P_t^T is the nominal price of tradables. If the country is in default, the

[76] Their sample does not include the Iraqi default in chapter 5, which experienced a large negative output loss both before and after the sovereign default.
[77] It means there is no recovery value on defaulted bonds. Cruces and Trebesch (2013) show that higher haircuts lead to longer exclusion from capital markets, which can be captured by lowering the parameter θ.

payments that households would have made to foreign lenders are confiscated and returned to the households. The sequential government budget constraint is then

$$g_t = d_{t+1} q_t^d \tau_t^d + (1 - R_t) d_t, \tag{4.1}$$

where d_{t+1} is the level of debt at t to be repaid at $t+1$, q_t^d is the price of one unit of face value debt; and τ_t^d is the tax collected on debt. The debt is denominated in tradable goods so that the effect can be measured in consumption. It follows the standard Eaton-Gersovitz allocation of debt with centralised borrowing and centralised default. Households take the country premium on borrowing as exogenously given, while the government internalises it into the country risk premium it pays on its external debt. The price of debt must satisfy a risk-neutral foreign lender that wants to cover their opportunity cost of capital, i.e., lenders are expected to earn the same return abroad as at home

$$\frac{Pr\{R_{t+1}=1|R_t=1\}}{q_t} = 1 + r^*. \tag{4.2}$$

Which means that the country spread is simply the probability of default in the next period.

4.3.2.Firms

Each firm will want to maximize profits, Π_t, and produce nontraded output according to

$$y_t^N = F(h_t), \tag{4.3}$$

where the function is concave and increasing. The input is simply labour h_t, provided by the households who are paid nominal wages, W_t. Firms maximise profits according to

$$\Pi_t = P_t^N F(h_t) - h_t W_t, \tag{4.4}$$

which can be rewritten as

$$p_t F'(h_t) = w_t, \tag{4.5}$$

with $w_t = W_t / P_t^T$ being the real wage in terms of tradable goods, and $p_t = P_t^N / P_t^T$ the relative price of nontradables in terms of tradables.

4.3.3.Households

Households are alike and make decisions based on information available to them at present time, with constant relative risk aversion. Their utility is maximised with respect to

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t) = \left(\frac{{c_t}^{(1-\sigma)}-1}{(1-\sigma)}\right), \tag{4.6}$$

with c_t being total consumption, the parameter $\beta \in (0,1)$ denotes the discount factor, and U is assumed to be concave and increasing. c_t is a composite of the two types of consumption: traded c_t^T, and non-traded c_t^N, and is given by its CES aggregator function

$$c_t = A(c_t^T, c_t^N) = \left[a{c_t^T}^{1-\frac{1}{\xi}} + (1-a){c_t^N}^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}}, \tag{4.7}$$

where A is a linearly homogenous function that is concave and increasing, a is the percentage of tradables in the total consumption basket, and ξ is the elasticity of substitution between tradables and nontradables. The firms are owned by the households in a uniform manner, and they therefore receive the profits from said firms. The household budget constraint is given by

$$P_t^T c_t^T + P_t^N c_t^N + P_t^T d_t = h_t W_t + \Pi_t + F_t + (1-\tau_t^d) P_t^T d_{t+1} q_t^d + P_t^T \tilde{y}_t^T. \tag{4.8}$$

The left (top) side of the equation is each household's spending, which consists of consumption of tradable and nontradable goods, plus their debt. The right-hand side of the equation is each household's income from their labour, profits from firms they own, the lump-sum payment (F_t), τ_t^d a tax on debt income received from the ownership of foreign debt, with $\tilde{y}_t^T$ being each household's endowment of traded goods, which is given and stochastic. In reality, τ_t^d can be thought of as a tax on capital flows, such as reserve requirements on banks or capital controls.

People in this economy are subject to no-Ponzi conditions. The relative price of nontradables, p_t, can be written as

$$p_t = \frac{A_2(c_t^T, c_t^N)}{A_1(c_t^T, c_t^N)}, \tag{4.9}$$

$$\Upsilon_t = U'(c_t) A_1(c_t^T, c_t^N), \tag{4.10}$$

$$\beta E_t \Upsilon_{t+1} = (1-\tau_t^d) q_t^d \Upsilon_t. \tag{4.11}$$

The household budget constraint therefore uses the Lagrange multiplier, Υ_t / P_t^T. Households supply inelastic labour $\bar{h}$ and it is assumed that $\bar{h} = h_t$, meaning the economy is at full employment. The assumption here is that the central bank stands ready to counteract any

distortions from nominal wage rigidities by devaluing the exchange rate, to ensure that the real wage is lowered.

4.3.4.Equilibrium

Households optimise their utility subject to their budget constraints and choose the composition of their consumption basket and borrowing. In equilibrium, the market for nontradables clears

$$c_t^N = y_t^N. \tag{4.12}$$

Each period, the country receives y_t^T endowment per household, stochastically and exogenously decided. To ensure there is a cost associated with default, it is assumed that $L(y_t^T)$ is a loss-function that is positive and increasing, so that

$$L(y_t^T) = max\{0, \delta_1 y_t^T + \delta_2 (y_t^T)^2\}.$$

If the country is not in default, output is simply equal to the endowment y_t^T. The loss-function also dissuades countries from defaulting during boom-times. The natural logarithm of tradable output y_t^T, follows the law of motion and is given by

$$ln(y_t^T) = \rho\ ln(y_{t-1}^T) + \eta\ \mu_t, \tag{4.13}$$

where μ is an independent random variable with mean equal to zero and standard deviation η, while ρ is a positive parameter with a value between zero and one governing the autocorrelation of output. The total consumption of tradables is chosen according to

$$c_t^T = y_t^T - (1 - R_t)L(y_t^T) + R_t[q_t d_{t+1} - d_t]. \tag{4.14}$$

When the country is not in default, the price of its debt q_t^d, must equal what is offered by foreign lenders q_t, otherwise nobody would be willing to offer credit, so that

$$R_t(q_t^d - q_t) = 0. \tag{4.15}$$

It follows that the law of one price also holds for actual prices, like with the price of money, so that

$$P_t^T = P_t^{T*}\varepsilon_t,$$

where ε_t is the nominal exchange rate from last period to t.[78] The price of foreign traded goods is normalised to one for simplicity. Finally

[78] When ε_t goes up, the currency for the donor country depreciates.

$$(1 - R_t)\tau_t^d = 0, \tag{4.16}$$

$$(1 - R_t)d_{t+1} = 0, \tag{4.17}$$

$$R_t\left[q_t - \tfrac{E_t R_{t+1}}{1+r^*}\right] = 0, \tag{4.18}$$

$$\tfrac{A_2\left(c_t^T, F(h_t)\right)}{A_1\left(c_t^T, F(h_t)\right)} = \tfrac{w_t}{F\prime(h_t)}. \tag{4.19}$$

Given the assumption of optimal monetary policy, the government can set the exchange rate ε_t and the level of the debt tax τ_t^d. Then the stochastic processes of consumption c_t^T, labour h_t, debt in the next period d_{t+1}, and the price of debt q_t, are given by processes of traded output y_t^T and the choice of default R_t, and initial condition of debt d_0.

4.3.5.Default

The government only engages in default when it is economically beneficial to do so. Default occurs when the loss of output by repayment v^r, is bigger than default v^d, or

$$v^r(y_t^T, d_t) < v^d(y_t^T). \tag{4.20}$$

The left-hand side of the equation is the value of being able to access international capital markets, and the right-hand side is the value of being in default. Continued repayment $R_t = 1$, has a value of

$$v^r(y_t^T, d_t) = \underset{\{d_{t+1}, h_t, c_t^T\}}{max} \left\{U\left(A\left(c_t^T, F(h_t)\right)\right) + \beta E_t v^g(y_{t+1}^T, d_{t+1})\right\}. \tag{4.21}$$

Where the last expression is the value of continued markets access, the optimal level of $h_t = \bar{h}$, and it is subject to

$$c_t^T + d_t = y_t^T + q(y_t^T, d_{t+1})d_{t+1}.$$

The value of default (v^d) and the value of having access to capital markets (v^g) are

$$v^d(y_t^T) = \underset{h_t}{max} \left\{ \begin{matrix} U\left(A\left(y_t^T - L(y_t^T), F(h_t)\right)\right) + \\ \beta E_t\left(\theta v^g(y_{t+1}^T, 0) + (1 - \ \theta)v^d(y_{t+1}^T)\right) \end{matrix} \right\}, \tag{4.22}$$

$$v^g(y_t^T, d_t) = max\{v^r(y_t^T, d_t), v^d(y_t^T)\}. \tag{4.23}$$

The default set is then given in terms of tradable-output levels of d_t

$$D(d_t) = [y_t^T : v^r(y_y^T, d_t) < v^d(y_t^T)]. \tag{4.24}$$

Equation (4.24) can be thought of as the optimal policy reaction of when to default, given the government's wish to maximise the full-employment real wage

$$w^f(c_t^T) = \frac{A_2\left(c_t^T, F(\bar{h})\right)}{A_1\left(c_t^T, F(\bar{h})\right)} F'(\bar{h}).$$

The probability of default in the next period if the country is repaying is

$$Pr\{R_{t+1} = 0 | R_t = 1\} = Pr\{y_{t+1}^T \in D(d_{t+1})\}, \tag{4.25}$$

and the price of the country's debt as a function of tradable output and the debt level is

$$q(y_t^T, d_{t+1}) = \frac{1 - Pr\{y_{t+1}^T \in D(d_{t+1}) | y_t^T\}}{1 + r^*}. \tag{4.26}$$

It is therefore possible to give the optimal size of the devaluation by, specified by the policy rule that stabilises nominal wages

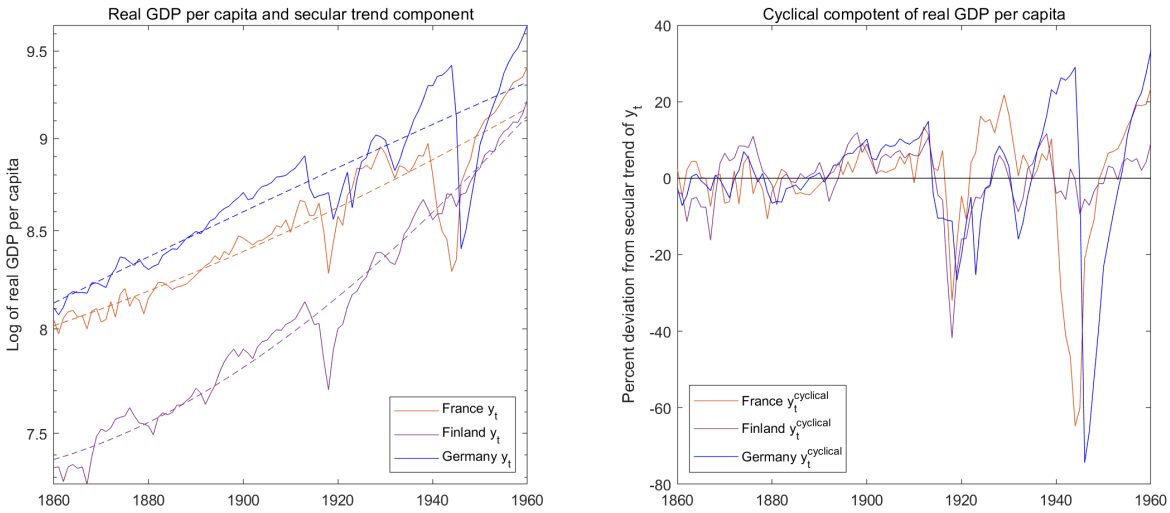
$$\varepsilon_t = \frac{w_{t-1}}{w^f(c_t^T)}. \tag{4.27}$$

It is assumed that that the government sets the optimal level of exchange rates as the regime is that of optimal monetary policy. As shown by Na et al. (2018), the value functions under the assumption of optimal monetary policy are similar to Arellano (2008).

4.3.6. Calibration

The model is calibrated to France in the 1870s (the Franco-Prussian Wars indemnity); Germany in the 1930s (World War I reparations); and Finland in the 1940s (World War II reparations). The output process of (4.13) is estimated using ordinary least squares for each of the episodes. Figure 4.1 shows real GDP per capita from 1860 to 1960 for the countries studied, with the log of output and the structural trend on the left, and the cyclical component obtained by log-quadratic detrending on the right.[79]

[79] The choice is motivated by the fact that a log-quadratic approach explains a lot more of the cyclical deviations than a log-linear approach. Appendix 4a (section 4.6) shows that a log-linear and HP(100) filter approach does not alter the results.



Source: Bolt et al. (2018) data for output. Note: log-quadratic detrending used to obtain cyclical trend. The dashed line is the secular trend (left-hand). Replication file, *lqtrend_p2.m*.

Figure 4.1: Secular and cyclical components of real GDP (1860-1960).

The autocorrelation and standard deviation of the cyclical trend used in the model are estimated from 1860 to 1930 before the German default. It therefore avoids the volatile period of the Second World War in the standard deviation parameter.[80] The output process yields the following for the three countries

$$ln(y_t^T)_{France} = 0.932\ ln(y_{t-1}^T) + 0.037\mu_t,$$
$$ln(y_t^T)_{Germany} = 0.932\ ln(y_{t-1}^T) + 0.039\mu_t,$$
$$ln(y_t^T)_{Finland} = 0.932\ ln(y_{t-1}^T) + 0.043\mu_t.$$

In addition to the autocorrelation of output, several parameters are used across the three episodes. All are standard in the literature and follow Na et al. (2018). The inverse of elasticity of intertemporal substitution of consumption is set at $\sigma = 2$, while the elasticity of consumption between traded goods and nontraded goods is $1/\sigma = 0.5$. The share of tradables in consumption is $a = 0.26$. Steady state traded output y^T and the labour endowment $\bar{h}$ are both set at unity. The value of the subjective discount factor $\beta = 0.85$, which might seem low but higher values of β worsens the overall fit of the model.[81] The range for traded output is set between 0.7 and 1.5.[82] The debt range for France and Finland is set between 0 and 1.5, while for Germany the upper range is 2. Appendix 4b shows the

[80] Autocorrelations of the cyclical component of real GDP are 0.958 (France), 0.941 (Germany), and 0.907 (Finland) for annual data. To avoid unrealistic distributional assumptions in making the number into quarterly to fit the model, the standard parameter in the literature is used for ρ. The standard deviations would be 0.072, 0.083, and 0.042 if the full period to 1960 was used.

[81] Appendix 4c (section 4.8) shows the sensitivity of output for various values of β.

[82] Following Na et al. (2018), 200 grid points are assumed for both output and debt. Their simulation approach for computing the transition probability matrix for tradable output is used.

debt density graphically for the two debt ranges, which are well outside each country's actual minimum and maximum debt levels, as per Table 4.1 earlier. The time unit of the model is in quarters of a year.

			France (1870-73)	Germany (1930-33)	Finland (1945-48)
Episode specific	α	Labour share in the non-traded sector	0.64	0.60	0.75
	r^*	Risk free return (quarterly)	0.0092	0.0035	0.0024
	θ	Probability of escaping default	0.0385	0.0312	0.0385
	δ_1	Loss-function	-0.35	-0.32	-0.32
	δ_2	Loss-function	0.44	0.42	0.40
	η	Standard deviation of μ	0.037	0.039	0.043
Standard parameters (same across)	ρ	Autocorrelation of output	0.932		
	σ	Inverse of elasticity of substitution in consumption	2		
	ξ	Elasticity of substitution between traded and non-traded	0.5		
	a	Share of tradables	0.26		
	y^T	Steady-state traded output	1		
	$\bar{h}$	Labour endowment	1		
	β	Discount factor	0.9		
Discretization of state space		Debt range	0 to 1.5	0 to 2	0 to 1.5
		Traded output range	0.7 to 1.5		
		Grid points for output	200		
		Grid points for debt	200		

Table 4.2: Model parameters.

The rest of the model parameters are episode specific. For the calibration of the French economy between 1870 and 1873, I follow Devereux and Smith (2007). The labour share of the non-traded sector is $\alpha = 0.64$, which is slightly lower than the literature. It is justified by a larger share of profits and rents to fixed factors than is the case in more recent studies. The annual world risk-free interest rate at the time was 3.7 percent. The time-unit of the model is a quarter, so $r^* = 0.0092$. It is the average interest rate of U.K. prime bank bills between 1870 and 1873, which was the largest bond market at the time.[83] Because France did not default, the parameter setting the length of default is $\theta = 0.0385$ following Chatterjee and Eyigungor (2012). The value implies that the country is in default on average for around 6.5 years.[84] The first loss-function parameter, δ_1, is calibrated to -0.35 while the second is estimated, $\delta_2 = \frac{(1-\delta_1)}{2}/max(y^T)$. Taken together with $\beta = 0.9$, it implies an average debt-to-GDP ratio around 72 percent for France when it is not in default, close to its actual debt-to-GDP in 1871.

[83] Chițu et al. (2014) show the U.S. dollar overtook Sterling as the dominant currency for bond issuance around the Great Depression. Accordingly, the U.S. is used as the risk-free rate for Germany and Finland.
[84] A default of 6.5 years is around the average for 100 systemic crises (Reinhart and Rogoff 2014, p. 50).

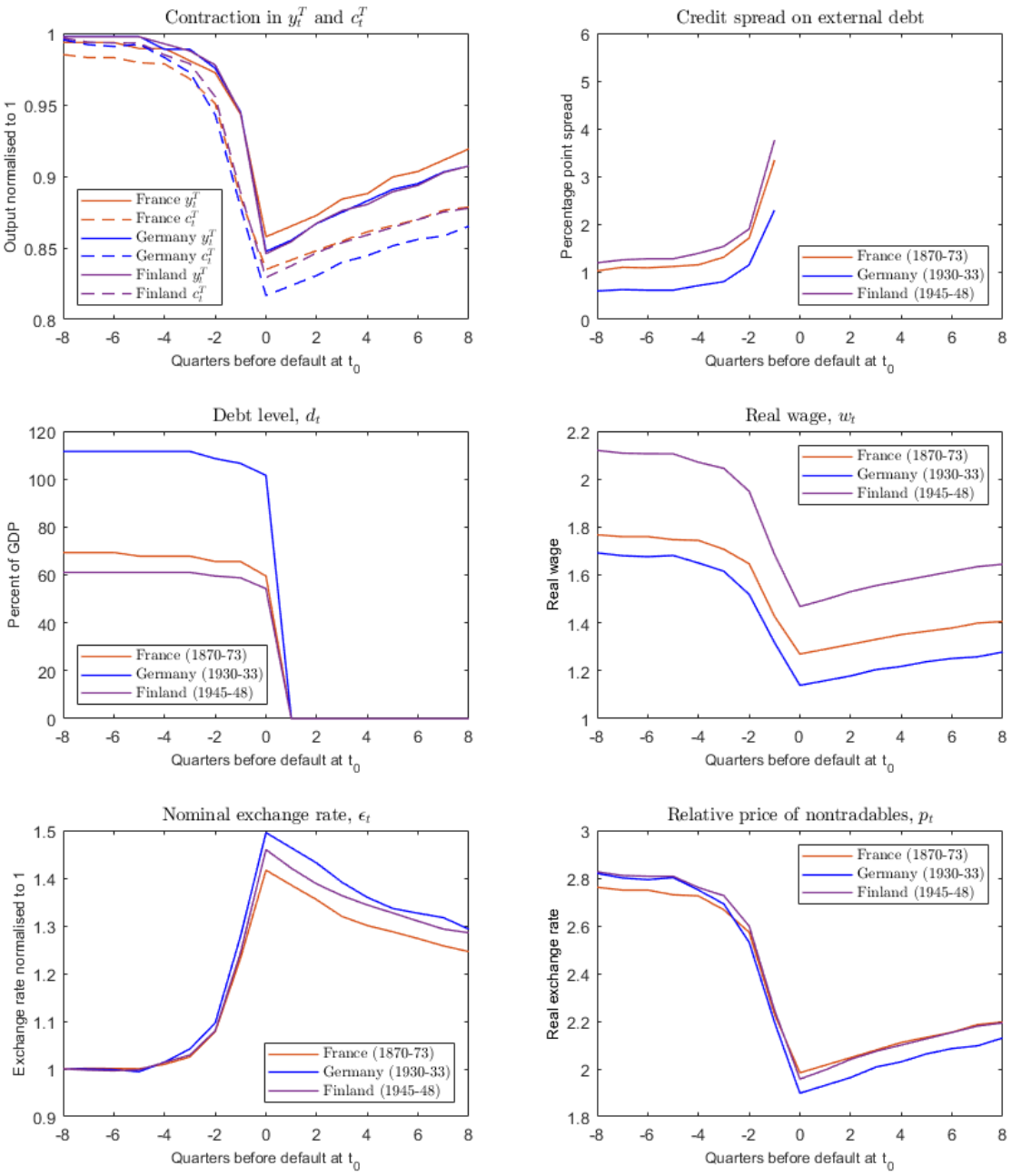
For the German 1930-33 calibration, labour's share of income is set at $\alpha = 0.60$ as the aggregate labour share of national income was close to 0.6 leading up to the default (Ritschl 2002, table b.5). Imputed wages would have to be calculated in trade and agriculture but given the lack of data and a low degree of mechanization in these sectors, it is assumed they are close to the aggregate. The average annual risk-free rate on U.S. 3-month Treasury bills was 1.4 percent, so that $r^* = 0.0035$. $\theta = 0.0312$, which implies a length of default of around eight years. Germany first defaulted on its sovereign debt in 1932 and was in default until the end of World War II but forcibly regained access to borrowing in 1940 (Klug 1993, p. 9-12). The loss-function parameters $\delta_1 = -0.32$ and $\delta_2 = 0.42$ are calibrated for a debt-to-GDP ratio of close to 110 percent, as German debt-to-GDP exceeded 100 percent in 1931 (Papadia and Schioppa 2015, p. 6).

For the calibration of the Finnish economy from 1945-48, $\alpha = 0.75$ which is standard in the literature. The world risk-free rate is still the U.S. 3-month Treasury bill, rate which averaged 1.0 percent, so that $r^* = 0.0024$. Like in France, given no default $\theta = 0.0385$. The loss-function parameters $\delta_1 = -0.32$ and $\delta_2 = 0.40$ are calibrated for a debt-to-GDP ratio of close to 65 percent.

4.3.7. Stylised macroeconomic facts about sovereign debt defaults

The model allows for the characterisation of certain stylised facts that typically accompany a sovereign debt default. It is simulated under optimal monetary policy, where the government can freely choose the exchange rate and the debt tax, across 1.1 million quarters for each of the three calibrations, where the first 0.1 million simulations are discarded.[85] The median values are calculated for y_t^T, c_t^T, d_t, w_t, ϵ_t, p_t, and the credit spread on external debt. The time of default is then normalised at t_0. Figure 4.2 shows the median of each macroeconomic indicator in the two years before and two years after default at t_0, for the French (orange), German (blue), and Finnish (purple) calibration. The time scale is in quarters of a year.

[85] The approach follows Na et al. (2018).



Note: Replication file, *plot_model.m*.

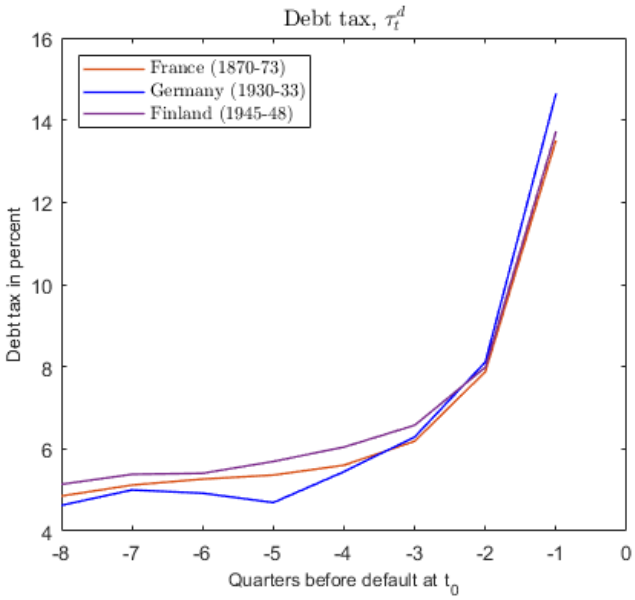
Figure 4.2: Stylised reaction around sovereign debt defaults.

Three stylised facts can be observed: *first*, like in most models of sovereign debt, a default occurs after a continuous contraction in tradable output across a short period of time. y_t^T falls 12 percent (France), 13 percent (Germany), and 14 percent (Finland) in less than one year before the government defaults at t_0 which triggers the loss-function $L(y_t^T)$. The government chooses to default when the cost of debt service is higher than the benefits of continued ability to borrow, as specified by the value functions (4.20) to (4.24). As the risk of default increases, the risk premium on external debt goes up. Higher interest rates

discourage borrowing so that the consumption of tradables c_t^T falls more than y_t^T. *Second*, default is accompanied by a large devaluation of both the nominal exchange rate ϵ_t, and the real exchange rate, shown by the relative price of nontradables p_t. The devaluation is not followed by a bout of inflation as nominal prices remain stable. *Third*, the reason there is no inflation is that the real wage w_t declines, which lowers the real labour costs of firms. The three stylised facts are all characterised in equilibrium.

The output contraction that leads to default is mostly a function of subjective discount factor β, the volatility of the economy η and its autocorrelation ρ. With a higher level of β, households will be more patient and ready to forego current for future consumption. The cost of default goes up with a higher β which makes countries default less often. Fewer defaults decrease the country risk premium and increase the level of sustainable debt. Section 4.8 shows the effect of increasing β. An increase in the level of volatility in the economy η has the reverse effect. A higher permanent volatility of output drives up the default frequency because there are more large negative income shocks, which increases the risk premium on external debt. The level of desired savings increases to protect against the volatility which lowers the level of debt. Increasing the autocorrelation of output ρ increases the default frequency and lowers the level of debt. The reason is that output costs of default are present at high levels of output. The lower ρ is, the more likely it is that output will be higher soon, which lowers the frequency of defaults. The level of real wages and the relative price level are affected by changes to a and α, but the direction of the adjustment before a default is not, neither is the frequency of default. Section 4.9 shows the model's sensitivity to different values of these parameters. The loss-function parameters (δ_1, δ_2) are calibrated to ensure the model matches the level of debt-to-GDP as observed.

The central bank can set the nominal exchange rate ϵ_t, which ensures that the external crisis does not spread to the nontraded sector. The government can also set the level of taxes on external debt τ_t^d, which in a historical setting is best interpreted as the introduction of capital controls. Using the same estimation for τ_t^d as for the other macroeconomic indicators, Figure 4.3 shows the median level of capital controls in the two years before a default. The model thus captures the introduction of capital controls in the years leading up to a sovereign default, as was the case in Germany in the 1930s.



Note: Replication file, *plot_tau.m*.

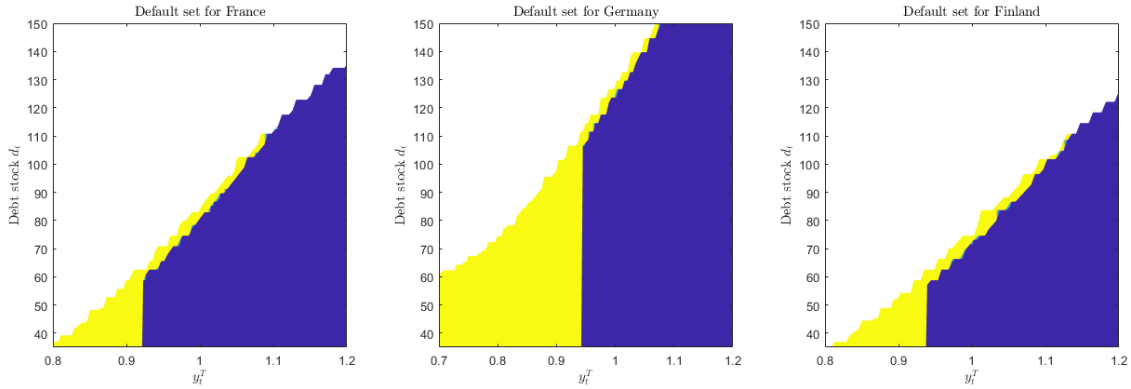
Figure 4.3: Estimate of capital controls.

The model as outlined above assumes optimal policy from the government with respect to the default decision and in setting the exchange rate and capital controls. As we will see in the next section, governments have not always had the option to do that historically. Countries might not have the option to default or devalue their exchange rate or been discouraged from levying capital controls from their neighbours or creditors. Why assume optimality in policymaking? It is certainly possible to include wage and currency rigidities, alongside explicit financial sanctions. But the point of the analysis is to explain *optimal* sovereign debt policy and compare it to reparations policy. By judging the historical episodes through a sovereign debt framework, it is possible to understand how extraordinary times of war reparations were. If the macroeconomic conditions are far worse than when countries default, it tells us that the enforcement mechanism for reparations debt is more binding than for other types of sovereign debt.

4.4. When default is optimal

The stylised facts of sovereign default presented in section 4.3.7 can help analyse the special case of war reparations. To apply the analysis to historical cases, the following three sections provide the context around how the reparations, as outlined in Table 4.1, were paid. The default set (equation 4.24) is shown graphically in Figure 4.4 for each of the three calibrations, with the level of debt on the y-axis and tradable output on the x-axis. The colour blue denotes the area in which the government repays debt, while the yellow area denotes where the

government defaults (white is outside the grid of the model). The figure shows how to interpret the model and compare to the repayment of war reparations.



Note: The dark blue area is the state denotes repayment while the yellow area is default. The white area is outside the ergodic distribution and not part of the grid. Replication file, *plot_default_sets.m*.

Figure 4.4: Default sets.

The model output is compared to historical data, which I collected for real GDP, credit spreads, debt levels, real wages, nominal exchange rates, and real exchange rates for the three cases.[86] To apply the model to historical data, the reparation is interpreted as an unexpected increase in the state variable d_0. At t_0 the country learns that it must pay the reparation, which is captured by a decrease in net output by the term $y_0 - d_0$. It is then possible to see where the level of net output lies in the default set, given historical data for the other macroeconomic variables. It will allow us to understand the costs of paying reparations and whether the optimal policy would have been to default. Sections 4.4.1, 4.4.2, and 4.4.3 discusses the model in the context of war reparations for the three cases. The difference and the issue of enforcement is discussed in section 4.4.4.

4.4.1. The Franco-Prussian War indemnity

France was forced to pay an indemnity to Germany after losing the Franco-Prussian War in 1871. The origin for war was a power struggle between the great nations of Europe. Prussia was victorious in its 1866 war against Austria, which put it in a dominant position over France. A diplomatic dispute led France to declare war in July 1870, with the first battle in August the same year. By September, Germany had won a series of decisive military battles and the war ended in early 1871 with Germany as winner. Germany annexed Alsace-

[86] Because of the lack of sectoral GDP for the period, tradable output is proxied by detrended real GDP per capita, available yearly.

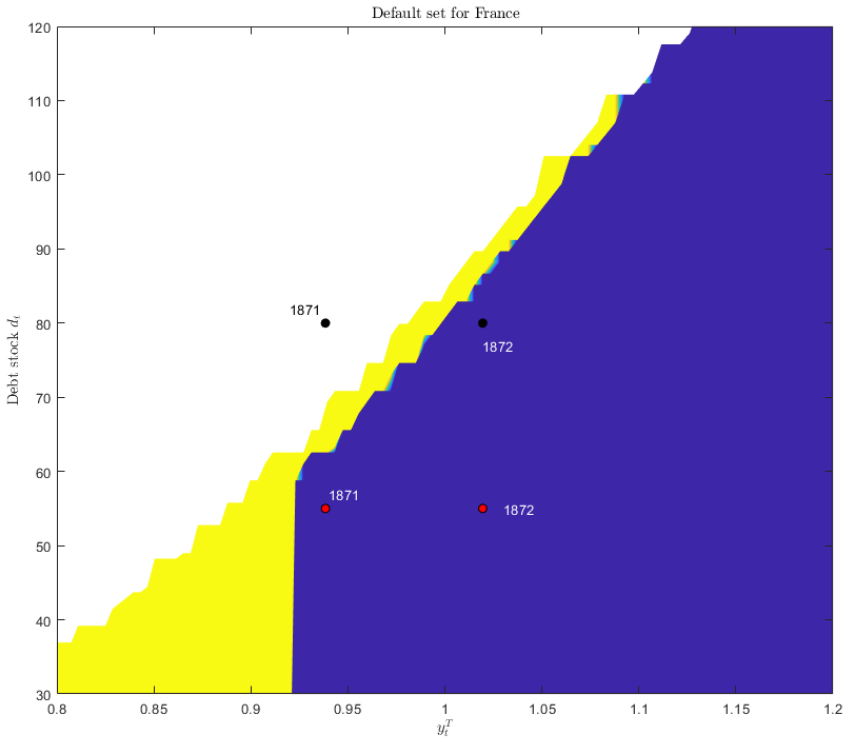
Lorraine, and as part of the peace settlement Prussian Chancellor Otto von Bismarck imposed an indemnity of five billion francs starting in 1871. The indemnity had the purpose of curbing French power.[87]

The indemnity had to be paid in four instalments over three years, with the majority (three billion) due by March 1874. The total size of the indemnity amounted to around 25 percent of French output (Monroe 1919, p. 269). At the time, it was considered too big to be payable (Gavin 1992, p. 175). As shown in Table 4.1, it was slightly larger in terms of output and taxes collected than the Napoleonic Wars reparations, with annual debt service costs and repayment of the indemnity amounting to nine percent of output a year. The first payment of 500 million francs was due 30 days after the Treaty of Frankfurt, which meant France had to borrow money quickly. In June 1871, France opened subscriptions for a 5 percent *rentes* perpetual bond, which was issued at a price of 82.5, equivalent to an interest rate of 6.1 percent. The bond was oversubscribed, and the total size of the loan was two billion, covering the first three of four instalments. In July 1872, a second bond was announced, this time targeting a size of three billion to repay reparations fully. The loan was oversubscribed 12 times and issued at a price of 84.5 (interest rate of 5.9 percent). By then, France had raised enough money to pay back the indemnity in three years.

According to Gavin (1992, p. 176) France had 13 billion francs in net foreign assets by the end of 1869. Between 1871 and 1874 when France paid the indemnity, its foreign investments fell but net exports rose, as money was diverged towards the bond issues (Monroe 1919, p. 273). The bond issues had high subscriptions from foreign investors, but the primary financiers of the loans were via Paris. At the same time, the French current account was consistently positive and French accumulation of net foreign assets continued in the 1980s. The loans issued were general purpose bonds guaranteed by the government. The indemnity was de facto senior to these loans, as the indemnity was linked to the removal of German troops, but there is no indication that a default was seriously discussed. Because the investor base for the loans was largely domestic, a subsequent default would hit French investors. Devereux and Smith (2007, p. 2392) show that the French terms of trade deteriorated during the repayment from 1871 to 1873 but conclude that the ability to borrow the money meant the impact on consumption was muted. The primary cost was a lower stock of net foreign assets.

[87] The history provided here is neither complete nor conclusive but is meant to offer a brief context for why the indemnity was imposed. This section follows Monroe (1919) for how the indemnity was financed and paid. For a general history of the period, see e.g., Kindleberger (1993, p. 241-50).

France's status as a net creditor might have influenced its debt and repayment strategy. Figure 4.5 shows the French default set, as well as where France was in 1871 and 1872. On the x-axis is deviation from trend real growth, and on the y-axis is the debt stock. The yellow area denotes areas where the model considers default to be optimal, while the blue area denotes areas where repayment is optimal. The red dots are French output and gross debt stock excluding the indemnity, while the black dots include the indemnity. As can be seen, once the indemnity is included in France's debt stock in 1871, it seems to be in the default area because of high debt and low output. Yet, France did not default and did not seem to seriously consider it. I propose four reasons for why France did not default, even though, as we will see, some macroeconomic indicators suggest a default was optimal.



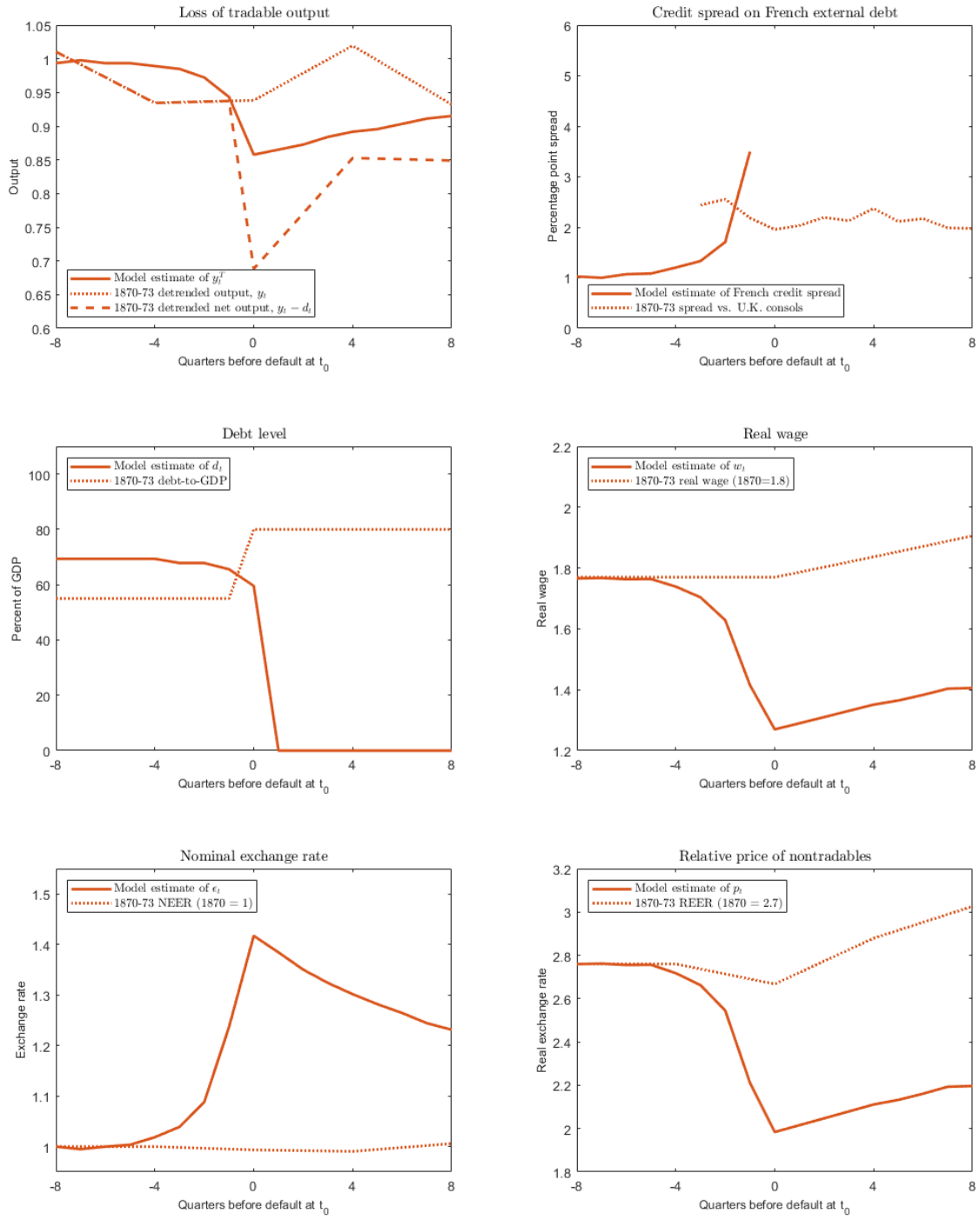
Note: The dark blue area is the state denotes repayment while the yellow area is default. The white area is outside the ergodic distribution and not part of the grid. The dots denote French debt excluding the indemnity (red dots) and including the indemnity (black dots) on the y-axis and detrended output on the x-axis. Replication file, *plot_default_set_france.m.*

Figure 4.5: French default set, debt stock, and detrended output.

Before discussing the reasons for why France paid the indemnity, Figure 4.6 compares the macroeconomic predictions of the model to historical data, collected for the years 1870-73. The figure shows historical data two years prior to the announcement of the indemnity at t_0 and two years after. The two years prior to a hypothetical default coincides with the end of the war (1871). Detrended output falls during the war but expands after, with GDP

increasing by 10 percent from 1871 to 1872 back to 1870 levels. In the upper left of the figure is detrended output where the median default occurs when output is 12 percent below its trend. French growth was below trend by around six percent but the fall in net output $y_0 - d_0$ is significantly bigger. Unlike in the model, the credit spread on French government bonds during the period were static, trading around 5 to 6 percent from 1870 to 1873, with no spike as the risk of default did not increase. The level of debt in the model before default is around 65 percent, close to the pre-indemnity level of 55 percent debt-to-GDP but below the 80 percent ratio in 1871 after the indemnity was announced.

The level of real wages in the nineteenth century was generally flexible, but for the period 1870-73 both nominal and real wages were stable. Monroe (1919, p. 278) provides evidence that wages went up in the mining industry which benefitted from higher exports, but the aggregate wage level was generally stable during the period according to the sources cited below Figure 4.6. The nominal exchange rate was stable because France was on the bimetallic standard (Flandreau 1996). The indemnity was paid in gold, silver, notes, and bills of exchange, with the latter being the primary way of payment. It meant that there was a large flow of specie underlying the indemnity as France were to provide bills of exchange in Germany, and therefore sold gold and silver in the market for bills, which influenced prices of both goods and money. However, because of the bimetallic standard, the overall level of nominal and real exchange rates fell relatively little.



Sources: Bolt et al. (2018) for output; Ljungberg (2019) for nominal and real exchange rates; Insee and Bank of England for bond yields; see Table 4.1 for debt. Data on real wages is an estimate based on BL (1898, p. 668) for Paris wages. A similar trend is found in Bowley (1898, p. 488). Replication file, *plot_france.m*.

Figure 4.6: Model estimate and French historical data (1870-73).

Despite a large loss of output, higher interest rates than in the model, and a large increase in debt, France nevertheless repaid both the indemnity and its debt. France borrowed five billion francs (25 percent of GDP) in 13 months and Devereux and Smith (2007) suggests

that consumption was largely unaffected. I suggest four reasons for how France was able to repay without entertaining the idea of default.

The first is that France was in an exceptionally good position to borrow large amounts of money because of its large stock of foreign assets at the end of the war. The Franco-Prussian War was over in less than a year and France did not have to sell all its foreign assets to finance the war. According to Ritschl (1996, p. 185), the French debt stock was around 55 percent of GDP in 1869, which is around 11 billion francs. Gavin (1992, p. 176) notes that at the same time, French foreign assets were around 13 billion francs, which is estimated to yield around five percent. We know from section 2.1.1 earlier that the current account, net of the indemnity, was negative of around two billion francs. It means that at the end of the war, France had no net debt, as its gross debt roughly equalled its foreign assets.[88] The debt stock in Figure 4.5 might therefore be overstated substantially because it is gross debt. In fact, it provides an additional incentive for repayment. A default might induce sanctions on France, as per the work of Bulow and Rogoff. Because France had little net debt, it might be especially vulnerable to sanctions or confiscations of its foreign assets, which might yield a higher return than the cost of its debt.

The second reason is that France could borrow enough money quickly to pay the indemnity, which meant the costs could be smoothed over many years. The type of debt that France used to borrow was a *rentes* bond, which is a perpetual bond with no maturity. The speed at which it issued debt meant that the upfront costs was minimal. The ease was shown both by the speed and by the large oversubscriptions to its loans, from both domestic and international lenders.

The third reason is related to how the bonds were issued. The bonds were underwritten by de Rothschild Frères (the Paris house), N M Rothschild & Sons (the London house), and the Barings Brothers in London.[89] In addition to underwriting the loan, the London house of Rothschild also guaranteed foreign exchange stability to facilitate the transfer to Germany. The loan required the combined effort of the Rothschild and Barings families, as outlined by its private documents (Ayer 1904, p. 55). The underwriters lent France credibility and enhanced scrutiny of the loans. Underwriters played an important role during the time, as has been outlined by in a series of papers by Flandreau, Flores, Gaillard, and Nieto-Parra

[88] The timing might even underestimate the level of net foreign assets a little because the French current account was around 1.1 billion francs in 1870, and the indemnity only started in 1871. But since the indemnity flows were known by then, it can be assumed that they were included in the debt strategy.
[89] The source for the loans is Ayer (1904, p. 54-57), which was a privately published book on the history of the London house of Rothschild.

(2009) and Flandreau and Flores (2012). The underwriters helped to place the bond and made the financing operation possible, but they also played a role in monitoring and enforcing repayment. Because the underwriters were heavily involved, the likelihood of being able to borrow money went up. It also increased the probability of repayment because the banking houses enforced market access.

The fourth reason is that France might have taken the optimal trajectory in terms of output, consumption, and wages. Looking at Figure 4.6, French output grew in the year after the war. It might have been clear to the French government that output losses in 1870-71 were war-related, and it would be costly to default. If the government knows that it can smooth out one bad year, it does not make sense to take the output loss associated with default (neither in the real world or in the model). The trajectory and stability of French wages and nominal and real exchanges rates would seem to confirm this view.[90] Had France defaulted on the indemnity in 1871, two things would likely have happened. The first is military intervention. Germany annexed Alsace-Lorraine but in the event of no payment, it might have intervened militarily, either to confiscate the money or grab more land. The second is that a default would have cut France off from borrowing internationally. The international banking houses and its neighbours would have stopped the flow of credit, possibly confiscated French foreign assets, or placed sanctions on France.

All four reasons for repayment can be true at the same time. The lower level of net output and the use of export proceeds to pay the indemnity, rather than accumulate foreign investments, suggests there was a real cost of resources to France. But France's external position meant it was well positioned to repay the indemnity quickly, and France would have incurred large political and economic costs had it attempted a sovereign default.

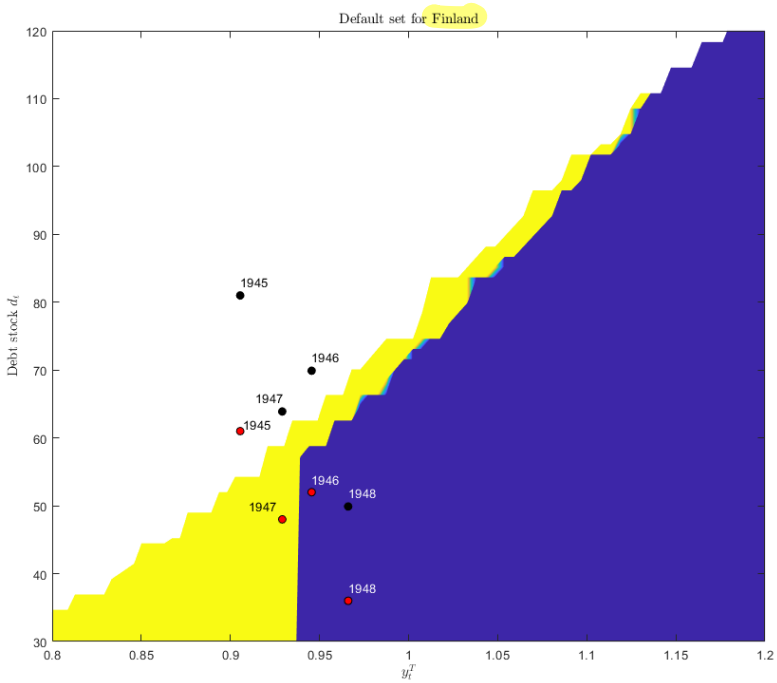
4.4.2.Finnish World War II reparations

Finland was on the losing side of World War II and had to pay reparations to the Allied forces, as agreed at the 1945 Potsdam Conference. The Peace Treaties of Paris (1947) set up the Allied Control Commission and the War Reparations Commission allocated the Finnish accumulated debt to the Soviet Union. In addition to incurring the cost of the Commission, Finland faced significant reparations and lost territory to the Soviet Union.[91] Reparations were to be paid entirely in kind, at an estimated cost of three percent of output per year

[90] It is also possible that the economy adjusted by lowering the level of real wages, but that it does not show up in the limited data source on French wages for the period.
[91] The Marshall Plan helped rebuild Europe but was politically offensive to the Soviets and Finland was pressured not to participate by the Soviet, an added indirect cost.

between 1945 and 1952 (Pihkala 1999, p. 26-37). The total size of the reparation was 300 million U.S. dollar, which was specified in the treaty. In terms national output, reparations were almost the same size as the Franco-Prussian indemnity. The uncertainty around pre-war GDP and GDP levels during the first repayment means that the reparations-to-GDP can only be estimated at somewhere between 17 and 30 percent. I will use the most reliable GDP number implying a 20 percent reparations-to-GDP.

From 1944 to 1947, Finland received loans from the U.S. worth 126 million U.S. dollar while paying out the equivalent of 232 million in reparations. Pihkala (1999, p. 32) estimates that the required dollar funding, had Finland bought only American goods and used them to pay the in kind reparations, would have been between 546 and 570 million dollar. It corresponds to around a third of total industrial production in 1945, though by 1952 it had fallen to four percent as the economy had grown. Finnish reparations were mostly funded by loans and foreign debt, which increased from 229 million dollar in 1945 to 661 million dollars in 1951 (Pihkala 1999, p. 46). During the period, Finland paid its sovereign debt and reparations despite exhibiting all the characteristics of a sovereign default, as explained in the model.

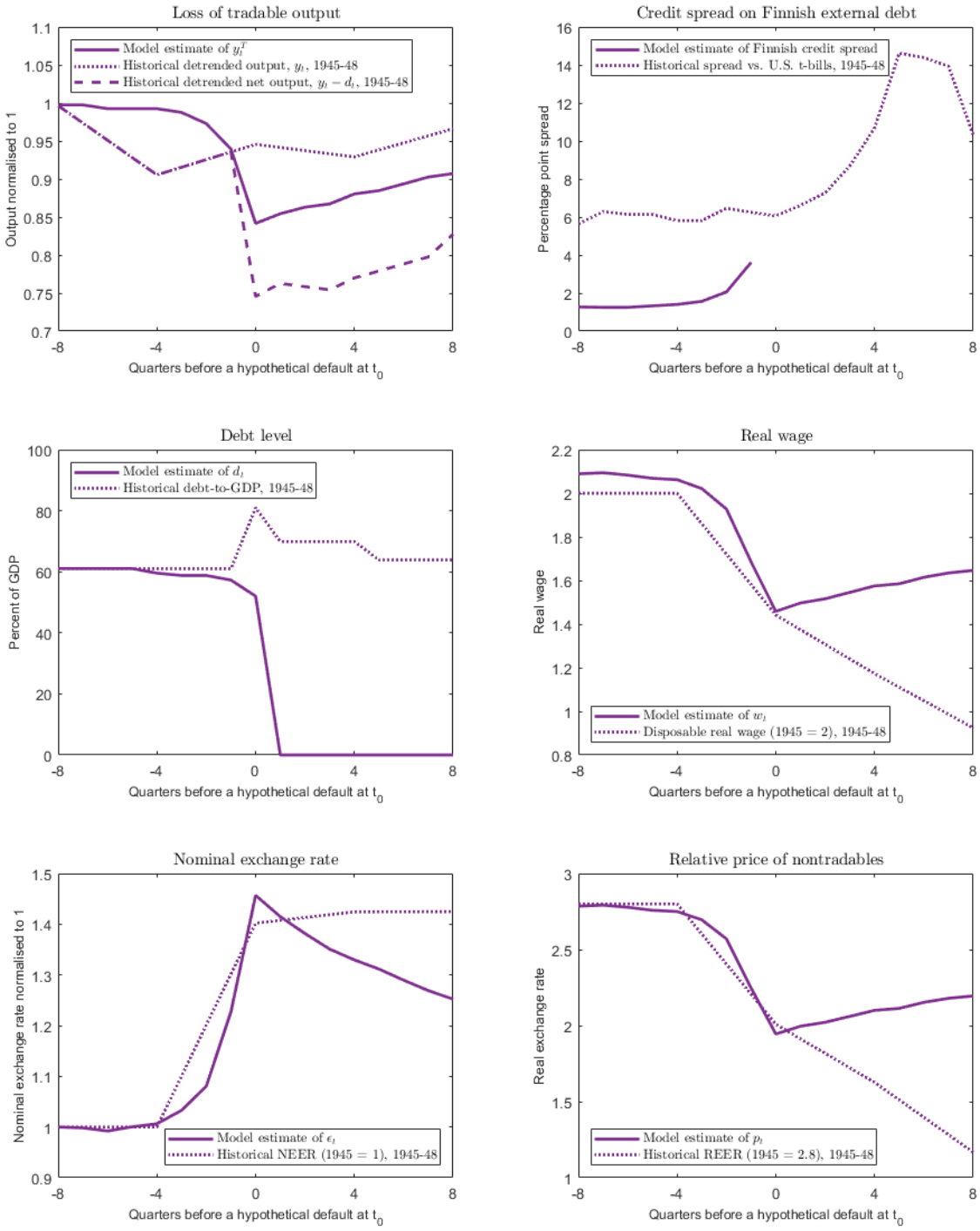


Note: The dark blue area is the state denotes repayment while the yellow area is default. The white area is outside the ergodic distribution and not part of the grid. The dots denote Finnish debt excluding the reparation (red dots) and including the reparation (black dots) on the y-axis and detrended output on the x-axis. Replication file, *plot_default_set_finland.m*.

Figure 4.7: Finnish default set, debt stock, and detrended output.

Figure 4.7 shows the default set of Finland for the years 1945 to 1948. Like in the previous section, the red dots denote Finnish sovereign debt excluding reparations on the y-axis, while the black dot are total liabilities including reparations. On the x-axis is detrended real output per capita. Finland came out of the Second World War with low output and a high debt stock. The level of Finnish debt-to-GDP was 60 percent in 1945 before the announcement of reparations. It jumped to 80 percent of GDP in 1945 as reparations were 20 percent of GDP. Only 28 percent of Finland's debt stock was foreign in 1945 but it grew to more than half by 1949 (Pihkala 1999, p. 46). Because Finland experienced such output loss in the immediate years following the war, Finland was in the default set from 1945 to 1947 if reparations are included in the debt stock. Only by 1948 did output rebound and its sovereign debt was reduced, placing it in the repayment area. Unlike in the French case earlier, the period from 1945 to 1947 was marred by economic crises in which wages fell drastically and the exchange rate was devalued.

Figure 4.8 plots the model predictions against Finnish historical macroeconomic data collected from 1945 to 1948. The largest output loss came in 1945 at the end of the war, where detrended real output per capita fell nine percent. Net output $y_0 - d_0$ decreased 25 percent as initial reparations were announced in 1945, before recovering slowly from 1946 onwards. The level of debt after the announcement of reparations was significantly above the level of d_0 in the model. The Finnish debt stock was negotiated at the end of the war and is therefore unchanged before 1945. Until the end of 1946, interest rates did not move much, hovering between six and seven percent, using Helsingfors municipal bonds as a proxy. But in 1947 the price of the five percent government bond maturing in 1961 dropped, which increased interest rates. Real wages fell by 50 percent from 1945 to 1948 and Finland devalued their currency the *markka* three times in 1945. Like the real wage, the real exchange rate (bottom right) overshoots the prediction of the model significantly.



Sources: Bolt et al. (2018) for output; Ljungberg (2019) for exchange rates; Federal Reserve for bond yields; Pihkala (1999) for wages and debt. Replication file, *plot_finland.m*.

Figure 4.8: Model estimate and Finnish historical data (1945-48).

The Finnish economy performed worse in terms of exchange rates and real wages than the model would predict for a default. In the model, the government's goal is to maximise full employment real wages, and a default marks the trough in real wages and output. An economic crisis does not spread to the domestic sector, because the government uses optimal

monetary policy (by devaluing the currency and increases tariffs) alongside a default. Finland's output, credit spreads, debt stock, real wages, nominal, and real exchange rates all performed worse in the years 1945 to 1947. One reason could be that Finland was unable to default on its sovereign debts, which meant that increased levels of domestic resources went to debt service. The only policy option was to devalue the currency, but because its debt was foreign debt, devaluations increased the value in domestic currency. While its loans were in foreign currency, however, reparations were paid in kind.

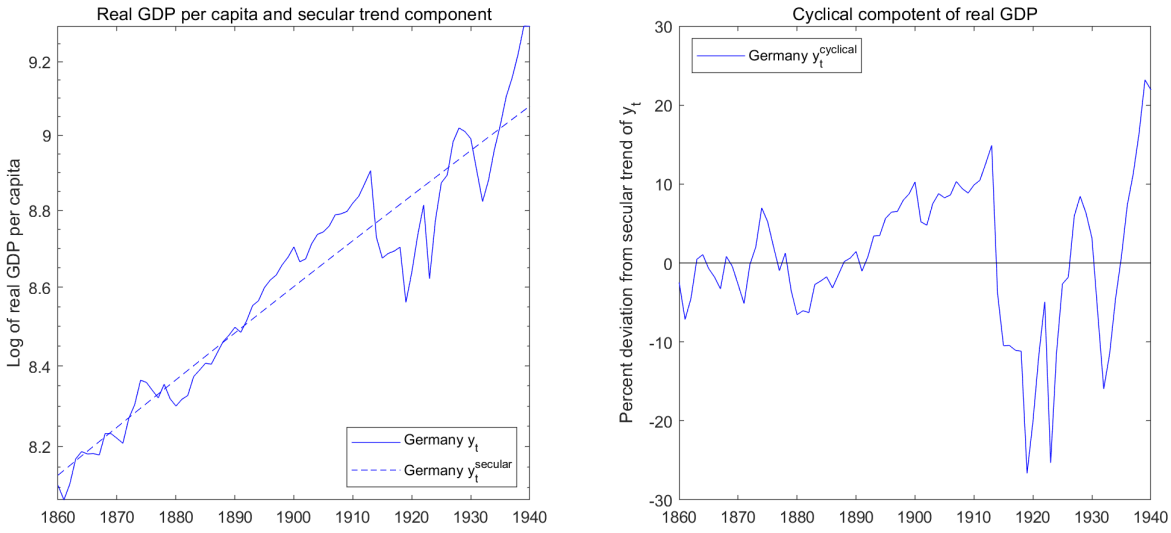
The reason Finland was unable to default on reparations was the political economy realities of its close relationship with the Soviet Union. Similarly, it was in the interest of Finland to have closer relations with Western Europe and the U.S., which meant a default on its debt to the U.S. was impossible. The only policy-option was a devaluation and export growth, especially to Western Europe. It meant that as reparations were paid, Finland could grow its way out of its debt problems, which meant that by 1948 it was no longer in the default set. When Finland joined the IMF and the World Bank in 1948, debt-to-GDP was already declining. It was, however, a path that did not include a default because it was impossible politically, even though it might have been a better economic policy.

4.4.3. German World War I reparations

The Treaty of Versailles (1919) stipulated that Germany pay reparations for World War I. The size of reparations was to be negotiated after Versailles by the Reparation Commission, but the Germans expected 30 billion to be an upper limit.[92] In 1920 news leaked of a larger-than-expected reparations bill of around 80 billion. It sent shockwaves through the German public. In 1921, the London Schedule of Payments set the total reparations bill at 132 billion gold marks, far above initial estimates. It would be payable in three tranches: A-bonds (for war damages) worth 12 billion or around 25 percent of 1913 GNP; B-bonds (for inter-Allied war debt) worth 38 billion or around 75 percent of GNP; and C-bonds, the majority, at 82 billion totalling 150 percent of GNP. The implicit understanding was that the C-bonds would not need to be repaid (Ritschl 2012a, p. 945). The total size of the A-bonds, the war reparations, added together with the existing German debt stock in 1920 of around 50 percent of GNP was equivalent in size to the French indemnity and debt stock of 1871 in terms of GDP. The French indemnity was specifically discussed in setting the reparations amounts after World War I (see section 2.1). Adding in the B-bonds for inter-Allied war

[92] See James (1986), Schuker (1988), or Ritschl (2002) for a comprehensive history. This section follows from there.

debts took German debt levels well above historical precedents, but total debt levels were close to that of Britain and France after the war, even though Germany had relied more on debt and less on taxes to finance the war compared to Britain (James 1986, p. 49-50).



Source: Bolt et al. (2018). Replication file, *lqtrend_p2a.m*.

Figure 4.9: German secular and cyclical real output per capita (1860-1940).

Germany experienced an extremely volatile business cycle in the interwar years, as the economy swung from hyperinflation to deflation and depression. Figure 4.9 shows German real GDP per capita as well as detrended GDP (to the right) for the period 1860 to 1940. As can be seen in the figure, the period from the start of World War I until the mid-1930s saw large output swings. Albrecht Ritschl (2012a) suggests that Germany had three distinct economic phases during the interwar years, which are shown in Table 4.3. Each phase saw different growth rates, capital flows, and inflation regimes – and reparations played a key role in each economic phase.[93]

	1921-23	1924-29	1930-33
Real growth (deviation from trend)	-14.0	0.8	-7.7
Current account	-	-3.1	0.4

Source: Bolt et al. (2018); Jones and Obstfeld (2001). **Note**: The numbers are mean deviation from trend growth and mean current account in percent of GDP for the years in each column.

Table 4.3: German economic phases between 1921 and 1933.

[93] There are different ways to break down Germany's economic phases. Harold James (1986, p. 213) suggests a different breakdown based on the structure of German wages after the stabilisation of the Mark, where 1924-25 saw rapid wage growth from a low base; mid-1925-26 saw a temporary slowdown in wage pressures; from 1927-28 wages increased with the civil service leading; 1928-30 wages kept rising while employers resisted unsuccessfully; and from 1931 wage rates fell dramatically.

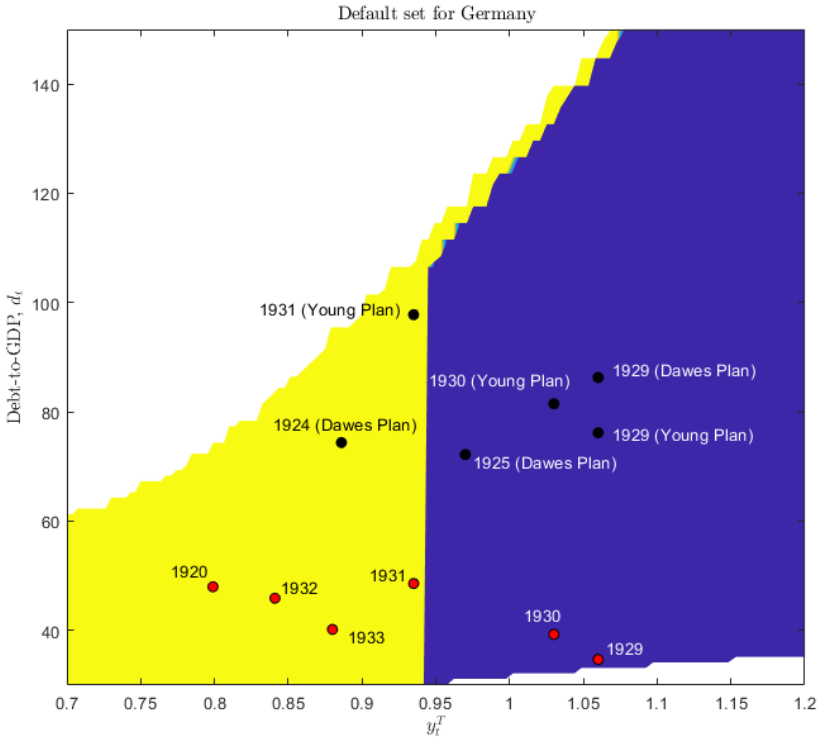
The initial phase from 1921 to 1923 was characterised by hyperinflation. During 1920, the German economy had stabilised but after the size of the reparations bill became clear, tax revenues plunged. The much higher-than-anticipated reparations bill resulted in tax "boycotts" from the German public (Ritschl 2012a, p. 950).[94] The government had to make up for lower tax revenues from the boycotts, so the central bank had to print money. During this period, only the minimal required transfers were forthcoming as the financial system collapsed, external creditors saw their claims reduced in real terms, and political instability increased alongside unemployment. Germany's capacity and willingness to finance reparations on international capital markets was limited. Its debts in 1921 were mostly foreign debt which increased its incentives to default. By late 1922, Germany refused to pay what they considered an intolerable and odious debt, as output losses made the debt burden worse. Germany was forced back to the negotiation table in January 1923 when the Allied occupied the Ruhr to enforce payment of reparations.

The second phase occurred from 1924 to 1929. The period was the mirror-imagine of the earlier years (see Table 4.3) as growth rebounded, inflation stabilised, and capital started to flow into Germany, which increased debt levels. Output was still more than ten percent below trend in 1924, but by 1925 output had almost recovered. In 1924, the Dawes Plan settled the reparations question and ended Allied occupation of the Ruhr (see e.g., Lutz 1930, p. 41-48 or Yee 2020). The payment scheme included only reparations (the A-bonds) but did not provide any explicit debt relief. The liability of reparations was therefore still significant, with the present value of the Dawes Plan annuity almost equal in size to the combined A- and B-bonds (Ritschl 2013, table 4.1). The Dawes annuity was considered unpayable by many at the time, even though the German commercial debt stock had been inflated away and was negligible by 1924 (see e.g., Costigliola 1976).[95] Germany had to attract large capital inflows from 1924 to finance the reparations transfers, something which it was successful in doing until 1929. The reason it was successful was that the Dawes Plan embedded investor protections into reparations, as shown by Ritschl (2002, p. 193-217). The protections were in the capital structure under the Dawes Plan. The Plan stipulated reparations remained junior to corporate debt claims in the central bank's foreign exchange window, providing a

[94] The literature also suggests that distributional conflicts and delayed stabilization played key roles in stoking hyperinflation. The section focuses on reparations as the key issue, but I do not suggest that to be the definite cause of hyperinflation. See e.g., James (1986, p. 126-32) for a discussion about the role of industry and investments on inflation.

[95] Fleisig (1976) argued Germany would have defaulted even without a global depression. Neto (1986), on the other hand, suggested the German government never tried to raise taxes or cut spending to produce the required primary surplus.

remedy to enforce commercial debt claims. The protections were needed in 1924 to ensure that Germany could borrow abroad to finance the transfers, as German debt was not sustainable. By 1924 German detrended output was 11 percent below trend and the present value annuity of the Dawes Plan was almost 75 percent of GNP. The combination of low output and high debt puts Germany in the default set, as can be seen in Figure 4.10. The figure shows the default set of Germany, with yellow area denoting default and the blue area denoting repayment, as a function of the debt-to-GDP stock and deviation from trend growth (the white areas are outside the grid of the model). The red dots show German commercial debt excluding reparations. After the stabilisation of the currency in 1924, German commercial debt was negligible and is left out of the graph for the years 1924-25 (James 1986, p. 40-43). The black dots in the figure show German total liabilities, which are commercial debt plus reparations annuities (the black dots are the present value of the Dawes Plan and the Young Plan for the years in brackets). By 1925, the rebound in output meant that Germany was no longer in the default set.



Note: The dark blue area denotes repayment while the yellow area is default. The white area is outside the ergodic distribution and not part of the grid. The red dots denote German debt commercial debt *excluding* reparations and the black dots is German *total liabilities* (including reparations). **Sources**: Ritschl (2012a, p. 945-6) for commercial debt in 1920; IMF data for commercial debt in 1924-5 (negligible); Ritschl (2013) for the net present value of Dawes Plan annuity and GDP in 1924 and 1925; Papadia and Schioppa (2015, p. 6) for data from 1928-33. The x-axis is deviation from trended output. Replication file, *plot_default_set_germany_all.m*.

Figure 4.10: German default set, debt stock, and detrended output.

Germany was incentivised to borrow from foreign creditors to pay reparations in several ways. Borrowing the money externally naturally eased domestic budgetary constraints and freed up money to be used for other purposes. Domestic credit expansion was difficult because hyperinflation had eroded both trust and wealth. Increased external debt also meant that private creditors would be incentivised to ally with Germany in future reparations negotiations. The end of reparations was the primary stated goal of economic policymakers, something they thought worth taking considerable financial risk over (Schuker 1988, p. 35). There were incentives for foreign creditors to lend to Germany as well. The first was that German debt levels by 1925 were low if reparations are excluded. German debt service was only 0.6 percent of government expenditures in 1925, compared with 28.4 percent in Britain (James 1986, p. 48). In an overall creditworthiness assessment, the reparations annuity must be included, but because commercial creditors had an enforcement mechanism on the foreign exchange reserves at the Reichsbank, it meant they were senior debt claims (Yee 2020). The invasion of the Ruhr in 1923 had showed that enforcement of reparations was binding, even though France and Belgium experienced high political costs of military intervention. As a result, the commercial debt stock increased from 1925 as Germany borrowed abroad and money was recycled from the U.S. in what Stephen A. Schuker (1988) termed "American 'Reparations' to Germany". From 1924 to 1929, Germany issued corporate and sovereign bonds across Europe and private foreign credit flowed into Germany which was used to finance reparations transfers (Accominotti and Eichengreen 2016, p. 476-78). The borrowing meant there was no transfer of resources between 1924 and 1929, because the current account matched the reparations flow. Germany paid 2.5 percent of national income every year from 1925 to 1932 in reparations, which peaked at 3.5 percent in 1929 (Machlup 1964, p. 374-95). In present value terms, the transfer was quite real of course because debt increased.

The third phase from 1929 to 1932 was marred by austerity and deflation. Already in 1927, the first financial troubles had started. The government issued a RM 500 million loan with a five percent interest, which had to be converted to a six percent loan to avoid the price of the loan falling too drastically in the secondary market (James 1986, p. 50-52). By 1929, the issue of financing began to dwarf other economic problems. The government tried and failed to issue the full RM 500 million of the Hilferding Loan despite big tax concessions to investors (ibid) and at the same time, tax revenues started to fall which led to a budget crisis in late-1929. The post-war economic structure was under pressure, as calls for both tax and spending cuts intensified with support from the Reichsbank. The problem of loan

financing got worse throughout 1929, as Germany tried and failed to obtain long term credit from international banking houses JP Morgan and Dillon Read (James 1986, p. 54-59). The government increasingly had to rely on short term treasury issuances which increased the rollover risk when the debt matured. The cause of the crisis was not simply due to a reversal of capital flows. James (1986, p. 39-110) has argued that the difficulty the government had in financing growing public expenditures stemmed from distributional effects. A larger bureaucracy, increased level of spending on agriculture and social welfare, and no reform of the many levels of government (Reich, Länder, and communes) helped redistribute wealth and income away from pre-war rentiers (James 1986, p. 51). The public financing issue was worsened by the weakness of the banking system, which turned into a full-blown banking crisis in 1931 (see e.g., James 1986 , p. 281-323). The economic crisis thus had domestic as well as global origins, because when the domestic economy started to weaken it did so alongside the start of the Great Depression. Germany's reliance on foreign debts hit a wall, and with it a looming balance of payments crisis.

The Young Plan negotiations occurred simultaneously with the increased financing troubles. There were signs of a run on the foreign exchange reserves in the spring of 1929 during the negotiations as it looked like there was no agreement (James 1986, p. 284), but a deal was reached in August 1929 and formally approved in 1930. The economic and political impact of the Young Plan was big. It was expected that the plan would offer some relief, but as Ritschl (2002) shows the outcome was instead a change in the structure of debt. The present value of the new reparations annuity under the Young Plan was slightly lower than the Dawes Plan, but the debt seniority of commercial creditors over reparations transfers was reversed. The implicit understanding during the Dawes years, as argued by Ritschl (2002) and Schuker (1988), was that reparations would be reduced dramatically. In the context of Figure 4.10, the implied belief during the Dawes years was that de facto debt levels were the red dots (commercial and sovereign debt) but not the black dots (which includes reparations annuities). The Young Plan made clear that German liabilities included reparations. The Young Plan was accompanied by an official loan ('the Young bond'), but private credit access dried up during 1929 (Ritschl 2012a, p. 954-57). Foreign loans became unavailable and domestic credit expansion was not possible under the Young Plan, as at least parts of the annuity payments became senior to commercial debt (Schuker 1988, p. 52). The debt sustainability of Germany became an acute problem because the total stock of reparations was not written down, but only reprofiled. Short-term creditors began to demand austerity policies to roll over existing loans, and because the government had lost access to long-term

foreign credit, the Brüning government engaged in austerity policies to regain long term debt solvency. Until the reversal of capital flows, high real wages in Germany had not affected the unemployment rate but after 1929 they did. The Young Plan ruled out a devaluation and made Germany unable to alleviate the pressure from high real wages, which translated into a sharp output contraction, as first outlined by Borchardt (in e.g., 1984, 1990).

The last French troops did not leave Germany until 1930, so there was very likely still a binding enforcement mechanism on reparations in 1929. A hard German default in 1929 might therefore not have been possible, which goes some way to understand why the Young Plan was agreed by both sides. A second reason is found in Figure 4.10. The present value of the Young Plan annuity in 1929 was 42 percent of GDP, while its outstanding commercial debts was 35 percent of GDP, for a combined 76 percent debt-to-GDP. The Dawes Plan annuity had a present value of 52 percent in 1929. Even though the German economy slowed during 1929, it was still above its long-term trend. Germany was therefore still outside the default set in 1929, even with a debt stock of 86 percent of GDP under the Dawes Plan and 76 percent under the Young Plan. An outright reading of the model affirms the view that by 1929, it was still in Germany's interest to have access to capital markets, which a unilateral default would have cut off. Germany gave up transfer protections from reparations in exchange for some debt relief and 300 million U.S. dollars in loans, which was hoped to be followed by additional credit. Instead, loans from U.S. and Canadian banks dried up in 1930 following the Young Plan (Schuker 1988, p. 50-63). With no new loans available to pay off existing interest and reparations, the money had to come from domestic sources.

The result was austerity and deflation, which came at extremely high social and political cost. By 1930, as Ritschl (2002) has argued, if Germany was committed to repaying reparations while not defaulting on its commercial creditors, it had no other options than austerity policies because of years of external debt-financing. But austerity policies lead to deflation, high unemployment, and a collapse in growth. Austerity policies came in the form of decrees from Brüning from December 1930 to December 1931, and the policies were a mix of tax increases (explicit and implicit), cuts to state welfare, and reductions in civil service pay (James 1986, p. 36). It is easy to see that Germany ends up in the default set a by 1931, with a high debt stock and much lower growth. In that sense, much economic and political pain was for nothing. The foreign credit constraint was self-fulfilling, as it made it impossible for Germany to escape its debt-deflation regime. The remedy for previous periods of high debt and low output was to borrow money, but by 1929 that was no longer possible. Schuker (1988, p. 63) notes that Brüning hoped to engage in foreign credit expansion in the spring of

1932, as it was expected the reparations issue would be resolved. The end of austerity was never enacted by Brüning, despite the Reichstag passing a law allowing more borrowing. The effect of austerity was a vicious cycle of lower revenues and problems of financing increasing deficits (James 1986, p. 60-73).

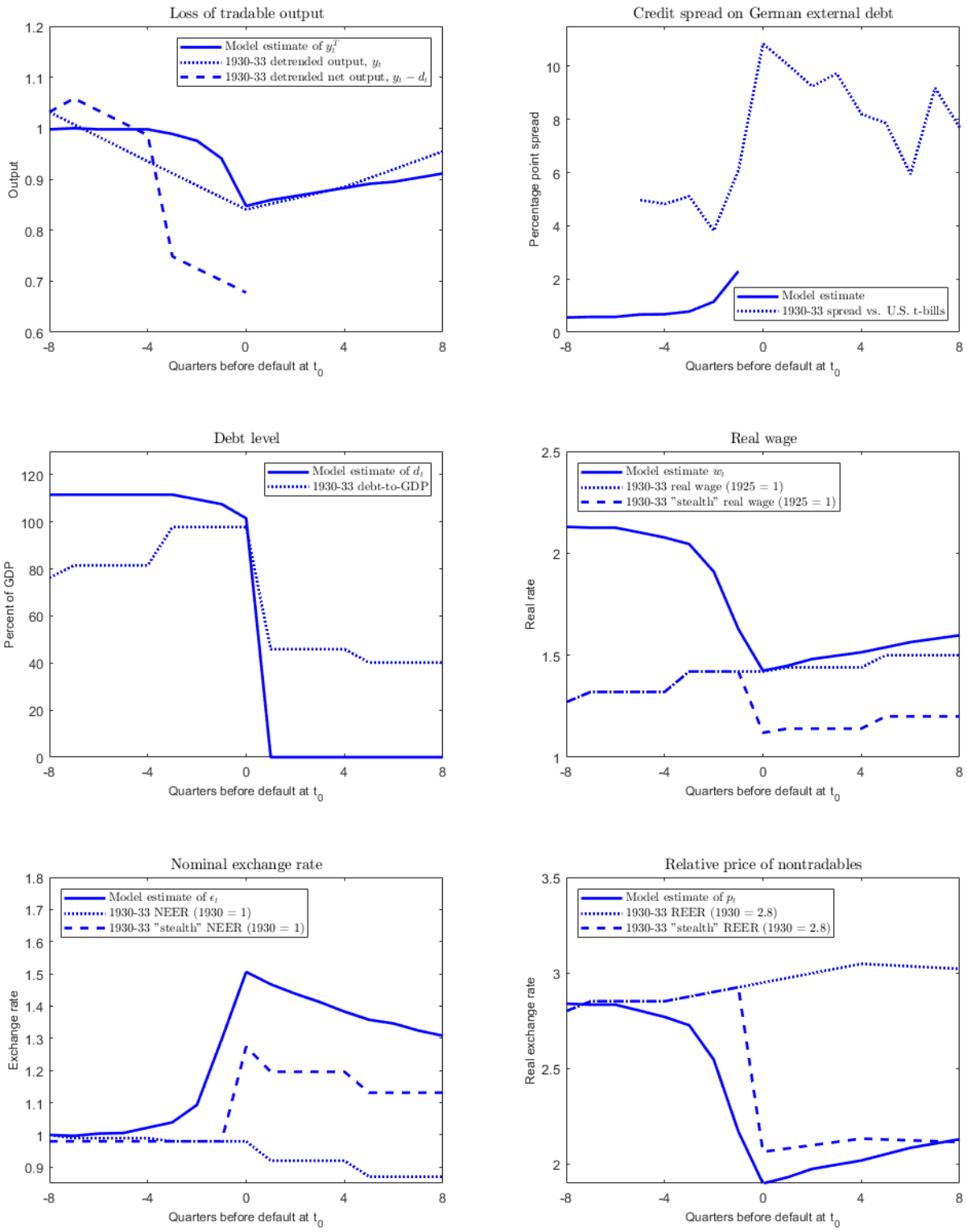
The public financing issue was a problem because of the structural weaknesses in the low-growth economy. Even small increases in nominal debt could not be sustained because output fell dramatically and increased the debt burden. The difficulty in rolling loans forced a tightening of credit and a reduction in the money supply (James 1986, p. 293) and continued austerity fuelled the economy into a debt-deflation crisis. By 1931, the political and military situation in Europe had changed and was markedly different than it was in 1923. Germany pushed for and received a moratorium on reparations payments from U.S. President Hoover in 1931 as the financial and economic situation deteriorated (James 1986, p. 34-35). At the same time, Germany obtained a 100 million U.S. dollar loan from a consortium of central banks as private credit flows stopped, to keep up payments on its other debt (Clement 2004, p. 36).[96] The central bank loan was the only real option of long term credit because political uncertainty made financing German deficits difficult, even though the deficits were relatively small compared to its European neighbours (James 1986, p. 71-73).[97] The other European nations and the U.S. had no appetite for a costly enforcement of reparations amidst an economic crisis. The Hoover moratorium had not cancelled reparations, but according to Schuker (1988, p. 64-65) the debate within the German business community throughout 1932 was whether to service foreign debts or default. The economic situation did not improve in 1932, and Germany negotiated a standstill with its short-term commercial creditors. At the Lausanne Conference in July 1932, reparations were de facto cancelled. The Lausanne Conference did not result in a German default on its sovereign debt, because Article 7 explicitly protected bond holders. But the agreement removed the direct repayment from reparations annuities that was previously embedded and meant that the debt had to be serviced out of the government's general-purpose finances (James 1986, p. 71-73). As can be seen from Figure 4.10, Germany was by 1932 well in the default set even without reparations (the red dots), as autarky policies became optimal to repayment of debt.

The standstill and de facto cancellation of reparations removed an important obstacle to a German sovereign debt default. Domestically in Germany, both the Nazis and the Communist Party advocated for a default, which was an alternative to austerity policies of

[96] The New York Federal Reserve, the Bank of England, the Banque de France, and the Bank of International Settlements.
[97] In 1931 German debt service as a share of public expenditures was 2.9 percent (James 1986, p. 48).

the Brüning cabinet. The outcome of the Lausanne Conference meant that the capital structure of German debt changed once again, as the long-term debt prioritised during the Young Plan years became junior to shorter term debt. Most of the long-term debt was to commercial creditors in the U.S. (Papadia and Schioppa 2015) but Germany could engage in discriminatory debt policy because U.S. sanctions were no longer effective due to its trade policy (see Ritschl 2002). Germany meanwhile prioritised reducing its debt to England because London banking houses continued to offer certain short term credit arrangements. The Brüning cabinet's policies were to reduce the credit constraint but once the Nazi's took power, a policy of default was explicit (Clement 2004, p. 49). Already by then the debate on whether to service commercial debts was, according to my analysis, redundant. By 1931, autarky was preferable to repayment of debt, as output losses were severe and the benefits from some access to borrowing was outweighed by the cost of servicing debt.

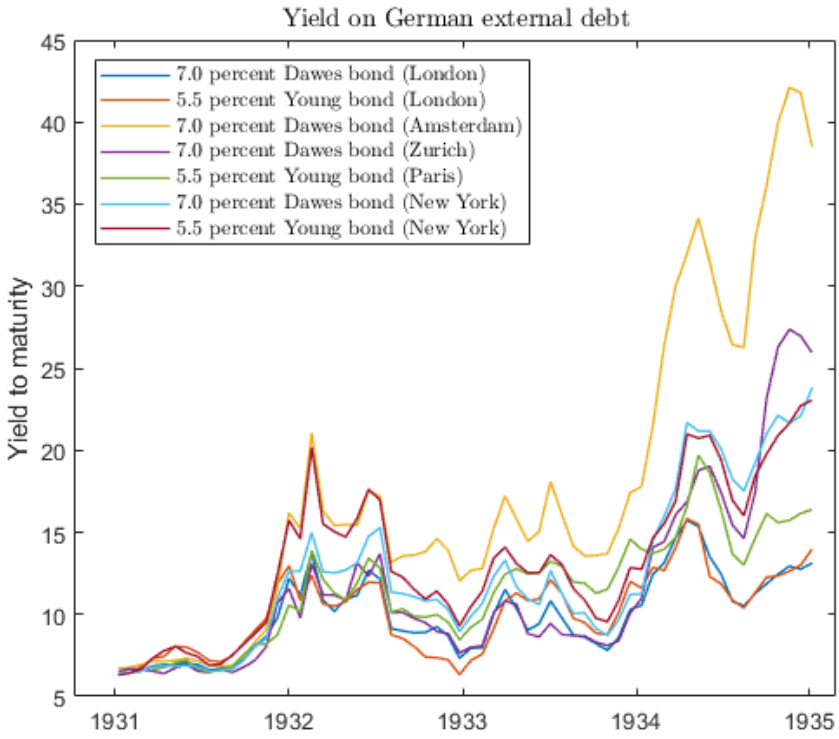
The stylised facts accompanying sovereign defaults were by 1932 all present in Germany, as shown in Figure 4.11. The policy of default was optimal, if even late. The figure shows model output and historical German data from the end of 1929 to 1933, with t_0 being 1932 in this figure (see below for a discussion of the default dates). German detrended real output per capita y_t collapsed 18 percent between 1930 and 1932, while net output $y_0 - d_0$ was 35 percent lower. The level of sovereign debt after the Lausanne Conference was 49 percent of GDP. The credit premium on German bonds over U.S. treasuries more than doubled in the year before the sovereign default. In the model it occurred as the probability of default rose. The middle-left figure in Figure 4.11 shows that the German debt stock after the default fell to 45 percent in 1932 and then to 40 percent in 1933. By 1938, its debt stock was down to 14 percent of GDP. Even though the government was unable to pursue an outright devaluation of its currency, it nonetheless did so by stealth method. Klug (1930, p. 18) estimates that exports subsidies meant German exports could be purchased abroad at a 30 to 60 percent discount. De facto German currency policy is therefore in line with equation (4.27). In the figure, the real wage, the nominal exchange rate, and the real exchange rate are plotted with their actual values and with the stealth devaluation. Nominal wages did fall but inflation fell more, and real wages rose despite mass unemployment. By 1932, real wages were more than 40 percent above their 1925 index while productivity had risen by less than half (Ritschl 2012b, p. 40).



Sources: Bolt et al. (2018) for output; Ljungberg (2019) for exchange rates; Ritschl (2012b, p. 40) for wages; Papadia and Schioppa (2015, p. 15) for debt and German bond yields; the Federal Reserve for U.S. yields; and Klug (1993, p. 18) for the estimate of the stealth devaluation, where the lower part of the range (30 percent) is used. Replication file, *plot_germany.m*.

Figure 4.11: Model estimate and German historical data (1930-33).

The German sovereign debt default can be dated in different ways because of the different types of external debt. The political debts of reparations and war debts were suspended for a year by the Hoover moratorium in June 1931, which was followed by the standstill agreement on short-term debt (Ritschl 2012a, p. 956). Reparations were de facto cancelled in 1932 at the Lausanne conference but it did not include the sovereign loans issued (Dawes and Young bonds). The standstill agreements led to a rally in the bond prices in early 1932 as cash was perceived available to repay those bonds, as can be seen in see Figure 4.12. The Nazis came to power in early 1933 and had an explicit policy of not paying long-term external debts. The 9 June law of 1933 (see Schacht, 1967, p. 137-41) created the "foreign exchange clearing office" through which all external interest and amortisations payments were to flow, which in effect meant money would be intercepted by the office. Additional defaults occurred in 1933 as Germany revoked the Gold Clause and announced it would only honour the nominal value of its debt (Clement 2004, p. 37-38). In 1934, a full moratorium on debt payments was announced alongside capital controls (Schuker 1988, p. 47-82). In 1934, another spike in interest rates occurred in the lead up to the full default in 1934 (Ritschl 2001, p. 329-30).



Source: Papadia and Schioppa (2015, p. 15). Note: Bonds converted to yields, using stated coupon, maturities in 1949 for the Dawes and 1965 for the Young bonds (Clement 2004, p. 47). Replication file, *plot_gdr.m*.

Figure 4.12: Yields on German external bonds (1931-35).

Albrecht Ritschl (2002) has argued that because sovereign debt policies and trade policies were interlinked, it was not possible to default while maintaining open trade with all its creditors. Where this research diverges from Ritschl, and others, is in estimating the policy of repayment before 1932. As is shown in Figure 4.10, German austerity policies proved to be more costly than continued debt service already in 1931, because of its effect on real growth. A sovereign default would have meant a return to financial autarky and likely trade sanctions, but it would have allowed domestic credit to expand and Germany to leave the stated policy of long-term debt sustainability. The argument here is therefore that the cost of austerity policies was larger than the gain from continued market access, limited as it was to short-term loans. In the model presented here, sovereign debtors will only pay their debts if the cost is not higher than financial autarky. Unlike much of the literature, I find that the point of optimal default came already in 1931, even assuming the Great Depression does not reduce the costs of autarky policies.

4.4.4. Enforcement of war reparations

The three reparations studied here were paid under very different circumstances. France, Germany, and Finland all found themselves, at one point or another, in a situation where a strict interpretation of the model would suggest that a sovereign default was the right policy. Defaults did not happen on reparations, and only Germany defaulted on its sovereign debt. The French and German cases are opposites, even if there are historical similarities and German reparations were, to some extent, designed with French indemnities in mind.

The model suggests that France should have defaulted in 1871, but they were right to pay given the macroeconomic and political situation. The quick rebound in output means that already by 1872, France is outside the default set. It had easy access to loans at reasonable interest rates, with high investor participation from both foreign and domestic sources. The most important factor was that France had accumulated a high stock of foreign assets, meaning its net debt was essentially zero, which incentivised a settlement that did not include sanctions or confiscations. It is a case in which enforcement of sovereign debt played a positive role, in that a default would have been more costly than repayment. It is also likely that military enforcement was not needed, because France was incentivised to repay because of its easy access to debt and stock of foreign assets. The macroeconomic situation was, crucially, one in which the current account was positive, meaning that while France repaid the indemnity it did not do so by indebting itself.

The situation is Germany was different. The model suggests that Germany was in the default set in 1920, in 1924 (using the present value of the Dawes annuity), in 1931 (even excluding the Young annuity), in 1932, and in 1933. It was forced to repay reparations in the 1920s with disastrous long-term consequences. Germany had limited access to borrowing until 1925, from which point it managed to escape output losses by borrowing abroad. Economic growth from 1925 to 1929 was built on a debt-spiral and real wages that were too high, given Germany's external position. A continuously negative current account helped keep real wages and the real exchange rate high, but it could only last if debt could be rolled over into new loans. The model suggests Germany should repay in 1929, but we know that it was folly – the debt stock could not be rolled over. Austerity by the Brüning cabinet was implemented to maintain market access, but it relied on two crucial facts. First, that the market would acknowledge debt sustainability and keep lending, and second, that domestically the policies could be implemented without political chaos. Both proved unsustainable. Based on the net foreign asset position, the current account, the high level of real wages and the real exchange rate, only a small shock to output would put Germany into the default set. Two years of costly austerity only yielded further ground for the Nazi takeover, rather than regaining market access as was the goal. Had Germany defaulted already in 1929, it would have saved two years' worth of interest payments and entered autarky at the same time, as market access was by then de facto gone.

Like the German case, Finland did not have the option of defaulting because of political pressure in the new geopolitical landscape that emerged from World War II. Unlike Germany, it managed to eventually grow its way out of debt trouble, and not by taking on more debt. The trajectory was suboptimal, however. It involved three devaluations, a fall in real wages of more than 50 percent, and large inflationary problems. A default would have allowed foreign exchange to be used for domestic purposes, but because it was not possible the macroeconomic adjustment had to come from elsewhere.

In France in the 1870s, the investors were largely domestic which would have made a default costly to the households who financed the indemnity. The same households and government who had stocks of foreign assets that were at risk. In Germany and Finland, creditors were almost all foreign and both countries had no foreign assets after the wars. The incentives and costs would have been in favour of a default. But investors knew that repayment would be enforced. It therefore makes sense that credit spreads did not increase following the announcements of reparations, as the probability of default did not increase as debt contracts were enforceable by military force. The fact that reparations in general are

enforced likely lowers borrowing costs.[98] Sovereign debt crises generally entail rollover risk of loans, but if investors know that their claims will be repaid, then they should be willing to lend at lower interest rates, if they are seen to be linked to reparations. Repayment can happen even if it does not make sense economically, and investors can lend more money to cover old debt, even if the debt is unsustainable.

Models of sovereign defaults, like the one presented in this paper, concerns itself with willingness to pay. It offers a way to judge if it is in the country's interest to pay its debt. Willingness to pay has been the norm since 1907 when the Drago Doctrine agreed that countries would not enforce sovereign debts by military force.[99] The invasion of the Ruhr in 1923 was a reversal to the time before the Drago Doctrine. Without discussing the legality of the invasion (see e.g., Allemés and Schuster 1924 for the case for and against), it was a break with the idea that creditors should not enforce debt contracts militarily. The idea of reparations is that they are involuntary, but they stand out as uniquely enforceable within sovereign liabilities. The reason is that they are political by nature. Both German and Finnish reparations were, to varying extend, a break with the Drago Doctrine.[100] The argument in this paper is that both cases show that the enforcement of reparations and reparations-related debt created a sub-optimal economic outcome. In Germany's case, it prolonged repayment and ensured default came only after the Nazi takeover and years of austerity. In Finland's case, it forced three devaluations and years of economically costly repayment, before it managed to grow its way out of debt.

4.5. Conclusion

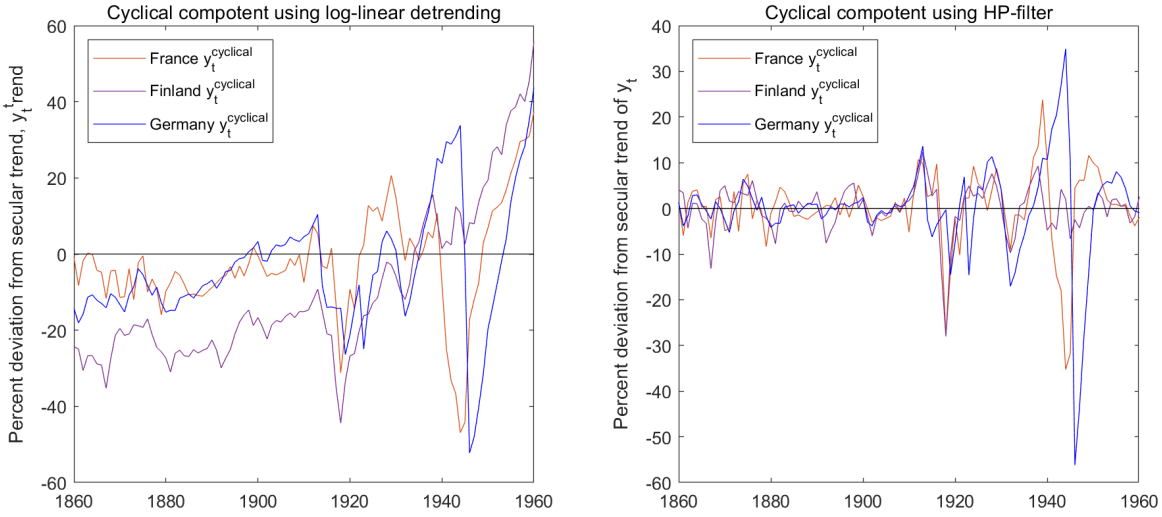
The literature on sovereign debt mostly focuses on recent examples of defaults. This paper situates the repayments of war reparations within the quantitative literature, to understand if the repayment was optimal. The economies of France in 1871, Germany in the 1930s, and Finland in 1945 are all shown to exhibit some macroeconomic characteristics that are typically seen during sovereign default, but they have very different outcomes. The enforcement of reparations by military force broke with the Drago Doctrine and created a suboptimal economic outcome. I argue that Germany would have benefitted from an earlier

[98] A related effect is shown by Accominotti et al. (2011) in their study of how the British empire helped remove the default risk of its colonies.
[99] Convention II, which was signed and ratified by all countries in this study (Germany, Finland, France, Russia, the U.K., and the U.S.) by 1910. There are certain exceptions in Article I, which states that the convention does not apply if states refuse or neglect to accept an offer of arbitration.
[100] Germany more so than Finland, as there was arguably no military intervention to enforce Finnish debt, but it was there implicitly in the political intimidation.

default and Finland was constrained in its economic policies. The Franco-Prussian War indemnity was enforced but would have likely been paid regardless, because of France's stock of foreign assets. Military intervention to force the payment of debt therefore only hurt economic policymaking.

4.6. Appendix 4a: Different detrending methods for real GDP

The results of the paper do not depend on the choice of detrending method. Figure 4.13a shows the cyclical components of output using log-linear detrending method to the left (King et al. 1988), and HP(100) filtering to the right. There are substantial differences in the length of the suggested business cycles, but the contraction in cyclical output in the years after reparations transfers is similar. As an example, for France from 1870-73 the deviation from the secular trend changes by less than one percent across all methods. The other episodes are similar. Quadratic detrending is therefore used throughout chapter 4 and the dissertation.

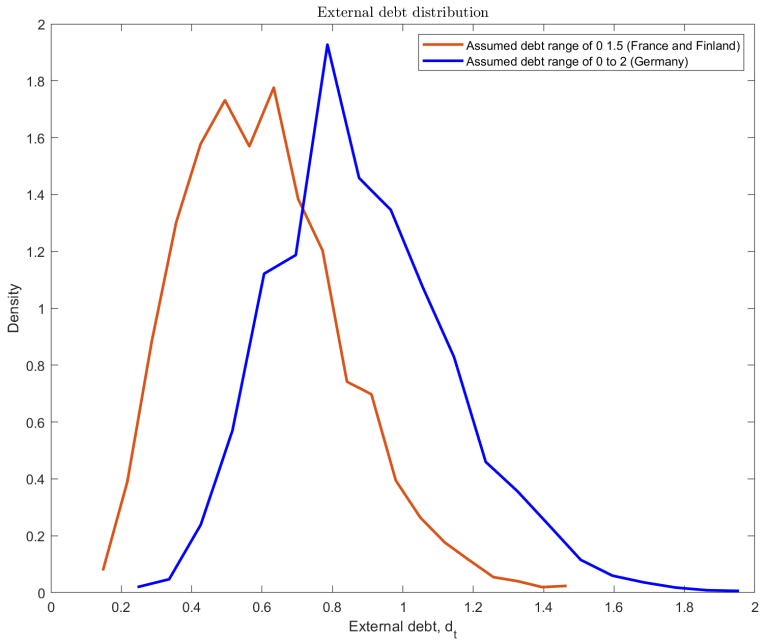


Source: Bolt et al. (2018). Replication file, *alt_trends.m*.

Figure 4.13a: Log-linear detrending and HP-filter of real GDP (1860-1960).

4.7. Appendix 4b: Distribution of external debt

Figure 4.14a shows the density distribution of external debt for the calibrations. Germany's debt level is assumed to fall between zero and 200 percent of tradable output, while France and Finland have an upper limit of 150 percent.

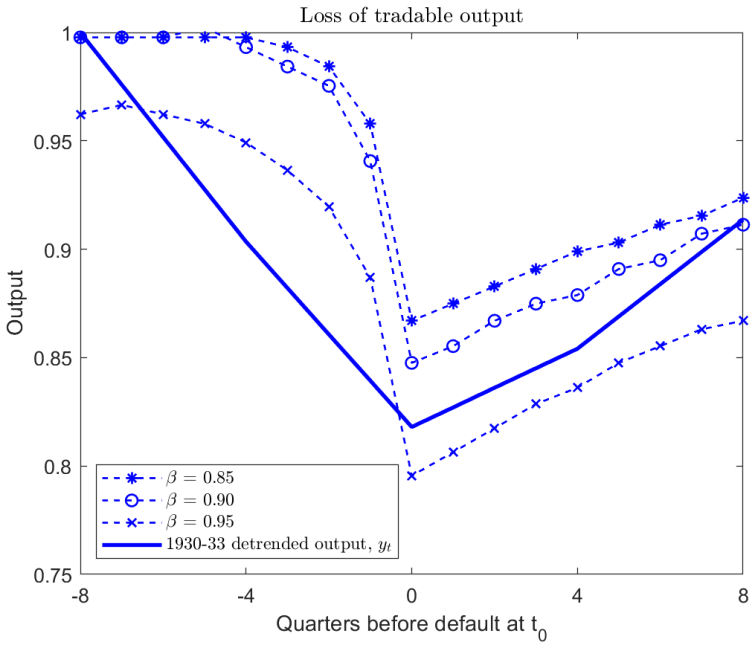


Note: Depending on the country being in good financial standing. Replication file, *debt_dist.m*.

Figure 4.14a: Distribution of external debt.

4.8. Appendix 4c: Varying the discount factor β

Figure 4.15a shows the model estimates for different values the subjective discount factor β for the German calibration. As the discount rate is lowered (higher β) the present cost of default goes up. For $\beta = 0.95$, the median output loss before default increases to over 20 percent. A higher value of β worsens the fit of the structural credit spread across episodes.



Source: Bolt et al. (2018). Replication file, *plot_b.m*.

Figure 4.15a: German model output for different values of β.

4.9. Appendix 4d: Model sensitivities

The table below show the model's sensitivities to changing various parameters. The baseline model is the German calibration, which is denoted by star in Table 4.4a. The table shows model statistics for the frequency of default, d/y denotes the average debt-to-GDP ratio in percent, $r - r^*$ is the credit spread in annual percent, y is detrended output, and tb is the trade balance. Sigma denotes the standard deviation and corr the correlation.

	Default frequency	d/y	$r - r^*$	$\sigma(r - r^*)$	$\text{corr}(r - r^*, y)$	$\text{corr}(r - r^*, tb/y)$
$\beta = 0.85$	1.90	86	2.33	2.18	-0.48	0.81
$\beta = 0.90^*$	0.96	112	1.05	1.31	-0.47	0.82
$\beta = 0.95$	0.29	150	0.31	0.61	-0.49	0.81
$\rho = 0.91$	0.08	200	0.09	0.26	-0.56	0.51
$\rho = 0.932^*$	0.96	112	1.05	1.31	-0.47	0.82
$\rho = 0.95$	1.98	52	2.40	2.77	-0.45	0.79
$\rho = 0.97$	3.94	17	6.19	7.26	-0.30	0.42
$\eta = 0.035$	0.53	177	0.55	0.79	-0.56	0.86
$\eta = 0.039^*$	0.96	112	1.05	1.31	-0.47	0.82
$\eta = 0.045$	1.62	56	1.84	2.09	-0.43	0.82
$a = 0.10$	0.95	112	1.05	1.31	-0.47	0.82
$a = 0.26^*$	0.96	112	1.05	1.31	-0.47	0.82
$a = 0.50$	0.98	112	1.05	1.31	-0.47	0.82
$\alpha = 0.30$	0.94	112	1.05	1.31	-0.47	0.82
$\alpha = 0.60^*$	0.96	112	1.05	1.31	-0.47	0.82
$\alpha = 0.75$	0.94	112	1.05	1.31	-0.47	0.82

Table 4.4a: Model statistics.

Source: Tables can be replicated by running *statistics_model_germany.m* with the varying calibrations from the German model, which is used as baseline and denoted by star.