Online Appendix 4 to "The Borchardt hypothesis: a cliometric reassessment of Germany's debt and crisis during 1930-32"

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Abstract

Online Appendix 4 reports the robustness checks of parameter values.

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Online Appendix 4

The model we use differs from the conventional IS-LM-BP framework by the introduction of the balance sheet effects, as indicated by the third term of equation (3) of the main text. Parameters that are crucial for our results are the sensitivity of the country risk premium, the steady-state ratio of total debt to net worth, and the share of home goods in the consumption aggregate. Therefore, we will focus on these parameters to examine the robustness of our results. Table $A3$ reports the robustness checks we have carried out.

[INSERT **Table** $A3$ about Here]

The sensitivity of country risk premium μ is a crucial parameter, because as the BP curve indicates, the balance sheet effects are increasing in μ. We draw from current estimates for this parameter as robust tests. The estimate of Meier and Müller (2006) for μ is about 0.06, implying that a 1 percent decrease in the net worth to capital ratio raises the risk premium by 6 basis points per quarter. Christensen and Dib (2008), using maximum likelihood estimation, find the value of μ to be about 0.04. For robustness checks, we also experiment with setting $\mu = 0.04$ and $\mu = 0.06$. Table $A3$ shows that a higher sensitivity of the country risk premium lessens the relative advantage of flexible exchange rates. Real GDP loss under flexible exchange rates relative to that of fixed exchange rates increases from 0.48 to 0.55 and to 0.64, as μ increases from 0.03 to 0.04 and to 0.06, respectively. However, flexible exchange rates still outperform fixed exchange rates.

In the next robustness check, we experiment with both a low value and a high value of ψ, which is the steady-state ratio of foreign debt to net worth. For the low (high) value of ψ we set $\psi = 4$ ($\psi = 15$). For $\psi = 4$, the performance of flexible exchange rates improves, strengthening the case for floating the Reichsmark. For $\psi = 15$, since ψ exceeds the above-mentioned threshold of 13.2, the balance sheet effects dominances so that floating is now worse than fixing the Reichsmark. Real GDP loss under flexible exchange rates is 21 percent larger than that of the fixed exchange rates.

As is shown in the BP curve, the balance sheet effects are decreasing in the share of home goods in the consumption aggregate γ. For a robustness check we experiment with a value of γ that is smaller than the one we have used and which also implies stronger balance sheet effects; namely, $\gamma = 0.60$. This value is also the one adopted by Céspedes, Chang, and Velasco (2003, 2004, 2005). As expected, real GDP loss under flexible exchange rates is now only 16 percent smaller than that under fixed exchange rates. Nevertheless, floating the Reichsmark is still a better choice.

We set the values of both the elasticity of substitution among different labor types (σ) and the elasticity of labor supply (υ) to 2. For a robustness check, we follow Smets and Wouters (2003) and Hristov (2016) and experiment with $\sigma = 3$, which is somewhat larger than the estimates obtained using U.S. firm-level data by Griffin (1996). Table $A3$ shows that setting $\sigma = 3$ does not affect our results at all.

A value for the elasticity of labor supply equal to 2 is between the relatively low elasticities that are typically estimated in the micro-labor literature and the larger elasticities usually obtained in DSGE models. For example, the elasticity of labor supply obtained from the estimated DSGE model ranges from about 2.0 to 3.0 (Del Negro et al. 2007; Justiniano and Preston 2010). For a robustness check we examine how the results change for $\upsilon = 1.5$ and $\upsilon = 3.0$. Table $A3$ shows that adopting alternative values for the elasticity of labor supply does not change the relative performance of flexible versus fixed exchange rates. Moreover, flexible exchange rates become even advantageous as the elasticity of labor supply increases.

The value of the inverse of the elasticity of money demand we use is taken from Ritschl (2003). For a robustness check, we also experiment with $\varepsilon^{-1} = 1.5$. Table $A3$ shows that our results are unaffected.

Remember that the price rigidity we use is the average of (a) the price rigidity from estimates for the pre-1914 period and (b) estimates made in modern times. For a robustness check, we also experiment with employing the minimum and maximum values of the estimates from both periods; that is, $\theta_p = 0.50$ and $\theta_p = 0.67$. Table $A3$ shows that flexible exchange rates are more desirable relative to fixed exchange rates when the

degree of price rigidity is high.

The literature strongly suggests that wages have a higher degree of rigidity than prices in the interwar period. It is thus important to have $\theta_w > \theta_p$ when setting the parameter values. To test the robustness of our results, we also experiment with using $\theta_w = 0.67$ so that wages and prices have the same degree of rigidity. We also experiment with higher wage rigidity by using $\theta_w = 0.82$, which is about the 95th percentile of the posterior distribution of the parameters obtained by Smets and Wouters (2003, 2007). Here, Table *A*3 presents that even under alternative degrees of wage rigidity, flexible exchange rates still incur a lower real GDP loss than fixed exchange rates.

Finally, Table *A*3 also reports simulated CPI inflation under fixed and flexible exchange rates, including the two cases of self-fulfilling inflation. Our robustness checks find no evidence that supports the fear of inflation.

Our paper aims to examine the hypotheses of the historiography about interwar Germany using the tools of quantitative macroeconomics. The methodology has inherent limitations due to its modelling assumptions, and our results are not free of caveats. We have adopted several strong assumptions, partly for the reason of tractability and partly to make the model fit the historical background. Relaxing these assumptions would not change our main results.

The first limitation is the model assumes that workers hold no stock of assets (cannot borrow and save), and so there is no consumption Euler equation like in the typical New Keynes framework (see, for example, Wickens 2012, chapter 14.4) that allows the interest rate to affect the consumption of workers. This implies that the model relies on the cost of foreign borrowing channel alone. The German hyperinflation during 1922-1923 wiped out almost the entire domestic savings and destroyed domestic capital markets, rendering it extremely difficult for entrepreneurs to raise capital through domestic markets. This historical background is the reason that we assume households cannot borrow and save, and as a consequence entrepreneurs have to resort to foreign capital markets. Allowing workers to hold stock of assets would provide an additional channel for the real interest rate in the transmission mechanism of interest rate policy and thus strengthen the case

for the flexible exchange rate.

The model assumes that capital completely depreciates. Allowing for incomplete capital depreciation should strengthen the desirability of flexible exchange rates (Céspedes, Chang, and Velasco 2004). In the model, the price of capital in terms of home goods is increasing in the real exchange rate. With incomplete depreciation of capital, a real exchange rate depreciation would raise the value of capital, thus increasing entrepreneurs' net worth. This would constitute an additional advantage of flexible exchange rates. Since balance sheet effects act through investment, allowing for incomplete capital depreciation would also make the balance sheet effects smaller, adding another advantage to flexible exchange rates.

We finally assume that entrepreneurs consume a portion $(1-\delta)$ of their net worth, and they only consume imported goods. This means that a portion of the economy's resources is transferred abroad and lost. This assumption is to ensure that entrepreneurs would never be able to depend on their own financing means, but rather have to borrow in the market to finance their investment. The literature that adopts the Bernanke-Gertler mechanism (as we do here) usually assumes that entrepreneurs have a finite horizon, and that a fraction of entrepreneurs exits their business each period (Meier and Müller 2006). The purpose is to guarantee that entrepreneurs remain dependent on external funds. Our assumption here serves the same purpose.

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Table A3. Robustness Checks

Parameter	Benchmark	Robust Check	CPI Inflation		Real GDP Loss
			Fixed	Float/SF_E/SF_A	Float Relative to Fixed
			Benchmark **-6.06**	**Benchmark** **4.11/3.19/4.66**	**Benchmark** **0.48**
Sensitivity of the country risk premium	$\mu = 0.03$	$\mu = 0.04$	-6.03	4.20/3.09/4.74	0.55
Sensitivity of the country risk premium	$\mu = 0.03$	$\mu = 0.06$	-6.00	4.26/2.98/4.78	0.64
Steady-state ratio of foreign debt to net worth	$\psi = 6.0$	$\psi = 4.0$	-6.14	3.91/3.19/4.45	0.38
Steady-state ratio of foreign debt to net worth	$\psi = 6.0$	$\psi = 15.0$	-5.72	5.42/2.75/5.86	1.21
Share of domestic goods in the production of consumption	$\gamma = 0.73$	$\gamma = 0.60$	-3.33	3.44/3.25/4.38	0.84
Elasticity of substitution for labor	$\sigma = 2$	$\sigma = 3$	-6.06	4.11/3.19/4.66	0.48

Elasticity of labor supply	$\upsilon = 2$	$\upsilon = 1.5$	-5.16	3.87/3.02/4.38	0.53
Elasticity of labor supply	$\upsilon = 2$	$\upsilon = 3.0$	-7.57	4.40/3.28/5.03	0.39
Inverse of the elasticity of money demand	$\varepsilon = 1/1.5735$	$\varepsilon = 1/1.5$	-6.06	4.11/3.19/4.66	0.48
Degree of price rigidity	$\theta_p = 0.6076$	$\theta_p = 0.50$	-5.92	4.22/3.13/4.99	0.62
Degree of price rigidity	$\theta_p = 0.6076$	$\theta_p = 0.67$	-6.21	3.95/3.19/4.42	0.26
Degree of wage rigidity	$\theta_w = 0.75$	$\theta_w = 0.67$	-8.73	4.54/3.34/5.24	0.32
Degree of wage rigidity	$\theta_w = 0.75$	$\theta_w = 0.82$	-3.98	3.47/2.79/3.92	0.60

Sources: Authors' calculation.

Notes: The benchmark adopts the parameter values reported in Table A2. CPI inflation and real GDP loss are computed for the period 1930Q2-1932Q2. SF_E and SF_A denote scenarios of self-fulfilling inflation according to equations (4) and (5) of the main text, respectively.