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CURRENCY VERSUS BANKING IN THE FINANCIAL CRISIS OF 1931*

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During the 1920s, Germany was the world's largest capital importer, financing reparations through U.S. credits. We examine financial channels in crisis transmission between these two countries around the German financial crisis of 1931. We specify a structural dynamic factor model to identify financial and monetary factors separately for each of the two economies. We find substantial crisis transmission from Germany to the United States via the financial channel, while monetary or financial crisis transmission from the United States to Germany was weak. We also find major real effects of the 1931 crisis on both economies, again transmitted via the financial channel.

1. INTRODUCTION

Between 1929 and 1932, output in the United States and Germany declined in unison, earlier and more strongly than in most other industrialized nations (see the data in Barro and Ursúa, 2008). The two economies were heavily exposed to each other, both through financial markets and the Gold Standard. German debt owed directly and indirectly to the United States was in the range of 13%–16% of U.S. GDP in 1931. Most of this debt was lost between 1931 and 1933.

The trigger event for this was the German financial crisis of July 1931. In a matter of days, it led to a run on the central bank and the commercial banking system, the nationalization of four of Germany's five largest banks, the introduction of capital controls, a moratorium on the politically toxic reparations, and a standstill on short-term debts that evolved into a full-blown debt default (James, 1986). Within months, other debtor countries in Europe followed suit and introduced capital controls as well. The German banking crisis was also instrumental in pushing Britain off the Gold Standard in September of 1931 (Accominotti, 2012).

There is general agreement that the 1931 financial crisis was a key event in deepening the Great Depression internationally (see already Friedman and Schwartz, 1963). The channels and the direction of crisis propagation and transmission seem less clear. Doubts about the credibility of Germany's commitment to the Gold Standard, as well as the fast depletion of its currency reserves, have been interpreted as evidence of a first-generation currency crisis (see Temin, 1989; Eichengreen, 1992; Ferguson and Temin, 2003). Building on research by Born (1967) and James (1986), Schnabel (2004) highlighted the vulnerability of German banks as a key factor and interpreted the simultaneous occurrence of a currency attack and a generalized bank run as a twin crisis.

At the same time, the 1931 financial crisis was a sovereign debt crisis (Ritschl, 2002a). Under the Dawes Plan of 1924, Germany had borrowed abroad heavily, paying reparations entirely on

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credit and running a current account deficit. Tighter terms for reparation payments under the Young Plan put an end to further German borrowing and triggered a policy of fiscal austerity. Doubts about this policy and about Germany's willingness and capacity to pay further reparations contributed to the outbreak of the crisis. When Germany's position finally unraveled, foreign debt including reparations under the Young Plan amounted to roughly 100% of German GDP.

Historians have emphasized the fact that Germany's foreign debt was mainly underwritten by the United States; see Kindleberger (1973) and, in particular, Schuker (1988). This included U.S. interallied credits from World War I to Britain and France, for which German reparations served as collateral. James (2001, 2009) argued for financial transmission of the 1931 crisis to the United States. For July 1931, Richardson and van Horn (2009) find evidence of financial distress at New York banks, coincident with the German banking crisis, but cite tightened regulatory oversight as the major cause. Mouré (2002) argued that France's default on her interallied World War I debt in the wake of the end of German reparations seriously worsened the credit crunch in the United States (see also Eichengreen and Flandreau, 2008). The financial crisis of 1931 also figures prominently in recent comparisons between the interwar depression and the Great Recession after 2007 (see Bordo and James, 2009).

This article is about quantifying the role of these financial factors in the international transmission of the Great Depression. We exploit a balanced panel of financial, money market, and real economy time series from both the United States and Germany. Germany was unique among the major European economies in collecting and producing high-quality time series data between 1925 and 1933, replicating the Burns and Mitchell business cycle project in the United States. That such an effort was made is itself a consequence of the stringent statistical reporting criteria of the 1924 Dawes Plan. A state-sponsored research institute was set up in Berlin to build up a coherent system of monthly business cycle statistics (Tooze, 2001). This data set is in many ways methodologically similar to the Burns and Mitchell (1946) data preserved in the NBER's macroeconomic history database, from which the U.S. data for this article are taken.

To analyze the issue econometrically and exploit the information embedded in many disaggregate time series, we choose the factor augmented vector autoregression (FAVAR) model of Bernanke et al. (2005). We identify the factors through exclusion restrictions (as in Kose et al., 2003). Monte Carlo Markov chain (MCMC) techniques are employed to infer the posterior distributions.

For each of the two countries, we specify a monetary component, a banking factor, and a real component separately.[2] The first is designed to capture monetary transmission channels under the Gold Standard, which would be in line with more traditional interpretations of the 1931 crisis as a first-generation currency crisis (as in Eichengreen, 1992, or Temin, 2008). The banking component is designed to be a measure of financial distress, reflecting the importance of banking crises during the Great Depression. Our real factors coincide well with traditional business cycle dating schemes and historical national accounts for the respective countries. At the same time, the real factors provide a convenient alternative to interpolations of historical national accounts.

Business cycle transmission with recent international data has been analyzed by structural VARs in Stock and Watson (2005) and by dynamic factor models, e.g., in Eickmeier (2007). To our knowledge, this article is the first study applying modern time series methodology to the international transmission of the interwar Great Depression. Due to the limitations that existed so far in extending VARs to panel data, existing econometric work on the international Great Depression, as in Bernanke and James (1991) and Bernanke and Carey (1996), was confined to cross section methods.

We approach the issue of international transmission in a twofold manner. First, we obtain impulse response functions from shocks to the factors both for the whole observation period to

[2] Robustness checks on the validity of our identification, obtained from an alternative specification with equal number of nonstructural factors, replicated the factors well.

TABLE 1
GERMAN COMMERCIAL DEBT SERVICE AND REPARATIONS (% OF GDP)

Year	Exports*	Interest (net)	Reparation* Payments	Current Account*	Long-Term Capital Inflows	Of Which: Stabilization Loans
1924	15.0	−0.4	−0.2	−2.4	1.5	0.4
1925	14.4	−1.5	0.0	−5.2	1.6	0.7
1926	15.6	−1.6	−0.2	−1.0	1.9	
1927	14.7	−1.9	−0.4	−6.0	2.1	
1928	15.5	−2.2	−0.6	−4.5	1.9	
1929	17.1	−2.6	−0.9	−3.9	0.5	
1930	16.5	−2.1	−1.2	−1.6	1.0	1.8
1931	16.1	−1.4	−1.7	0.9	−0.1	
1932	12.8	−0.3	−1.6	0.5	0.0	

NOTES: *Excluding reparations in kind.
SOURCE: Deutsche Bundesbank (1976) and Ritschl (2012).

late 1932 and a truncated sample that ends before the 1931 financial crisis. Second, we assess the contribution of the individual factors to the forecasting power of the factor model at critical junctures around crisis of 1931.

As expected, we find evidence of monetary and financial crisis transmission from the United States to Germany. However, this transmission was comparatively minor. In contrast, we obtain evidence of crisis propagation from Germany on the United States. This effect is pronounced after July 1931 and is transmitted mainly through the financial stress components. We also find Germany's financial factor to have strong predictive power for U.S. real activity from late 1930, suggesting a systemic component of the financial crisis.

The rest of this article is structured as follows: The next section briefly reviews Germany's foreign debt and reparations problem at the root of the financial crisis of 1931. Section 3 characterizes the dynamic factor model we employ. Section 4 provides the data. Section 5 obtains the factors and evaluates the relative importance of currency and banking in the 1931 crisis. Section 6 concludes.

2. HISTORY BACKGROUND: U.S. EXPOSURE TO GERMAN DEBT

The exposure of the United States to German debt was indirectly linked to Germany's post-World War I reparations. Parts of Germany's reparations were designed to reimburse America's European World War I allies for their interallied war debts to the United States (Ferguson, 1998). Stabilization of the German economy after the hyperinflation of 1923 rested on the principle that reparations to the Europeans were senior in rank and that reimbursement of war interallied debts would have to wait until the German economy had made full recovery. The U.S.-brokered Dawes Plan of 1924 linked the new German currency to gold at the prewar parity and placed the newly independent central bank under international control. Reparations were rescheduled to start from a low initial level, a stabilization loan was issued and floated in international markets, and international investors were granted transfer protection of their profits from any foreign exchange demands for reparations.

Germany's stabilization was seen by contemporaries as an instant success. A foreign borrowing boom followed, mostly involving U.S. lenders. New York banks restocked the German banking system with liquidity after the end of hyperinflation. In addition, German bonds were floated on the U.S. market in large volumes. During 1924–29, Germany became the world's largest capital importer, absorbing U.S. net capital exports almost in their entirety (Ritschl, 2002b). As a consequence, reparations were paid smoothly but were fully recycled through credit. In addition, Germany ran sizable current account deficits (see Table 1). This failure to

TABLE 2
LEVELS OF GERMAN FOREIGN DEBT AND GDP

Year	Commercial Foreign Debt (billion Reichsmarks)	Reparations (billion Reichsmarks)	GDP	Reparations/ GDP (%)	Total Foreign Debt/GDP (%)
1928	27	37	89.0	45	72
1929	31	37	89.2	42	76
1930	32.6	35	89.9	39	82
1931(midyear)	33.6	33.5	*68.5*	49	98
1931(end)	26.6	33	*58.1*	57	102
1932	25.9	–	56.4	–	46

NOTES: Figures in italics are quarterly, annualized. Reparations are NPV of annuities, discounted at Dawes and Young loan rates.
SOURCE: Calculated from data in Deutsche Bundesbank (1976) and Ritschl (2012).

effect proper transfers of reparations attracted the attention of Keynes (1929) and his critics Ohlin (1929) and Rueff (1929) in their classical controversy over the transfer problem.

Political historians have argued that during the late 1920s, Germany deliberately used the loophole provided by transfer protection under the Dawes Plan to provoke a payments crisis and jeopardize reparations (Link, 1970; Schuker, 1988). Archival evidence in McNeil (1986) suggests that German government officials were confident that in a future transfer crisis, Germany could shake off reparations without damaging her commercial foreign creditworthiness. One source framed this as taking New York's bankers hostage to the reparations conflict. However, given a high reparations total and the lack of German cooperation on the issue until 1923, it was not straightforward that much international credit to Germany should come forth after 1924. Ritschl (2002a) argued that transfer protection of foreign investors' profits under the Dawes Plan made commercial loans to Germany senior to reparations, which would provide an economic rationale for the lending spree.

U.S. commercial lending to Germany was nearly evenly split between bank credits and bonds (Schnabel, 2004). New issues of German bonds in New York peaked in early 1928 and then ebbed away. Worries about rapid growth of Germany's foreign debt and a future clash with reparation claims caused New York banks to limit their further engagement while at the same time avoiding a rush to the exit. J.P. Morgan shifted its riskier European assets into Lee Higginson, a Boston bank that later failed in the wake of the 1931 financial crisis (James, 1986).

The recycling of German reparations through American credit stoked fears of a major financial crash also in political circles. During a central bankers' conference on Long Island in 1927 it was agreed to try and bring the international monetary imbalances under control. Among other things, this would have to involve a slowdown in German borrowing, which the German Reichsbank struggled in vain to achieve (James, 1986).

At the onset of the Great Depression, Germany's total foreign debt in 1929 stood at 76% of GDP (Table 2). Germany's foreign debt consisted of reparations and commercial debt in roughly equal measure. Had one part of the debt been absent, the debt burden imposed by the other would have seemed rather trivial. It was the combination of the two elements of debt that made a payments crisis likely in a recession. Transfer protection for commercial credits was revoked in the Young Plan of 1929, leaving the status of existing commercial credits to Germany in doubt and making any further outlays junior to all existing claims, including reparations. Hence, prospective lenders of fresh money faced fundamentally different risks under the Young Plan than under the Dawes Plan. This made international support in a currency crisis far less likely than under the Dawes Plan.

Data in Table 1 bear out a sudden stop in long-term capital inflows in 1929 as a response. Current account reversal was delayed by one year through stabilization loans in connection with the Young Plan (Ritschl, 2012). Once these were used up and the international depression made itself felt, Germany plunged into a public sector budget crisis (James, 1986). By the time

TABLE 3
U.S. EXPOSURE TO GERMAN DEBT

	Billion U.S.$	Share of German Foreign Debt Total (%)	Relative to U.S. 1931 GDP (%)
German commercial debt directly owed to the United States	2.0	12.5	2.6
Young Plan debt indirectly owed to the United States	8.3	51.0	10.8
U.S. exposure to Germany (lower bound)	10.4	63.5	13.6
Potential further exposure to German Debt	1.9	11.8	2.5
U.S. exposure to Germany (upper bound)	12.3	75.3	16.1
German net capital imports (cumulative 1924–30)	3.52		4.6
United States net capital exports (cumulative 1924–30)	3.98		5.2

SOURCE: U.S. Bureau of the Census (1975) and Deutsche Bundesbank (1976).

the financial crisis arrived, nominal GDP had fallen by 20% from its 1929 peak, and the ratio of foreign debt to GDP approached 100%.

Germany's slide into depression was accompanied by stiff deflationary policies, which have been discussed controversially ever since, see James (1986) and Ferguson and Temin (2003) for opposing interpretations of the evidence. The motivation for these policies was an austerity response to the looming foreign debt crisis (Ritschl, 2002a), mandated to a large extent by the Bank of England and the Federal Reserve of New York. In return, both central banks arranged unofficial standstills of German debts. Such an arrangement was in operation among New York banks during 1930 and 1931, accompanied by heavy write-offs. Upon request of the Federal Reserve, New York banks even held on to their German assets after the financial crisis had broken out in full. A moratorium on German reparations was proclaimed by U.S. president Hoover in July 1931.

The moratorium aimed to protect U.S. commercial credit to Germany, which was concentrated at the long-term end (see Table 3). A standstill was negotiated on German short-term debt. This affected Britain disproportionately, as large parts of Germany's foreign debt were held by London merchant banks specialized in trade finance, while New York banks with short-term positions in Germany were more broadly diversified (Accominotti, 2012). As a consequence, the immediate impact of Germany's financial crisis on the New York banking sector was muted. However, in spite of the favorable treatment of U.S. credits in the Hoover moratorium, German bond prices in New York fell rapidly, and had lost 50% of their value by the end of 1931. Early writedowns and coordination among New York's banks under the aegis of the Fed of New York had averted a banking crisis. Nevertheless, bank equity losses due to the German crisis were substantial: U.S. banks had underwritten over one billion U.S. dollars in German securities, and were owed over half a billion in German and other European bank debt.

Although the Hoover moratorium proclaimed only a temporary time-out on reparations and interallied war debts, it was seen as an acknowledgment that the Young Plan did not work. As the Young Plan was an attempt to obtain reimbursement from Germany for Western Europe's debt service on interallied war debts, its suspension fed expectations that both reparations and interallied war debts would be condoned. At the Lausanne conference of August 1932, an accord between Britain, France, and Germany suspended reparations indefinitely, conditioning a formal end of reparations on the United States condoning the interallied war debts. U.S. rejection of the agreement in December 1932 led to unilateral defaults by Germany on reparations and by France and Britain on their interallied war debts. This wiped out half of Germany's foreign debt, with U.S. owners of war bonds bearing the cost. After successive tightening of capital controls, Germany in May 1933 also suspended transfer on its long-term debt service (Einzig, 1934). Only in 1953 was a debt settlement reached (Guinnane, 2004).

Germany's default affected U.S. loan portfolios heavily, as most of Germany's borrowing had been financed directly or indirectly in the U.S. market (see Table 3). U.S. losses from Germany's debt crisis and default were in the range of 13%–16% of U.S. GDP of 1931. Given America's high exposure, our main interest in the following is to ask two questions of the data. First, can we identify channels of crisis transmission between the two economies before and during the Great Contraction? Second, can we detect any influence of the mounting German debt crisis via the financial transmission channel, both nationally and internationally?

3. A STRUCTURAL DYNAMIC FACTOR MODEL

We follow developments in dynamic factor analysis that have augmented VARs with information gathered from a large cross section of time series. Our approach is to make the factors informative by applying suitable exclusion restrictions. Let a data panel Y_t, spanning a cross section of N series and an observation period of length T, be described by an observation equation:

$$Y_t = C + \Lambda f_t + U_t, \tag{1}$$

where f_t is a $K \times 1$ vector containing the latent factors, U_t is an $N \times 1$ vector of variable-specific idiosyncratic components, C is an $N \times 1$ vector of constant terms, and Λ is the $N \times K$ coefficient matrix linking the K common factors to the ith variable. More precisely, the Λ matrix provides for a structural interpretation of the factors, where each factor loads on a subset of the data by imposing zero restrictions. In this context, we define

$$\Lambda = \begin{bmatrix} \Lambda^{US} & 0 \\ 0 & \Lambda^{D} \end{bmatrix},$$

where

$$\Lambda^{US} = \begin{bmatrix} \Lambda^{real} & 0 & 0 \\ 0 & \Lambda^{monetary} & 0 \\ 0 & 0 & \Lambda^{financial} \end{bmatrix}$$

and

$$\Lambda^{D} = \begin{bmatrix} \Lambda^{real} & 0 & 0 \\ 0 & \Lambda^{monetary} & 0 \\ 0 & 0 & \Lambda^{financial} \end{bmatrix}.$$

Accordingly, the structural factors are defined as $f_t = [f_t^{US}, f_t^{D}]'$, where f_t^{US} and f_t^{D} can be again subdivided into real, monetary, and financial factors. The law of motion for the factors, which is in VAR form, is defined as

$$f_t = \phi_1 f_{t-1} + \cdots + \phi_q f_{t-q} + v_t, \tag{2}$$

with $v_t \sim \mathcal{N}(0, \Sigma)$. The idiosyncratic components U_t are assumed to follow an AR(p) process:

$$U_t = \Theta_1 U_{t-1} + \cdots + \Theta_p U_{t-p} + \chi_t, \tag{3}$$

where $\Theta_1, \ldots, \Theta_p$ are $N \times N$ diagonal matrices and $\chi_t \sim \mathcal{N}(0_{N\times1}, \Omega_\chi)$ with

$$\Omega_\chi = \begin{bmatrix} \sigma^2_{1,\chi} & 0 & \cdots & 0 \\ 0 & \sigma^2_{2,\chi} & \vdots & \vdots \\ \vdots & \cdots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma^2_{N,\chi} \end{bmatrix}.$$

3.1. *Specification of Priors and Estimation.* For the AR parameters of the idiosyncratic components $\Theta_1, \Theta_2, \ldots, \Theta_p$, we specified the following prior:

$$\theta^{prior} \sim \mathcal{N}(\underline{\theta}, \underline{V}_\theta),$$

where $\underline{\theta} = 0_{p\times1}$ and where

$$[\underline{V}_\theta] = \tau_1 \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & \frac{1}{2} & \vdots & \vdots \\ \vdots & \cdots & \ddots & 0 \\ 0 & \cdots & 0 & \frac{1}{p} \end{bmatrix}.$$

We choose $\tau_1 = 0.2$. The shrinkage prior we specified implies that we punish more distant lags. This is subsequently applied by progressively decreasing the uncertainty about the mean prior belief that the parameters are zero for increasing lag values.

For each of the factor loadings, we specified the following prior:

$$\lambda^{prior} \sim \mathcal{N}(\underline{\lambda}, \underline{V}_\lambda),$$

where $\underline{\lambda} = 0$ and $\underline{V}_\lambda = 100$. For each of the variances of the disturbances in χ_t, we specified the following prior:

$$\sigma_\chi^{prior} \sim \mathcal{IG}\left(\frac{\alpha_\chi}{2}, \frac{\delta_\chi}{2}\right),$$

where we choose $\alpha_\chi = 6$ and $\delta_\chi = 0.001$, which implies a fairly loose prior. $\mathcal{IG}$ denotes the inverted gamma distribution.

For the parameters of the VAR equation (2), we follow Bernanke et al. (2005) and impose the Kadiyala and Karlsson (1997) Minnesota-type prior on the VAR parameters. Then, the prior distribution of the covariance matrix Σ and the VAR parameters Φ can be expressed by

$$\Sigma_{prior} \sim \mathcal{IW}(\underline{\Sigma}, K+2),$$

with $\mathcal{IW}$ representing the inverse Wishart distribution and

$$vec(\Phi_{prior}) \sim \mathcal{N}(0, \Sigma_{prior} \otimes \underline{G}),$$

where $\underline{G}$ imposes less weight on more distant lags.

To ensure that the dynamic factor model is uniquely identified, the upper $K \times K$ block of the factor loadings matrix is set to the identity matrix, where each diagonal element corresponds to one of the structural factors (Bernanke et al., 2005). Estimation is via the Gibbs sampler.[3]

[3] For a full documentation, see the working paper version of this article (Ritschl and Sarferaz, 2009).

4. DATA

Data are at a monthly frequency from September 1925 to November 1932. The U.S. series are taken from the NBER's macroeconomic history database, which itself is partly based on the Burns and Mitchell (1946) research project on business cycle chronologies of the interwar period. As mentioned above, this project also had its German offshoot, the business cycle statistics of *Institut fuer Konjunkturforschung* (IfK) in Berlin, the precursor of today's *Deutsches Institut für Wirtschaftsforschung* (DIW). This makes the German data set rather unique, as its methodology is broadly in line with the Burns and Mitchell approach and therefore lends itself to comparative analysis. We take the data from a compilation of the institute's collection in Wagemann (1935).

We selected the series with a view to including leading and contemporaneous indicators wherever possible. For output, these include series for steel and capital goods as well as broad indices of industrial output. For both countries, the monetary series include the leading central bank interest rates, as well as money market and commercial paper rates. To obtain indicators of financial distress, for the United States we employ the NBER's data on the number of deposits in suspended banks, as well as the BAA–AAA corporate bond spread (Gertler and Gown, 1999) and a money market spread between 90-days call money in New York and three-monthly Treasury bills, akin to the Treasury Bill-Eurodollar (TED) spread analyzed by Dewachter and Iania (2011). Lacking similar data for Germany, we use a number of indicators on the volume of banking activity. All data except for the interest rates were transformed into first differences. For a more detailed description of the data set, see the Appendix.

5. ESTIMATION RESULTS

For the empirical results, we choose the lag lengths $p = 1, q = 7$.[4] We cycled through 500,000 Gibbs iterations, discarding the first 400,000 draws as burn-in and saving every 10th draw. All convergence diagnostics conducted were satisfactory.[5]

5.1. *Real and Nominal Factors.* To add structure to the factor approach, we restrict the data space on which factors are allowed to load.[6] For both the United States and Germany, we identify three factors, one of them real, the other two nominal. The first factor is designed to capture real activity in the respective national economies. The two nominal factors load on interest rates and banking series, respectively. We choose this identification strategy with the aim of identifying two international transmission channels, deviations from uncovered interest parity in the fixed exchange rate mechanism of the Gold Standard and a financial channel fed by distress in the banking system.

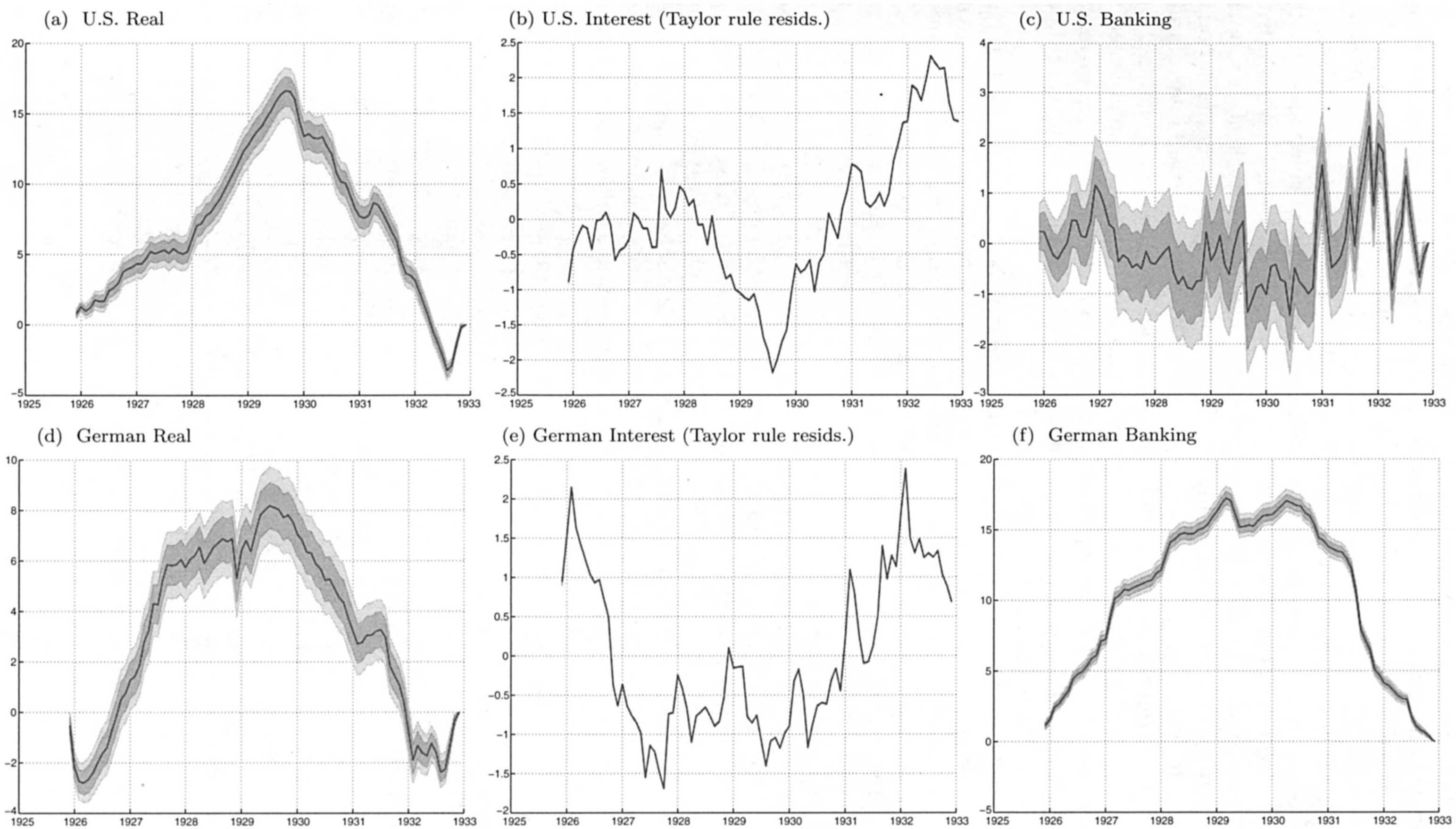
The real factor for the U.S. loads on output data for investment goods, as well as a contemporary index of output in manufacturing and trade (see Appendix A.1, Series 1–4). This factor, shown in Figure 1(a), reflects traditional business cycle chronologies well and is highly correlated with the most commonly used indices of industrial production. We found the result to be very robust to changes in the specification of the time series included. We also notice a very good fit with a broadly based factor of economic activity calculated in Ritschl et al. (2008). Results once again confirm the observation by Stock and Watson (1998) that one-factor models describe the real state of the economy quite well.

The U.S. banking factor in Figure 1(c), is a financial stress indicator, constructed from data on failing banks, as well as money market and corporate bond spreads. Liquidity tightness is measured by a TED spread between 90-day loans in New York and three-monthly Treasury notes and certificates. The corporate bond spread is Moody's BAA–AAA spread. The resulting

[4] We increased lag length q to up to 10 without seeing much change. As we saw no principal change in results, we did not go further up. Results look fairly similar for slightly lower q.

[5] See the Appendix for a more detailed discussion.

[6] To check the robustness of our identification, we also estimated a nonstructural Bayesian factor model. The resulting factors are almost identical. Results are further confirmed by the factor loadings .



NOTES: Latent common components for the United States and German real, monetary, and financial variables. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 1

STRUCTURAL COMMON FACTORS FOR THE UNITED STATES AND GERMANY factor declines from a previous peak in early 1926 to a low in late 1930 and increases strongly after that to flatten out at a high level in late 1932 (see Appendix A.1, Series 5–10).[7]

Modeling interest rate mechanisms in the presence of deflation and large output gaps implies having to deal with the data censoring problem presented by the zero lower bound. We take a shortcut through the issue of what central bank policy at the time may have been and proxy it by a well-understood and plausible monetary rule instead. Specifically, we obtain the monetary factor for the United States in Figure 1(c) from a Taylor (1993) rule measuring the deviation of interest rates from an interest rate target and obtaining their common component for the money market interest rates in our data set (see Appendix A.1, Series 11–13).[8] We construct the target interest rate from CPI inflation and an output gap, modeled as the cyclical component of a Hodrick–Prescott (129,600) filter of monthly industrial production data over the period of 1925–38. The parameter values are as in Taylor (1993). In this way, the observed interest rates near the ZLB during the contraction after 1929 translate into positive and high deviations from the negative target rate implied by the rule. The factor thus obtained can be interpreted as a monetary distress indicator. It falls precipitously from 1928 to mid-1929, and then increases throughout to mid-1932, with a minor interruption in early 1931. A pronounced upward shock is visible in mid-1931, at the time of Germany's 1931 crisis.[9]

Figure 1(d) shows the German real activity factor (see Appendix A.1, Series 14–17). Fast recovery from a recession in 1925/26 is followed by a marked slowdown in 1927. Real activity peaks in the summer of 1929 and is already in decline at the time of the New York stock market crash. A beginning recovery in the first half of 1931 is suddenly chocked off by a strong downward shock at the time of the German crisis. After a double dip in summer 1932, recovery set in and was well under way before early 1933, when the Nazis got to power. Results are in line with conventional wisdom (see James, 1986).

The German banking factor in Figure 1(f), loading on the banking series in our data set (see Appendix A.1, Series 18–22), is similar to series generated by Schnabel (2004) and Adalet (2005).[10] It shows almost continuous improvement to March 1929, when a first setback occurred, coincident with the first Young Plan crisis (see James, 1985). Recovery to early 1930 was followed by a second setback, coincident with the adoption of the Young Plan, Schacht's resignation from the Reichsbank presidency, and the downfall of the last parliamentary government. After that, the banking factor begins a precipitous decline, which accelerates into a collapse at the time of the mid-1931 crisis. There is no recovery until early 1933.

The German monetary factor in Figure 1(e) is again a monetary distress indicator, obtained from money market interest rates under the same Taylor rule as before (see Appendix A.1, Series 23–25). It peaks during a posthyperinflation recession in 1925 and again during the first reparations crisis of late 1928 and early 1929. Like its U.S. counterpart, it increases precipitously during the subsequent contraction. The spring of 1931 and the subsequent financial crisis stand out clearly. The indicator reaches its all time peak in early 1932. Germany's two nominal factors both show a shock in mid-1931. Eyeballing the evidence from the factors, one may conclude that both a currency and a banking crisis were at work.

Drawing the evidence from this section together, a common salient feature of the factors, and thus of the common underlying dynamics of our time series, is the marked deterioration in mid-1931, around the time of the financial crisis. This effect is not limited to the German data and is indeed visible also in the factors we extracted from the U.S. series. The next section will trace the phenomenon further, employing impulse response analysis of a structural FAVAR.

[7] We experimented extensively with a variety of different banking series and a U.S. banking factor extracted from them. None of these alternatives affected the principal findings of this article.

[8] An alternative approach would be to work with the historically observed interest rates and place strong restrictions on the sign of the impulse responses. We did this in the working paper version.

[9] We experimented extensively with alternative monetary factors that loaded on monetary aggregates or on both money and interest rates. None of these alternatives affected the qualitative results of our analysis.

[10] Calculating a BAA–AAA spread would be impractical, as Germany's financial markets remained closed for extended periods in the wake of the 1931 financial crisis.

5.2. *Currency versus Banking: The Transmission of Shocks.* This subsection relates the above factors to each other in a VAR analysis. As the factors are identified, their dynamic relationships can readily be given a structural interpretation as well. We analyze the transmission of surprise shocks within and across the two economies using impulse response functions. Our interest focuses on the relative importance of monetary shocks, transmitted through the Gold Standard mechanism, and of shocks to the banking system, transmitted through the mutual exposure of the two countries' financial sectors to each other.

We orthogonalize the shocks using mostly the temporal Cholesky decomposition. Our principal identification strategy is to assume that the U.S. factors do not react simultaneously to international conditions, while the German ones do: U.S. real activity is assumed endogenous to U.S. monetary and banking conditions only. German currency conditions are assumed endogenous to U.S. factors but exogenous to German banking conditions. We furthermore assume that the German real factor is endogenous to all other factors.

We choose this ordering with a working hypothesis in mind, reflecting conventional wisdom on the interwar Gold Standard as in Eichengreen (1992). This prior hypothesis is that monetary transmission through the interest rate mechanism took precedence over financial or real channels. As a consequence, evidence pointing to other transmission mechanisms will not just result from a prior implicit in the identification scheme, but instead from overturning that prior.[11]

We obtain interest rate shocks under the assumption of a Taylor rule as described above. Near the zero lower bound, the researcher's object of interest is an unobservable counterfactual, the negative rate of interest the central bank would have chosen. Modeling interest rate shocks as the deviation from a Taylor rule, we obtain a measure of monetary distress caused by the zero lower bound. However, even this admittedly counterfactual exercise does not impose sufficiently strong identifying restrictions. Under a recursive identification scheme, the responses to an interest rate shock under a Taylor rule still generate large and persistent sign puzzles. Hence, we go further and also employ a sign restriction methodology as in Uhlig (2005). In the spirit of his approach, we are agnostic about the response of output and instead restrict the responses of the U.S. interest and banking factors. All other shocks are orthogonalized using the recursive Cholesky ordering discussed above.

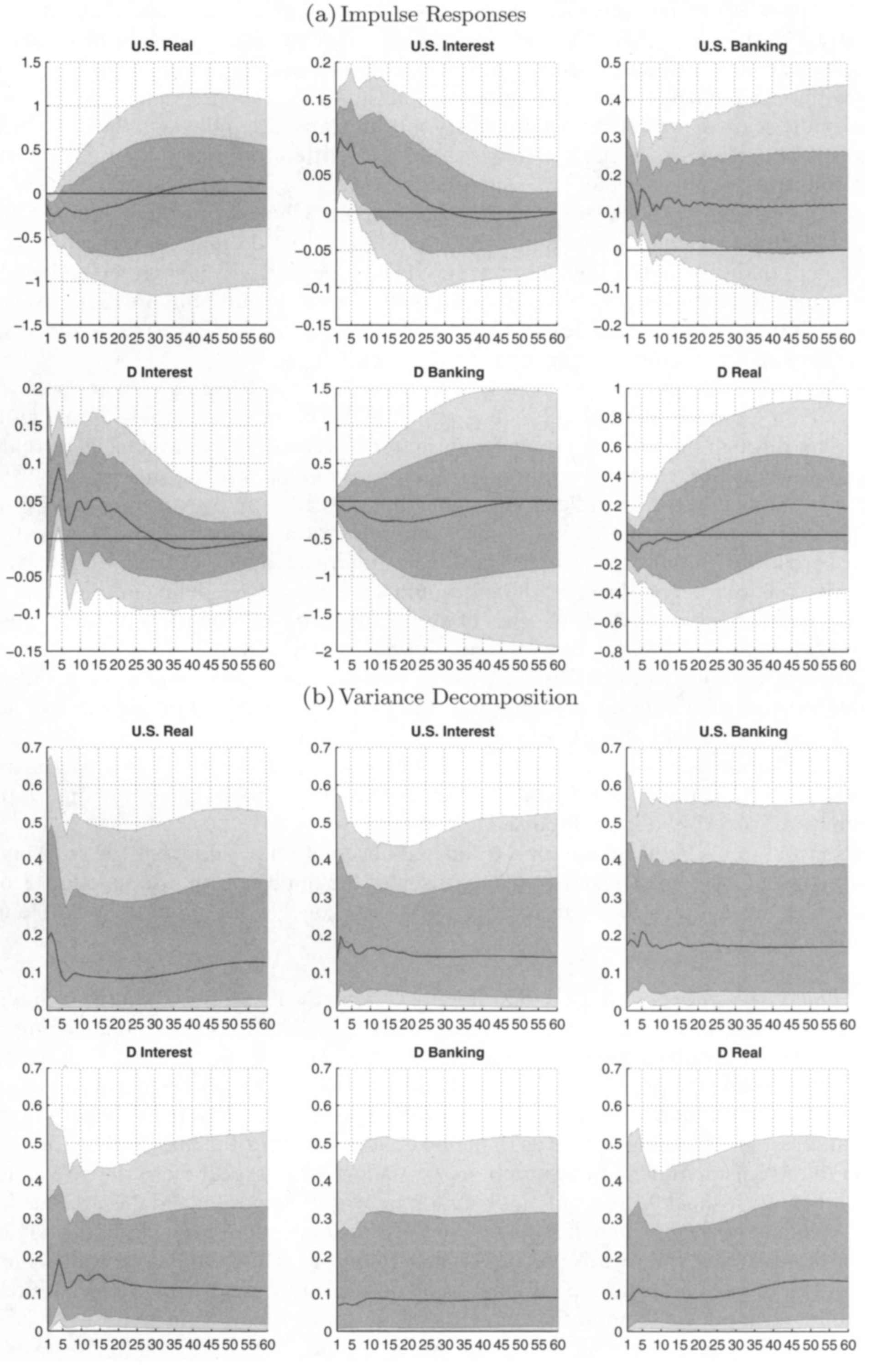
We also run the FAVAR model for a truncated observation period from 1925 to May 1931, before the onset of the financial crisis. Comparison of the impulse response functions from the full and truncated samples allows us to draw additional conclusions about the possible impact of the 1931 crisis.

5.2.1. *Full observation period, 1925–32.* Figure 2 shows the responses to shocks in the cyclical interest component from a Taylor rule. The responses of the U.S. monetary and banking factors are restricted to be positive for six months after the shock, whereas the response of the real factor is unrestricted. While the overall effects seem highly persistent, the sign restriction appears to be binding. After the six-month horizon, there is growing probability mass in the negative orthants for U.S. interest and banking as well as in the positive orthant for the U.S. real factor.

Under the strong identification assumptions we made, we can expect the variance explanation of a Taylor-interest shock for output and banking to be quite high. Indeed it is around 20% on impact. At longer horizons when the sign restriction is no longer active, shocks to the Taylor rule explain around 10% of the forecast error variance in output. This would be broadly consistent with results of Sims (1999) in a longitudinal study of U.S. monetary policy in the 20th century. The medium term effects seem somewhat weaker than those obtained in factor models for the postwar period by Bernanke et al. (2005) and Amir Ahmadi and Uhlig (2007). However, there is substantial probability mass reaching up to 30% of the forecast error variance. Results are sensitive, though, to relaxing either the sign restrictions or the Taylor rule assumption.

Figure 3 shows the responses to increasing financial distress as measured by shocks to the U.S. financial factor. Shocks to banking are quite persistent; their real effects peak after six months

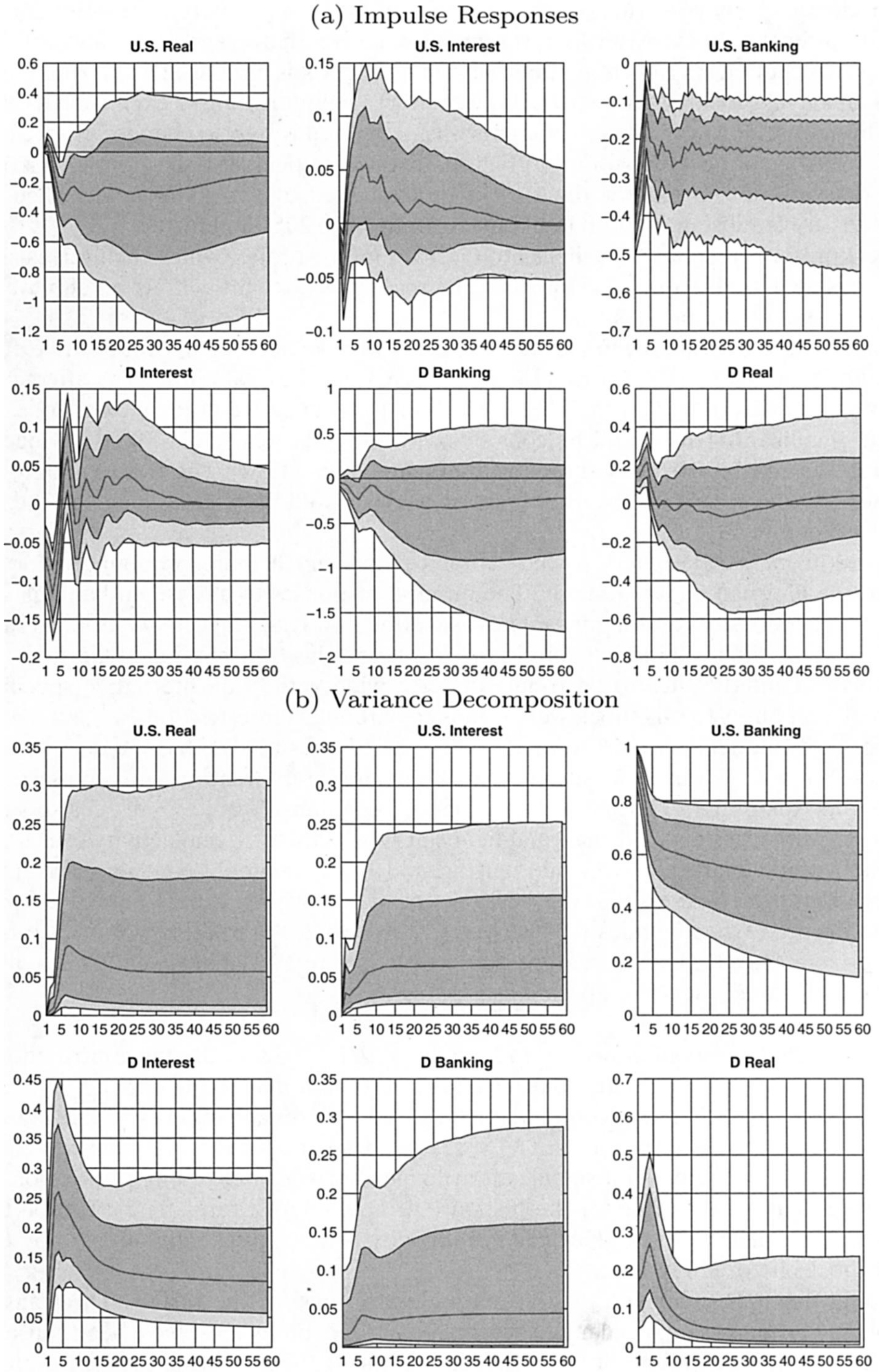
[11] Permutations of the Cholesky orderings left the qualitative results largely unaffected.



NOTES: Responses of all variables (a) to and fraction of the variance explained (b) by a contractionary one-standard-deviation shock in the U.S. interest rate factor. Interest rates are the deviation of the factor from a 1993 Taylor rule. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass. A sign restriction operates on the responses of the U.S. real and the U.S. monetary factors for the first six months after the shock.

FIGURE 2

U.S. INTEREST RATE SHOCK UNDER A TAYLOR RULE



NOTES: Responses of all variables (a) to and fraction of the variance explained (b) by a contractionary one-standard-deviation shock in the U.S. financial factor. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass. A sign restriction operates on the responses of the U.S. real and the U.S. banking factors for the first six months after the shock.

FIGURE 3

U.S. FINANCIAL SHOCK

and then dissipate. By construction, the response of U.S. real activity is negative for the first six months after the shock. After that, it remains negative on average, but draws with positive responses do occur, again indicating that the sign restriction is binding. The German responses to a U.S. financial shock are unrestricted. They show a counterintuitive expansionary response at short horizons. However, the effect is short-lived and not robust to changes in specifications.

The forecast error decompositions in Figure 3 indicate a peak at a six-month horizon, when 10% in the variation in the real factor can be explained by shocks to financial conditions. However, there is substantial probability mass going up to 20% and further.

Figure 4 presents responses to shocks to German interest rates, which themselves are again measured as deviations from a Taylor rule. The responses have little effect on either economy and are plagued by sign puzzles.

Monetary market tightening in Germany appears to have near-significant positive effects on real conditions in the United States. However, these effects explain little. The effect of monetary tightening in Germany on the U.S. interest factor is negative at longer horizons, without becoming significant. This would be consistent with the classical Gold Standard mechanism, however in the nonstandard way suggested by Eichengreen (1992): The U.S. economy acted as a short-term monetary shock absorber for the interwar Gold Standard, much like the Bank of England did before 1914.

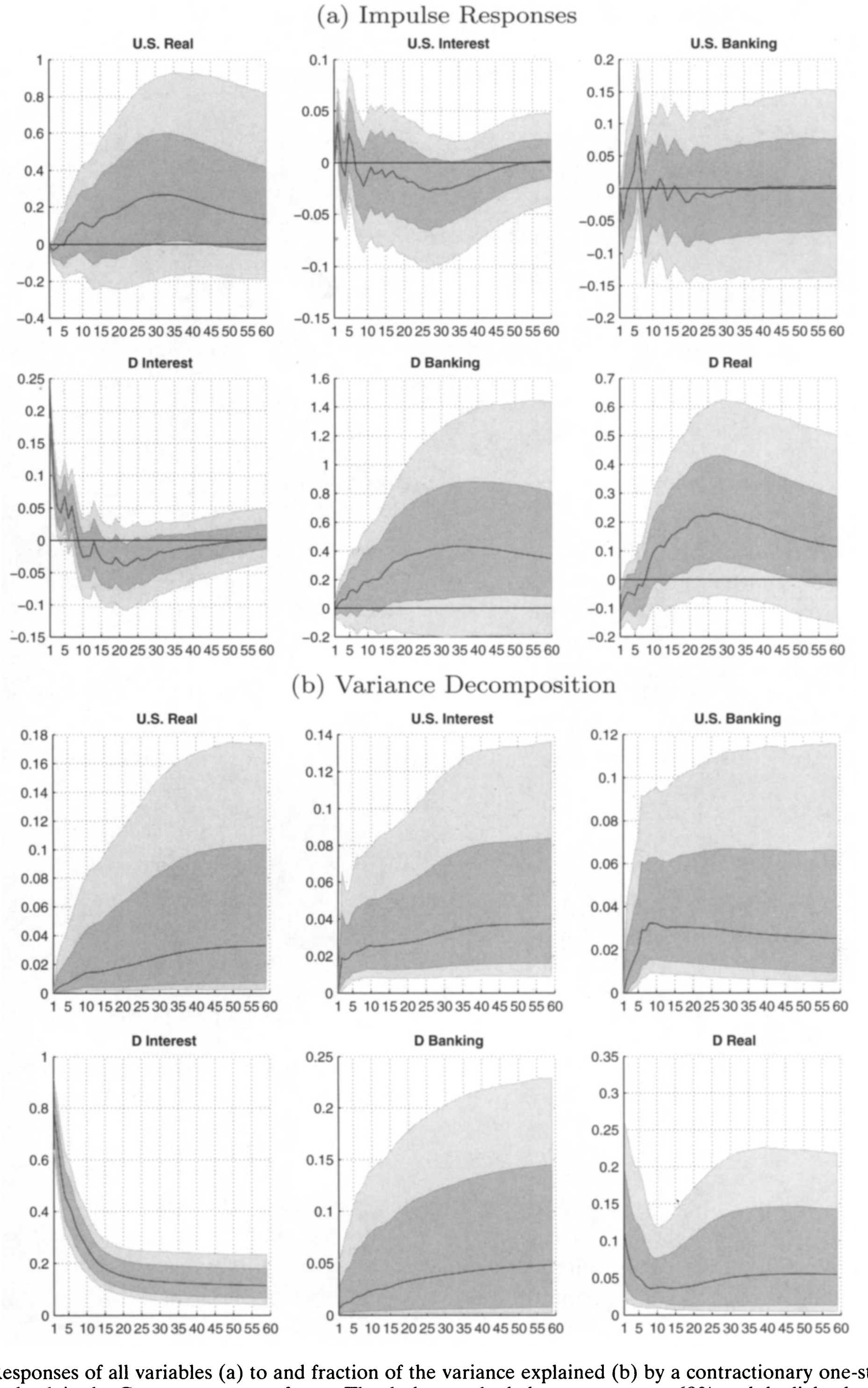
Spillovers from the periphery to the center become much more pronounced for adverse shocks to the German banking factor. The impulse responses to a German banking shock in Figure 5 reveal persistent and significant adverse effects on U.S. real activity, interest rates, and to a lesser extent, financial market conditions. We found this transmission of German financial shocks to the United States to be robust under a wide variety of alternative specifications. Notably, all responses to this shock were obtained without sign restrictions.

This result would lend support to the hypothesis of James (2001) that the deepening of the U.S. recession in 1931 was at least partly triggered by the international repercussions of the 1931 crisis in Austria and Germany. The variance decompositions in Figure 5 also show that explanatory power of these international financial shocks for U.S. real activity exceeds that of U.S. monetary and financial shocks (in Figures 2 and 3). As the impulse responses average over all observations from 1925 to 1932, this begs the question of whether there was a deep structural link between the two economies that generated this result. Alternatively, evidence from the subperiod from May 1931 to the end of our sample in late 1932 may weigh so heavily that it drives results for the observation period as a whole.

5.2.2. *Truncated observation period, 1925 to May 1931.* To identify the contribution of the 1931 crisis to this surprising result, we truncate the observation period to end in May 1931, right before the crisis erupted in full. Responses to an adverse German banking shock in Figure 6 are now less pronounced. The response of U.S. real activity to deteriorating financial conditions in Germany is still negative and significant at longer horizons but briefly positive on impact. A similar sign change is visible for the response of U.S. interest rates. The effect on the U.S. financial factor is again diffuse. German real activity is not significantly affected by German financial shocks before May 1931.

Excluding the 1931 crisis and its aftermath clearly weakens the results. The transmission effects of the Germany's financial meltdown on the U.S. economy must have been considerable.

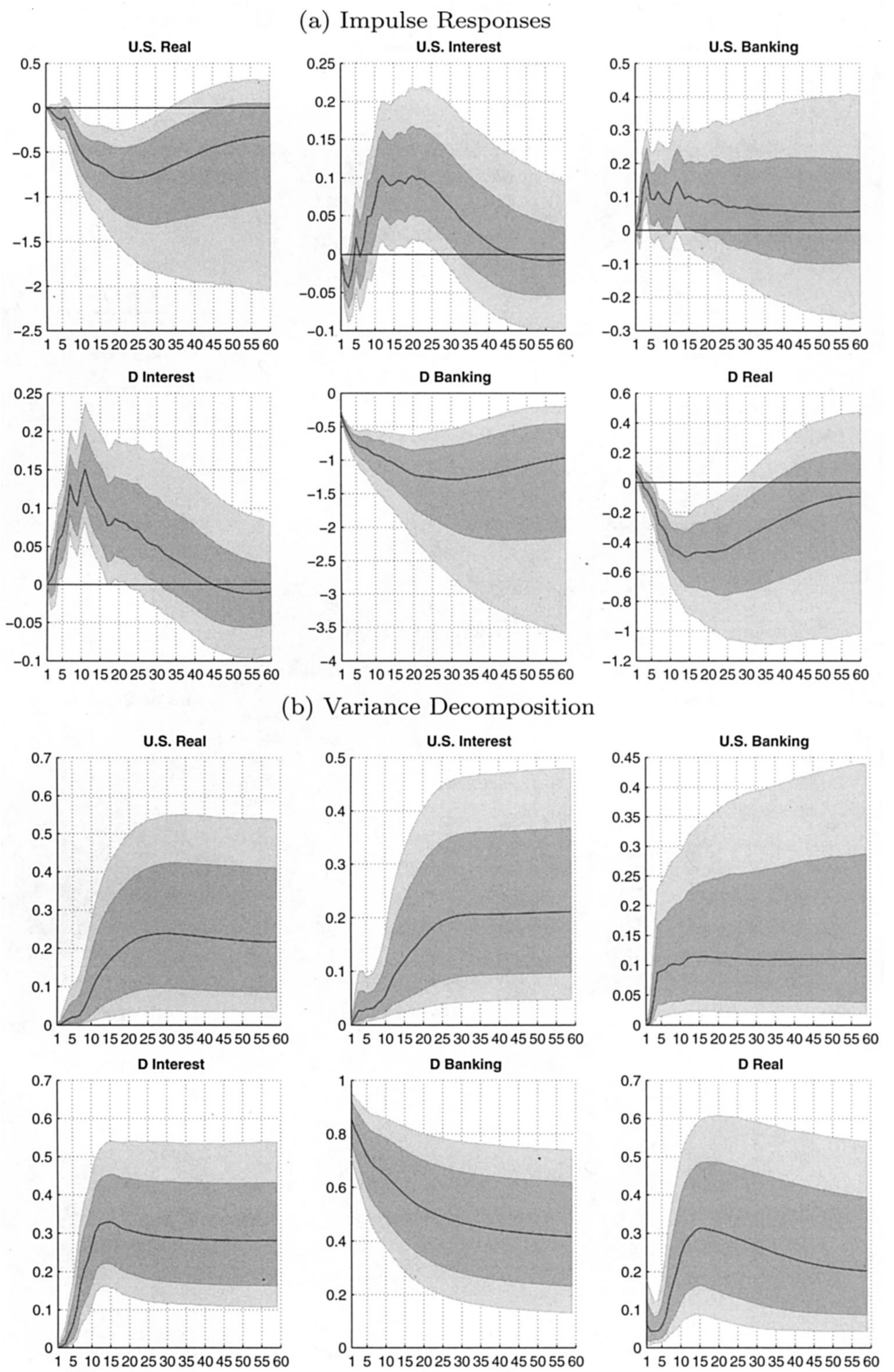
Still, the significant response of U.S. real activity during the subperiod before the 1931 crisis in Figure 6 suggests the effects obtained for the whole observation period in Figure 5 are not entirely generated by the 1931 crisis. If a structural link existed between the two economies, it clearly did not operate through the U.S. financial channel: There is neither circumstantial nor quantitative evidence that Germany's mounting debt crisis generated banking crises in the United States. We see this partly as a consequence of the debt management by New York's banks mentioned above: German debt was almost not traded, a standstill on credits to Germany was widely observed, and some of Germany's debt was shifted off balance and out of the New York Fed district into Lee Higginson, a Boston bank that did fail in 1932. We also note that



NOTES: Responses of all variables (a) to and fraction of the variance explained (b) by a contractionary one-standard-deviation shock in the German monetary factor. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 4

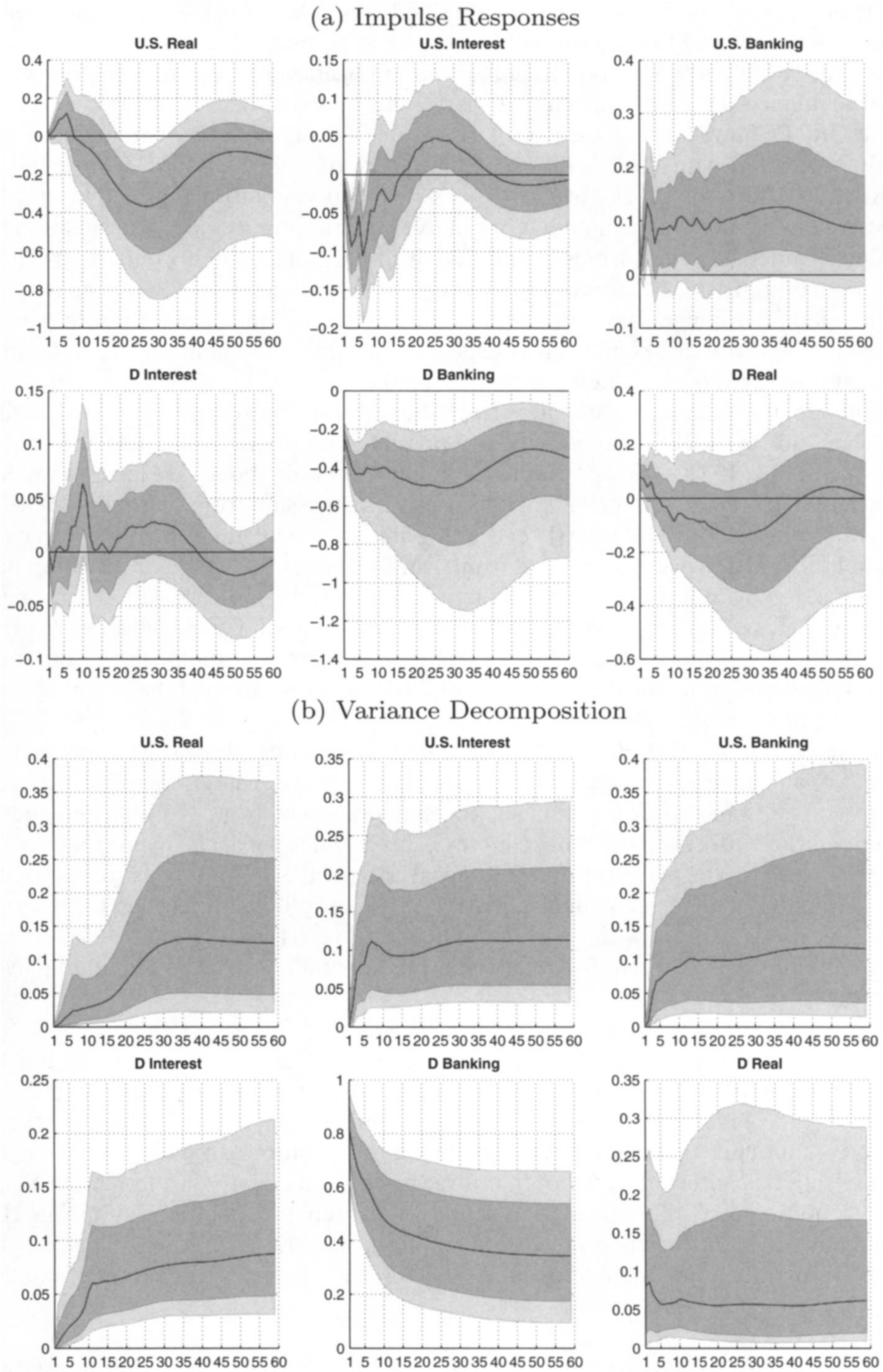
GERMAN INTEREST RATE SHOCK UNDER A TAYLOR RULE



NOTES: Responses of all variables (a) to and fraction of the variance explained (b) by a contractionary one-standard-deviation shock in the German financial factor. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 5

GERMAN FINANCIAL SHOCK



NOTES: Responses of all variables (a) to and fraction of the variance explained (b) by a contractionary one-standard-deviation shock in the German financial factor when sample period is truncated to 1931:35. The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 6

GERMAN FINANCIAL SHOCK, TRUNCATED SAMPLE large parts of German debt, as well as the interallied World War I for which reparations served as collateral, were held by the general public and the government.

Drawing the results of this section together, our application of a dynamic factor model finds only weak evidence for crisis transmission from the United States to Germany before and during the Great Contraction of 1929–33. This is true of both monetary and financial channels commonly associated with the operation of the interwar Gold Standard. Conversely, we do find substantial effects of shocks to Germany's financial system on real activity in the U.S. economy. Again the monetary channel is of relatively minor importance. Transmission through the banking channel, however, seems quantitatively important and highly persistent. The effects reach their maximum after 20 months. Their variance explanation for U.S. real activity exceeds 20% in the median at longer horizons, with considerable probability mass reaching up to and exceeding 40%. We also find significant effects of financial shocks emanating from Germany on U.S. interest rates and to a lesser extent on U.S. banking.

Apparently, most of these transmission effects did not materialize before the 1931 crisis—with medium-term effects on U.S. real activity as a possible exception. Truncating the observation period to end in May 1931, the responses to Germany's banking shocks are less pronounced and less significant. Clearly, the effects of financial crisis transmission from Germany to the United States were strongest after June 1931, exceeding the 20% contribution to the forecast error variance in U.S. real activity we obtained from averaging over the whole observation period.

We also find the overall role of nominal factors in the German recession to be stronger than in the United States. Averaging over the whole observation period, financial shocks account for over 30% of the forecast error variance in German real activity at the peak. Again, this effect appears to be mostly limited to the period after mid-1931: Truncation of the observation period makes the responses more diffuse.

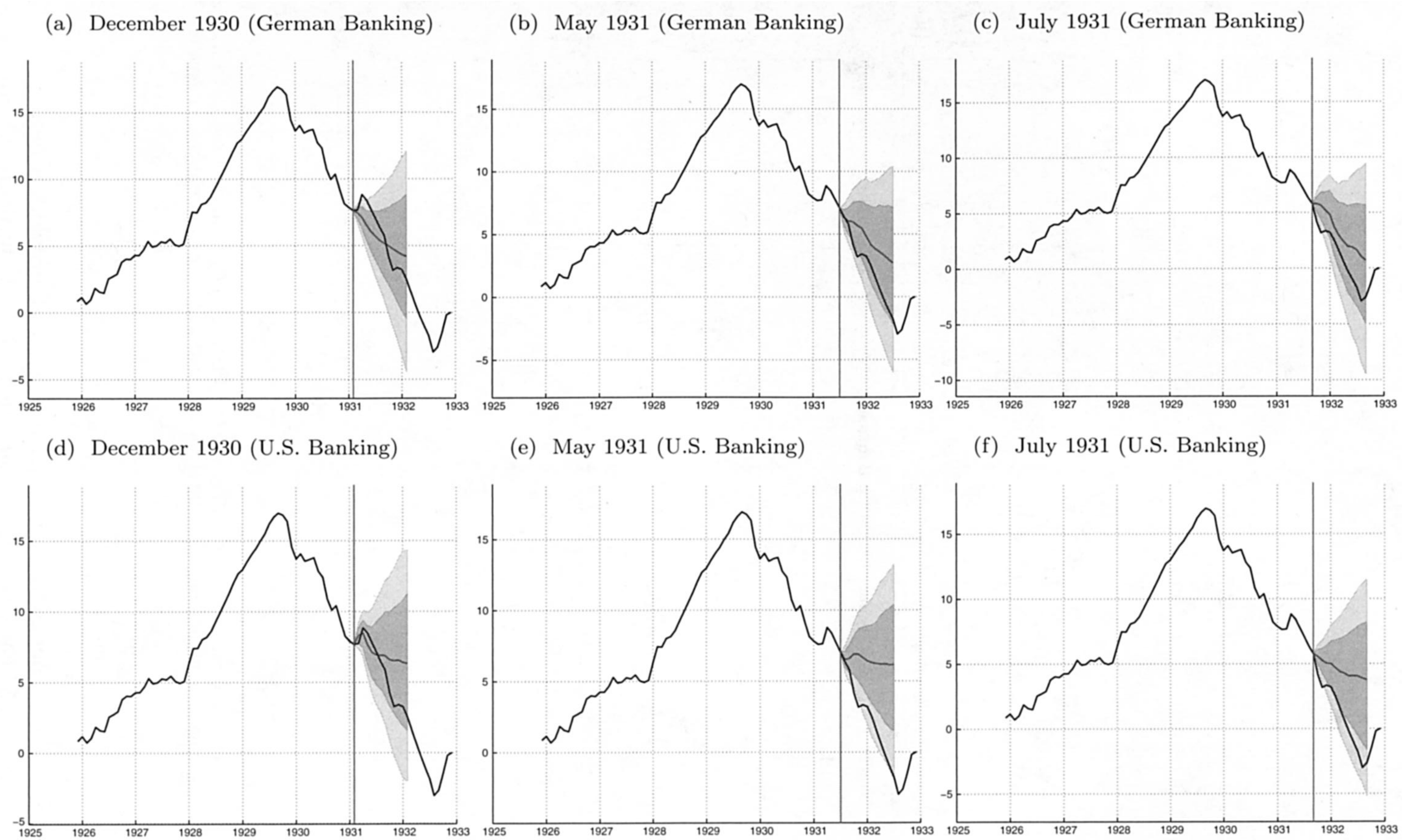
The results so far imply that shocks to banking conditions played an important role in the international transmission of the depression. The impulse response analysis suggests that counter to conventional wisdom, financial transmission went from Germany to the United States, with marked effects on the real economy. This effect is particularly pronounced for (but not entirely limited to) the period after the financial crisis of 1931. This is consistent with the view of James (2001) that the German financial crisis had major spillover effects on the international economy. It is also consistent with the claim of Schnabel (2004) that Germany's 1931 crisis was causally a banking crisis, whereas monetary transmission under the Gold Standard played only a limited role.

5.3. *Currency versus Banking: The Systematic Effects.* Our attention thus far has focused on the transmission of surprise shocks. In this section, we examine possible systematic effects that agents may have factored into expectations. Systematic components included in the agents' information set at time *t* would be reflected in the accuracy of forecasts made on the basis of that information set. To capture this, we obtain forecasts of real activity in the United States and Germany, conditional on the information set at critical junctures before and during the 1931 crisis. We compare the predictive power of conditional bivariate forecasts including the U.S. versus the German banking factor, repeating the forecast at critical junctures of the financial crisis.[12]

5.3.1. *Conditional forecasts of real activity in the United States.* Figure 7 shows bivariate conditional forecasts of U.S. real activity for December 1930, the first major banking crisis in the United States, May 1931, on the eve of the German financial crisis, and July 1931, after the German crisis had fully erupted. Forecasts in the upper panel include U.S. real and banking factors. Forecasts in the lower panel include the U.S. real factor and the German banking factor.

Results show that for December 1930, the U.S. banking factor outperforms the German banking factor in predicting U.S. output at short horizons, while the forecast from the German

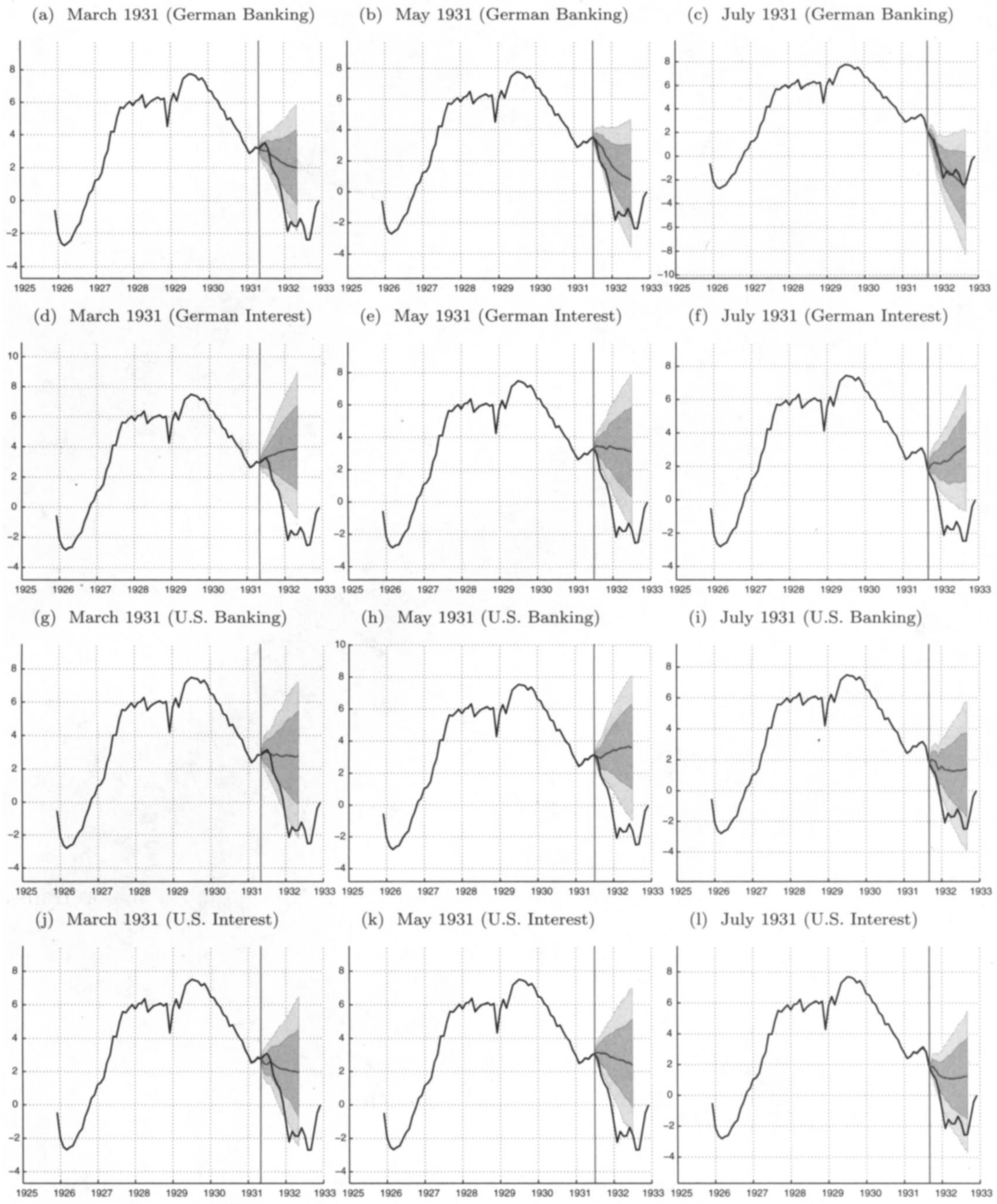
[12] A wider set of forecasts appears in the working paper version.



NOTES: Forecasting the U.S. real factor from December 1930, May 1931, and July 1931, using U.S. banking variables (d–f) and German banking variables (a–c). The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 7

FORECASTING THE U.S. REAL FACTOR



NOTES: Forecasting the German real sector from March, May, and July 1931, using German (a–f) and U.S. variables (g–l). The dark gray shaded area represents 68% and the light shaded area 90% of the posterior probability mass.

FIGURE 8

CURRENCY VERSUS BANKING: FORECASTING THE GERMAN REAL FACTOR

banking factor does better at longer horizons. German banking provides a better forecast of U.S. real activity than U.S. banking in May and July 1931, respectively. Overall, German banking conditions in the run-up to the 1931 financial crisis were informative about U.S. real activity, confirming the results from the impulse response analysis in the previous section.

5.3.2. *Conditional forecasts of real activity in Germany.* Figure 8 shows bivariate forecasts of Germany's real factors at critical junctures. As before, one additional U.S. and German factor is included per graph to evaluate its contribution to forecasting performance. The upper two panels show the contribution of the German banking and interest factors, respectively. The lower two panels represent the contributions from the respective U.S. factors.

As before, the German banking series (first row) has better predictive power for real activity around the financial crisis—but no earlier than that: The forecast conditional on information in March 1931 is unable to capture the later output collapse, except at the lower 95% percentile. Only as the crisis drew nearer were German financial market indicators able to predict its impact more precisely. By comparison, the contribution of the U.S. banking factor (third row) to the real activity forecast for Germany remains quite diffuse. We also notice that the German currency factor (second row) plays no role in forecasting the crisis, not even in July 1931. U.S. interest rates (last row) do somewhat better, albeit with far less precision than the German banking factor.

This appears to confirm the conclusions from the previous section: The crisis of 1931 was at its core a financial crisis with international repercussions; monetary crisis transmission under the Gold Standard was not a major driver of events.

6. CONCLUSION

This article assessed the relative importance of monetary versus financial channels in the transmission of the Great Depression between the United States and Germany, the two main centers of financial flows and financial turmoil in the interwar period. We employed a structural dynamic factor model including real, monetary, and financial factors in both economies between 1925 and 1932. Our real factors trace established business cycle chronologies very well. Our nominal factors for Germany suggest that both monetary and banking conditions in Germany deteriorated severely and persistently in the 1931 crisis.

The main finding of this article is that banking conditions constituted a major transmission channel of the Great Depression. Contrary to expectation, transmission through the financial channel went from Germany to the United States, from the periphery to the core. This effect comes out stronger after the 1931 crisis. By contrast, transmission of nominal shocks from the United States to the German economy was substantially less pronounced than conventional wisdom on the workings of the interwar Gold Standard would suggest. Germany's beginning foreign debt default, the unraveling of the Young Plan for German reparations in 1931, and the breakdown of a standstill pact among U.S. banks with exposure to Germany during the crisis emerge as potential explanations for this evidence.

The results of this article suggest that international financial exposure played a major role in the propagation of the Great Depression and confirm that banking distress in the financial meltdown of 1931 was a major event that deepened the international recession.

APPENDIX

A.1 *Data.*

	Series	Factor No.	Mnemonic
1	U.S. Steel Production	1	m01135a
2	U.S. Index of Industrial Production and Trade, Seasonally Adjusted	1	m12004c
3	U.S. Index of Orders for Machinery Tools and Forging Machinery	1	m06029
4	U.S. Index of Production of Machinery, Seasonally Adjusted	1	m01277b
5	U.S. BAA–AAA Corporate Bond Yield Spread	2	m13035/6
6	U.S. Pseudo-TED Spread (Three-Month U.S. TBills, 90-Day Time Money)	2	m13029/m13003
7	U.S. Number of Suspended Member Banks of Federal Reserve System	2	m09037
8	U.S. Number of Suspended Nonmember Banks of Federal Reserve System	2	m09038
9	U.S. Deposits in Suspended Member Banks of Federal Reserve System	2	m09040
10	U.S. Deposits in Suspended Nonmember Banks of Federal Reserve System	2	m09041
11	U.S. Commercial Paper Rate	3	m13002
12	U.S. Discount Rates	3	m13009
13	U.S. 90-Day Time-Money Rates on Stock Exchange Loans	3	m13003
14	German Orders of Machines	4	XXI.65
15	German Steel Production	4	XXI.8
16	German Industrial Production	4	III.11
17	German Employment in Metal Trade Sector	4	m08021
18	German Savings Deposits	5	XIV.28
19	German Demand Deposits	5	XIV.32
20	German Creditors	5	XIV.9
21	German Circulation of Bills of Exchange	5	XIV.3
22	German Debtors	5	XIV.13
23	German Reichsbank Discount Rates	6	X.1
24	German Private Discount Rates	6	X.16
25	German Discount Rates on Nonfinancial Bills of Exchange (Warenwechsel)	6	X.17

NOTES: Factor No.: 1: U.S. Real; 2: U.S. Banking; 3: U.S. Monetary; 4: German Real; 5: German Banking; 6: German Monetary.

SOURCE: U.S. ('m12345') data from NBER Macrohistory Database, www.nber.org/databases/macrohistory/contents/. Most German data ('XYZ.12') from *Institut für Konjunkturforschung*, Wagemann (1935).

A.2 *Convergence Checks.* As a first step, convergence was checked by starting from different initial values and by comparing the results. Moreover, we employed visual inspections and numerical convergence diagnostics. To visualize the evolution of our parameters, we show recursive mean plots. We present recursive mean plots for the free parameters of the factor loading matrix, variances of the serially correlated error terms in the observation equation, the elements of the variance covariance matrix of the disturbances in the factor equation, and due to lack of space the maximum absolute eigenvalue of the VAR coefficients. We have also calculated autocorrelations at the 50th lag and the total number of draws needed to obtain a certain precision as suggested by Raftery and Lewis (1992).

Figure A.1 illustrates the recursive mean plots of the model's parameters. As can be seen, the mean of most parameter values stabilizes as the number of iterations increases, indicating convergence of our Gibbs sampler. Figure A.2 depicts the convergence diagnostics for the factor loadings (points 1–19), the factors (points 20–529), the variance covariance matrix and the absolute maximum eigenvalue of the VAR equation (points 530–551), the AR coefficients of the idiosyncratic components (points 552–577), and the variances of the idiosyncratic shocks (points 578–602). As can be seen in Figure A.1(a) most of the autocorrelations are below 0.2, indicating that the chain mixes quite well and that the sampler performs efficiently. Moreover, the number of draws suggested by the Raftery and Lewis (1992) diagnostic shown in Figure A.1(b) is far below our actual number of draws (we used 0.025 for the quantile, 0.025 for the

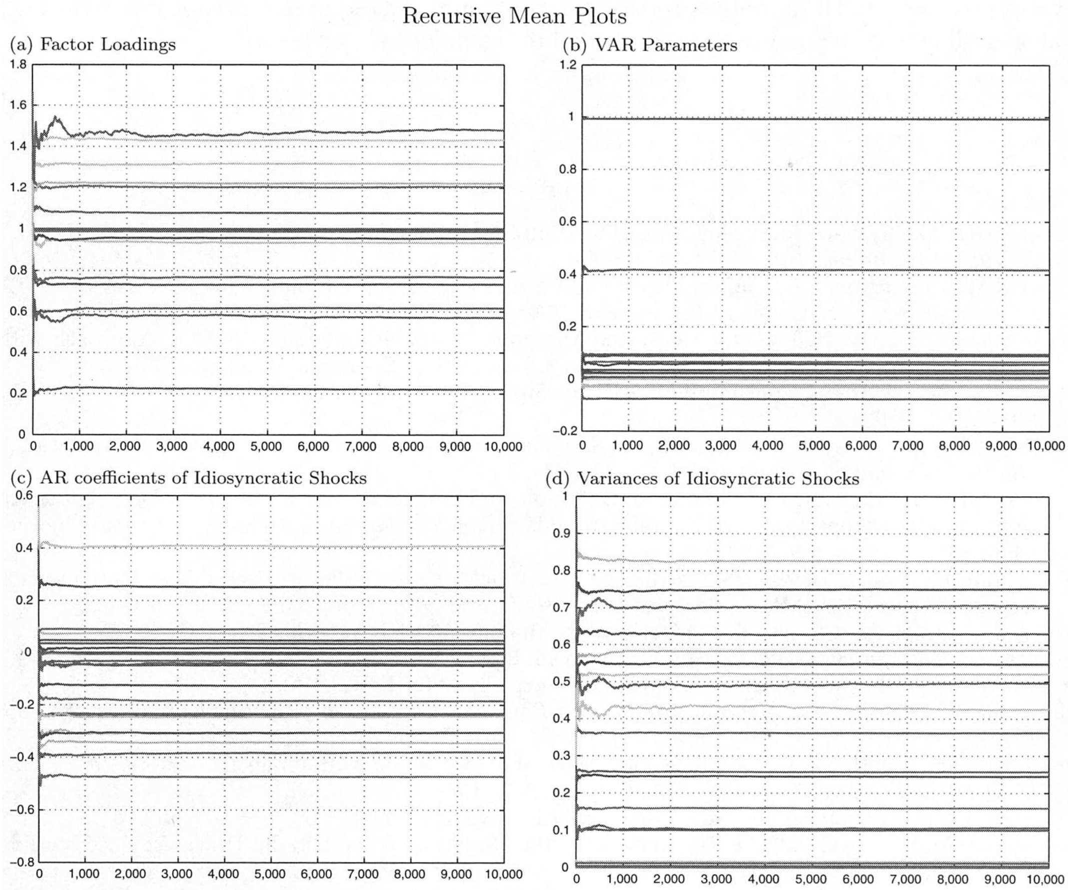


FIGURE A.1

RECURSIVE MEAN PLOTS ARE CALCULATED AFTER DISCARDING THE FIRST 400K DRAWS AS BURN-IN, USING EVERY 10TH DRAW.

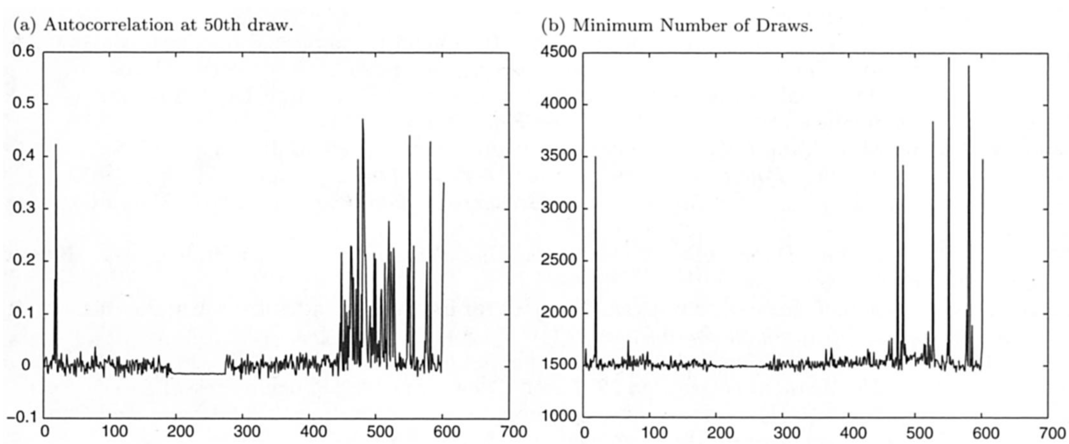


FIGURE A.2

CONVERGENCE DIAGNOSTICS.

level of precision, and 0.95 for the probability of obtaining the required precision). We conclude that according to convergence tests conducted the sampler has converged.

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