Did Monetary Forces Cause the Great Depression? A Bayesian VAR Analysis for the U.S. Economy*

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Abstract

This paper recasts Temin's (1976) skeptical question of whether monetary forces caused the Great Depression in a modern time series framework. We analyze money-income causalities for the U.S. in a recursive Bayesian framework. To account for macroeconomic regime changes and policy shifts, we allow for time-varying coefficients and stochastic volatility. Examining a variety of traditional and credit channels of monetary policy transmission, we find only a very minor role for monetary policy before and during the slump. Results are robust under various specifications and indicate remarkable parameter instability, suggesting monetary regime changes during the depression. This suggests that the dynamic money/income relationship may have been endogenous to policy regime changes. Experimenting with non-monetary alternatives, we find strong evidence of an investment downturn, which predicts a major recession already in early 1929.

Keywords: Money/income causality, Great Depression, Gibbs sampling, Bayesian vectorautoregression, leading indicators, conditional forecasts

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1 Introduction

Since the work of Friedman and Schwartz (1963), monetary orthodoxy has associated the Great Depression with restrictive monetary policies. From mid-1928 to August 1929, the Federal Reserve responded to the stock market boom with repeated interest rate hikes and a slowdown in monetary growth. Monetary policy continued to be restrictive during the depression, as the Federal Reserve interpreted bank failures such as the that of the Bank of the United States in late 1930 as the necessary purging of an unhealthy financial structure.[1] Impulses from monetary policy did not come to be expansionary until the New Deal, and when the swing finally occurred it apparently came as a surprise to economic agents (Temin and Wigmore, 1990).

The monetary paradigm has come in several different versions, as noted by Gordon and Wilcox (1981). In its most extreme form, expounded e.g. by Schwartz (1981), it states that both the initial recessionary impulse and the later deepening of the recession were caused by monetary tightening on the part of the Federal Reserve. A less hawkish position, identified by Gordon and Wilcox (1981) to be consistent with the views in Friedman and Schwartz (1963), would concede that while other factors may have played their role in initiating the recession, monetary policy was focal in aggravating the slump. Such an augmented version of the monetary paradigm is also consistent with the emphasis placed on bank panics by Bernanke (1983, 1995) and others. This research has argued for financial rather than monetary channels of transmission, emphasizing the role of information asymmetries and participation constraints in debtor/creditor relations, as well as of debt deflation as in Fisher (1933).

Research on price expectations during the depression has largely underscored the monetary interpretation. According to central banking theory (see e.g. Clarida et al. 1999), systematic monetary policy that follows pre-determined rules should have little real effects. Contractionary monetary policy would therefore be reflected by unpleasant deflationary surprises. Hamilton (1987, 1992) examined commodity futures prices and indeed found that investors consistently underestimated price

[1] See Wheelock 1991 on the doctrines of the Fed at the time.

declines during the downturn. Evans and Wachtel (1993) employed a Bayesian methodology to infer inflation expectations, only to conclude that the public's expectation of deflation remained consistently below its actual speed. The only paper we are aware of which does support the interpretation of well-anticipated inflation is by Cecchetti (1992).

In line with this consensus on deflationary surprises, recent research has also looked into a sticky-wage mechanism of monetary transmission. Bernanke and Carey (1996) looked into cross-country evidence to argue that in international perspective, wage stickiness was the dominant mechanism of monetary policy transmission during the depression. Bordo et al. (2000) calibrate a dynamic general equilibrium model with money in the utility function and nominal wage rigidity. Both their impulse-response functions and their simulated output series attribute strong effects to monetary policy, both during the onset and the propagation of the U.S. depression.

Wages also figure prominently in recent work on a non-monetary interpretation of the Great Depression. Coale and Ohanian (1999) calibrate a general equilibrium model with collective wage bargaining to argue that real wage rigidity under New Deal regulations prevented faster recovery. Similar work has been conducted for Britain by Ohanian (2000) and for Germany by Fisher and Hornstein (2001). The real wage rigidity view supports a tendency that has become influential among economic historians, with work by Borchardt (1979) on Germany and Broadberry (1986) on Britain.

At the other end of the spectrum of non-monetary alternatives, Harrison and Weder (2001) employ very similar calibration techniques for a sunspot model in which animal spirits affect investors' expectations, and finds strong evidence for an investment-led downturn. This would be in line with earlier research of Temin (1976), who viewed a housing recession and declining consumer spending at the end of a long boom as the fundamentals driving the U.S. economy into depression.

These studies thus offer a rich menu of competing simulation results, all claiming to be consistent with the evidence on the U.S. economy but sometimes mutually excluding each other. In the light of this indeterminacy, the present paper sets out to take a fresh look at the empirical facts on monetary policy transmission in the U.S. interwar economy. We look into the statistical properties of the underlying time series and their dynamic interactions from a strict forecasting point of view. To account for the limitations of the information set available to agents at any point in time, we employ a Bayesian updating algorithm. This allows for structural uncertainty and time-varying parameters as the information set expands over time.

Recent empirical work on monetary policy transmission has focused on the adjustment of beliefs and the distortions to policy efficiency when agents perceive a possible change in monetary policy regime changes, as posited by the Lucas (1976) critique. Leeper et al. (1996) employ Bayesian updating techniques to account for regime changes in a simulated model economy. Sims and Zha (1998) calibrate a dynamic general equilibrium model with two policy regimes to evaluate the interactions of policy moves and changing beliefs of the public. In the same vein, Sargent (1999) argues that parameter instability in vector autoregressions with time-dependent coefficients is a likely effect of underlying changes in policy regimes.

In the present paper we follow this line of research by employing recursive estimation and forecasting techniques. This helps to spot possible regime changes and structural breaks that distorted the beliefs of contemporary agents and may have affected the channels of policy transmission. In our statistical modeling framework we are unable to gather all the informal and anecdotal information available to contemporary agents.[2] We compensate for this by looking into economic and financial aggregates that we hope can map this information into the domain of quantitative analysis. If shocks to monetary policy had a major impact on the course of events, adding the monetary policy variable to this information set should enable us to predict output in a satisfactory manner.

Just as the Bayesian updating philosophy allows parameters to change as new information comes in, this methodology also helps to overcome stationarity and small-sample problems in a smooth way. Since Perron's (1989) critique of the unit root hypothesis and Hamilton's (1989) work on regime switches, there has been

[2]An attempt to obtain such information through reading the contemporary business press is made by Nelson (1991).

widespread skepticism about the correct way of modeling economic time series in the presence of apparent structural breaks. This together with the shortness of the available time series appears to have impeded time series work on the inter-war period. In this context, Bayesian analysis seems particularly attractive, as it avoids imposing a specific time trend, allows for learning about stationarity and is thus flexible enough to accommodate both unit-root and trend-stationary time series (see Sims and Uhlig 1991).

In addition to forecasting the performance of the U.S. economy over time, we also obtain the impulse-response functions in a recursive way. This methodology consists in isolating the dynamic response of any given variable to a shock to another variable in the system. As the shocks to the different variables may be mutually correlated, isolating them from each other involves a prior decision that enables the researcher to assign shocks and variables to one another. Technically speaking, this consists in imposing identifying restrictions on the variance-covariance matrix of the disturbances through a suitable orthogonalization procedure, most commonly the Cholesky factorization, which we employ as well.

We also adhere to a common standard as far as the specification of our estimates and the list of variables are concerned (laid out e.g. in Bernanke and Mihov 1998, or Uhlig 1999). Our data we take from a standard source, the NBER Macrohistory database (see appendix for further details). Owing to the particularly violent swings of the U.S. economy at the time, we place emphasis on the time-dependent nature of our system. As Temin (1989) has noticed, the experience of the Great Depression may itself have generated breaks in expectations, and different monetary regimes may have prevailed. The precise theoretical nature of such regime changes continues to present a puzzle (Sargent, 1999). Thus, we take an agnostic approach and allow for time dependence in all of our statistics, including the impulse-response functions. As expectation regimes evolved over time, so may have the dynamic effects of monetary policy. Updating the information about the U.S. economy necessarily implies updating the information about the dynamic responses to monetary shocks. The only “deep” parameters that we impose and keep unchanged concern the ordering of the variables in the Cholesky decomposition of the variance-covariance matrix.

The rest of this paper is organized as follows. Section 2 describes the basics of the model and the underlying prior assumptions. Section 3 obtains unconditional forecasts of output from the reduced form at various critical junctures and at different time intervals. Section 4 discusses the evidence on the efficacy of monetary policy from the impulse response functions. Section 6 briefly turns to an analysis of alternative nonmonetary indicators. Section 7 concludes.

2 The Basic Model Setup

In line with the VAR methodology established by Sims (e.g. 1980) and widely used nowadays, we study money-income causality in a reduced form that takes care of the dynamic lead-lag relationships among the variables in the equation:

$$\mathbf{x}_t = \mathbf{c} + \sum_{j=1}^{12} \mathbf{A}_j \mathbf{x}_{t-j} + \mathbf{u}_t, \mathbf{u}_t \sim N(\mathbf{0}, \mathbf{H}). \tag{1}$$

In this vector autoregression, $\mathbf{x}_t$ is the vector of variables at time t, to be regressed on lagged values of the same vector, where the maximum lag is of order p. The parameter matrix $\mathbf{A}_j$ (of dimension $n \times n$) contains the coefficients on the lagged variables of lag j. $\mathbf{H}$ is the variance-covariance matrix of the disturbances.

There is widespread agreement on the variables to be included in a reduced-form assessment of monetary policy. Following up on Leeper et al. (1996) and Bernanke and Mihov (1998), we include two different specifications that account for various channels of monetary and financial transmission. To account for the more traditional monetary paradigm that focused on the quantity of money, our workhouse specification includes money, output, a general price index, a wholesale price index as well as total and non-borrowed reserves held by banks. We also check for a more interest-rate oriented transmission mechanism, substituting the money aggregate with the Fed discount rate and, alternatively, short-term money market rates. For the monthly frequency which we use, the broadest output index we found was a series on U.S. industrial production (interpolated quarterly series on GNP would be in Balke and Gordon 1986). As a general price level, we take the CPI, while for the wholesale price index, we choose a series for manufactured goods, which excludes agricultural commodities (we do not want to attempt a monetary explanation of the agricultural crisis of the 1920s). All data come from the NBER macrohistory database (see the appendix for further details on data sources).

To attain maximum generality of our results, we follow the BVAR approach of Doan et al. (1984) and allow the coefficients in the $\mathbf{A}_j$'s to be time dependent. For each of the (transposed) rows in the concatenated parameter matrices $\begin{pmatrix} \mathbf{c} & \mathbf{A}_1 & \dots & \mathbf{A}_p \end{pmatrix}$, we assume the following AR(1) proces:

$$\mathbf{a}_t = (1 - \pi_8)\,\bar{\mathbf{a}} + \pi_8 \mathbf{a}_{t-1} + \boldsymbol{\nu}_t, \boldsymbol{\nu}_t \sim N(\mathbf{0}, \mathbf{Q}). \tag{2}$$

where π_8 is a weighting parameter and where $\bar{\mathbf{a}}$ is an assumed long-term value for $\mathbf{a}_t$. The disturbance term $\boldsymbol{\nu}_t$ is assumed to be uncorrelated with the disturbances in the original VAR, i.e.$\mathrm{Cov}\,[\mathbf{u}_t, \boldsymbol{\nu}_t] = \mathbf{0}$. Together, equations (2) and the corresponding line in the equation system (1) define a linear dynamic system, where equation (1) is the observation equation, (2) is the transition equation, and $\mathbf{a}_t$ is the (unobservable) state vector. In this general time-dependent formulation, the estimation problem for $\mathbf{a}$ is converted into a conditional forecasting problem for $\mathbf{a}_{t|t-1}$, given the information at time $t-1$. Under the normality and independence assumptions about the disturbances, $\mathbf{y}_{t|t-1}$ and $\mathbf{a}_{t|t-1}$ are jointly normally distributed conditional on $t-1$, and computation of $\mathbf{a}_t$ can be implemented using the Kalman filter algorithm (Harvey, 1992; Hamilton, 1994).

Prior information or prior beliefs about the system may enter at several stages. Among these is the standard Litterman prior, which represents the researcher's prior belief that each time series is a random walk.[3].

This approach allows to calculate time dependent forecasts, impulse responses and forecast error decompositions. At every step of our recursive algorithm, we back out an update of the variance-covariance matrix of the observation equation, $\mathbf{H}_t$,

[3]For details see the description fo the model in the appendix. We adopt the parameter values originally proposed by Doan et al. (1984) and reproduced in Hamilton (1994). Cchanges in the prior made little difference for the results, as promised by Uhlig 1994

following the procedure in Doan et al. (1984). The impulse-response funcations and variance decomposition are then obtained from the orthogonalized errors, applying a Cholesky decomposition to H_t. This algorithm allows us to track structural shifts, both in the magnitude and direction of the dynamic multipliers in the impulse-response function and the explained component of the forecast error variance.

3 Forecasting the Depression from Monetary Shocks

If monetary shocks contributed decisively to the Great Depression in its various stages, including the monetary instrument in a time series model of the critical period in question should replicate the empirical evidence in satisfactory fashion. As nonmonetary indicators appear to have consistently failed in predicting the 1929 downturn, even when VAR methods are applied (Dominguez et al., 1988; Klug and White, 1997), we concentrate our attention on standard specifications of monetary transmission mechanisms on output as the ones discussed in the preceding section. Throughout this section, we adhere to a strict updating philosophy, which implies that we limit ourselves to out-of-sample forecasts. We will focus on forecasting the behavior of the economy in historical time at critical junctures, obtaining what has been labeled "unconditional forecasts" (Canova, 1995). In the next section, we shall turn to an analysis of the impulse response functions or "conditional forecasts".

Since the work of Friedman and Schwartz (1963), a common claim is that monetary restrictions after 1927 caused the slide of the U.S. economy into recession. The Fed reacted to the upcoming stock market boom by curtailing money supply and through repeated interest rate hikes, beginning in August, 1928 (Temin, 1989). We take an agnostic stance on whether the Fed's interest rate policies or its money supply were more effective and simply analyze both elements separately.

Research on credit crises and financial channels of monetary policy transmission has been shaped by work of Bernanke (1983) and Bernanke/Gertler (199x). Monetary policy may have affected the real side of the economy through the constraints imposed on the banking system. To account for financial restraints in our forecasting exercise, we follow Sims and Zha (1998) and also examine a specification which includes the desposits of failed banks as a measure of credit tightness in the U.S. economy.

To see if monetary policy contributed to the onset of the Great Depression in quantitatively important fashion, we conduct two forecasting exercises for each model. First, we include all information up to September 1929 and then let our model forecast output up to late 1930. This forecast provides an idea of how the model's endogenous dynamics up to September, 1929, would have affected the US economy in 1930, had no other shocks occurred. As most of the monetary restriction occurred from the second half of 1928 on, we repeat our exercise. This time, however, we stop including additional information in August, 1928, and forecast over a two-year horizon into late 1930. This second forecasts gives us an idea of the endogenous model dynamics in the absence of any shocks after late 1928.

[Figure 1 about here]

The results in the first two graphs of Figure 1 show very little difference between the two forecasts. In neither case, a depression of any sizeable magnitude would have occurred. The forecast from September 1929 does predict a mini recession for early 1930, but nothing similar to the downward spiral that actually occurred. If we start forecasting from 1927, the profile is entirely flat: there is no recession, nor is there the further upswing in output that occurred between mid-1928 and mid-1929.

Note that this observation appears to be robust to the change in the monetary instrument or to changes in the specification. Trying to beat this result, we experimented with numerous modifications and specifications, including a wide range of variables from stock market data and gold flows to agricultural exports, however to no avail. As both of our workhouse specifications also include bank reserves, we also find little evidence of indirect effects of monetary policy that would have transmitted themselves through the banking system, as the financial propagation hypothesis of Bernanke (1983) would have it. Given our frustrated efforts, we have little doubt left that the slide into the Great Depression caught U.S. monetary policy by surprise.

The initial impulse appears to have come from other than monetary sources.

During the propagation of the Great Depression, we also find only a limited role for monetary policy. Repeating the above exercises for late 1930, we again see that the data predict a recovery (last graph in Figure 1). Only at very short horizons could the model predict further declines in output correctly. In Figure 2 we plot rolling 3 and 6 month ahead forecasts from our money and interest models, which are being updated in monthly intervals. For the downswing of the depression, the 3 month ahead prediction of further decline appears to work well. Note that for the second phase of the depression from late 1931 on, there is a lot of new turbulence; the short term forecasts generally perform much worse than they do in the downturn. In contrast, the confidence bands for the 6 month prediction are already performing poorly during the downturn, indicating a recovery that was not to come. An analyst looking into the data would have concluded most of the time that an upswing was just around the corner[4].

[Figure 2 about here]

This seems consistent with the well-established observation that academic experts, advisors, and the Federal Reserve itself had it all wrong during the depression (Dominguez et al., 1988; Wheelock, 1991). We may criticize them for having done such a bad job. But looking at monetary policy alone, we cannot do much better, however hard we try.

4 The Quantitative Impact of Monetary Policy

We now turn to the quantitative effects of monetary policy on the U.S. economy before and during the Great Depression. Although monetary shocks appear to perform poorly in explaining the major turning points of the depression, it would be mistaken to conclude that money had no effects at all. To examine this question,

[4]We note in passing that this was another conjecture of Temin (1976, p. 76). See Mayer (1978) for a criticism of Temin (1976) and an evaluation of the importance of this - then missing - piece of evidence.

we explore the dynamic multiplier effects of innovations to monetary policy, which are propagated through equation (1) by the coefficient matrices $\mathbf{A}_j$.

An obvious but questionable procedure would be to treat the whole observation period from 1922 to 1935 as one monetary regime and accordingly obtain impulse responses using information from the whole span. However, we bear in mind Lucas' (1976) warnings about parameter instability in the presence of a change in monetary policy regimes. If either policy rules or the expectations of the public about the underlying policy models changed after 1929, any results on the quantitative effects of monetary policy would necessarily be spurious. Leeper and Zha (1996) evaluate the impulse-response functions of simulated monetary policy in a dynamic general equilibrium model with two policy regimes, finding that perceived policy changes temporarily counteracts the short-run effects of money that their model otherwiose assumes.

We view our recursive coefficient updating algorithm as a way of detecting such regime changes, following an idea set out in Sargent (1999). If for a wide enough class of specifications, neither the impulse responses nor their explanaroty power for the forecast errors are time invariant, we feel it safe to conclude that not policy but rather a fundamental regime change in expectations were at work. That is to say, we observe a movement, not on a policy response function but rather of the function itself, pointing to deeper parameters at work that might not be properly captured by one or another of the monetary interpretations of the Great Depression.

Research by economic historians has indeed emphasoized the possible role of expectationsal regimes. Most prominently, Temin (1989) evaluates the evidence on the U.S. depression collected by contemporaries and later scholars to conclude that major shifts in the expectations of the public must have occurred at several critical junctures of the depression.

A possible answer to this problem based on classical statistics could be to account for these regime changes through deterministic trend components, as suggested by Perron (1989), or through Markov switching models in the spirit of Hamilton (1989). This would imply fixing structural breaks and switchpoints exogenously, assuming that between any two switches the deep parameters of the system remain unchanged.

The recursive methodology which we follow here provides a natural way of finding such shifts endogenously, as it has a ready interpretation as the outcome of Bayesian learning about macroeconomic regines. Changing parameter structures over time also translate into time dependency of the impulse response functions: as time goes on and new observations are added to the information set, the information pertaining to the conditional forecasts changes as well. We implement this by updating the impulse-response functions at our observation frequency, i.e. every month. As the Kalman recursions take time to converge from their initial conditions, we will always disregard the evidence for the first three or four years and start interpreting the results only from 1927 on.

Figure 3 graphs the evolution of the time-dependent impulse responses to orthogonal one-standard deviation innovations in money, defined as M1 and employing the data of .[5] To keep the graph readable, we plot the impulse responses only at selected fixed intervals (3, 6, and 12 months).

[Figure 3 about here]

We first look into the response of money to its own shock. As can be seen, the 1929 crash induces a structural break; money is apparently endogenous, at least to some extent. Turning to the impulse responses of wholesale and consumer prices, we find that during the two years preceding the depression, their responses have opposite signs. This is one version of the so-called price puzzle first described by Sims (1992). Prices initially tend to move in the wrong direction in reaction to a monetary shock. Note also that the output response to money, shown in the last chart of Figure 3, is positive and remarkably stable prior to the slump.

The advent of the depression affected the dynamic parameter structure in very marked fashion. The two price series now react strongly positively to quantity of money impulses, i.e. money and prices fall together. The same is true of output, which becomes more sensitive to money impulses as the depression deepens. If we

[5]We employ a broader concept of money consistent with M1 in Friedman and Schwartz (1963). Attempts to employ high-powered money instead resulted in impulse responses which all had wrong signs. To make sure, we cross-checked this result with the standard RATS software package, however without obtaining major changes in result.

had obtained the same result with high-powered money in the place of M1, we would be tempted to argue that evidence supports the account e.g. in Temin (1989) of an increased importance of monetary policy during the spread of the Great Depression. However, the fact that we could not replicate these results with high-powered money induces us to be cautious about such an interpretation. More research is still needed to determine whether the seeming increase in the impact of money impulses during the second phase of the depression is not an artifact generated by the endogenous components of money demand.

[Besprechung von Variance Decompositions]

To account for a more demand-oriented perspective on monetary policy, as proposed e.g. in Bernanke and Blinder (1992), we again adopted an alternative specification in which money is replaced by the federal discount rate.[6] Results are plotted in Figure 4. Again, we refrain from interpreting the evidence before, say, 1926, where results may still be dominated by the Kalman filter algorithm's initial convergence. Later on, the responses again exhibit the price puzzle: the initial response in prices to a discount rate hike is positive. During the depression period, this puzzle even seems to become worse, as prices now move in the same direction as the fed discount rate even at 12-month lags. Interest rate policy was clearly ineffective in stabilizing prices; if anything it was counter-productive.

[Figure 4 about here]

Up until late 1931, interest rate policy does seem to have had the desired effects on reserves, contracting them during the stock market boom and expanding them during the recession. Note, however, the blips in either graph after the stock market crash of 1929. Apparently, the interest rate reductions of late 1929 and early 1930 failed to have an immediate effect on banks' behavior, contrary to previous experience. The converse is true for the interest rate hikes of late 1928, which apparently had a stronger than normal effect on non-borrowed reserves but failed to influence total reserves. We also note that during the stock market boom, the output response

[6]The modified system then has the ordering (ascending in the order of endogeneity): federal discount rate, non-borrowed reserves, total reserves, commodity prices, CPI, output.

to innovations in the interest rate is falling steadily: at the time the stock market collapsed, interest rate policy was less efficient than ever since 1926 in influencing output. Only during 1930 do we see a correction; contrary to much folk wisdom, the interest rate cuts of that year did have a positive effect on output and were more effective than the increases in the two preceding years.

The salient feature of Figure 4 is again the structural shift that occurs in late 1931, when the Fed raised its discount rates several times in response to the European banking crises and Britain's departure from the gold standard. None of the impulse-response functions in the graph remains invariant to this regime change, and their subsequent behavior looks irregular. Clearly, conducting monetary policy in the chaotic conditions that prevailed after 1931 would have been a difficult task for anyone. This second phase of the depression, as Temin (1989) has termed it, exhibits all kinds of puzzles in the nominal variables concerned, while the real effects of interest policy on output seem to be erratic and on the decline.

In sum, the evidence on the Fed's discount policy seems to suggest that before the onset of the depression and in its initial phase, its effects remain within the normal bounds, being far too small to explain the collapse in output after 1929. Interest rate changes alone would probably have generated a mild recession in 1930 and an equally mild upswing thereafter. Furthermore, given the price puzzles in our results, the interest rate hikes before the stock market crash can only hardly be held responsible for the later deflationary collapse. Our data clearly show a second phase of the recession after late 1931. However, this period is marked by extreme lack of stability of the underlying dynamic structure. As the previous regularities faded away, no stable relation between interest rates, prices, and output was left that could have been exploited for economic policy.

5 Credit Channels of Monetary Policy Transmission

The evidence gathered in the previous section may still give an only incomplete account of monetary policy transmission, as the possible effects on the liquidity of the banking system were included only partly. Research on the effects of credit crunches in the post-war U.S. economy (Gertler, Bernanke/Gertler) suggests that banking crises may have an additional, adverse effect operating through domino effects of credit restrictions that may not be adequately captured by only including data on the total and unborrowed reserves of the banking system, as in the specifications examined in the previous section.

Starting in December, 1930, the U.S. banking system went through several waves of banking crises, culminationg in the bank holiday of January, 1933. Friedman/Schwartz and many others, most notably Bernanke (1993), have pointed to the possibly harmful effects of the Federal reserve System's failure to provide sufficient liquidity to ailing banks, thus deepening the financial crises further.

In this section, we follow the approach of Sims and Zha (1998) and measure the possible effects of these liquidity crunches by the deposits of failed banks, a time series which eshibits a marked upward jump in late 1930. It could be argued in the spirt of Bernanke (1993) that credit crunches provided an additional channel of transmission of monetary policy from 1931 on.This would help to explain, not the onset of the Great depression in the U.S. but its further deepening after 1930.

Figure 5 shows the recursive impulse response functions and the vcariance decompositions of the above interest rate model of monetary policy, where the non-borrowed reserves of the banking system have been replaced with deposits of failed banks. All other assumptions including the ordering of the variables in the Cholesky decomposition remain unchanged.

[Figure 5 about here]

6 "Real" Alternatives: Forecasting the Depression from Leading Indicators of Real Business Activity

Of course, we are slightly less agnostic about forecasting the depression than the previous sections suggested. In this section, we present an alternative based on leading indicators of investment activity. Temin (1976) had suggested that a sharp decline in residential construction led way into depression. We take this evidence on board by looking at residential building permits, another time series we found in the NBER macrohistory database. We combine this series with classical leading indicators of equipment investment, such as steel production and shipments of machinery, to predict manufacturing output. The system we specified thus includes manufacturing output, building permits, production of steel sheets, steel ingots, machine shipments, and prices of metal products.

As before in Section 3, we are interested in the performance of output forecasts before the stock market crash of October, 1929. We also leave the principal methodology unchanged, i.e. we infer the unconditional forecasts in historical time from a Bayesian VAR with time dependent coefficients and a Litterman prior. Results, shown in Figure 6, are clear-cut: a 36 month forecast produced with the information set of September, 1929, already predicts almost half of the decline that later actually occurred. As soon as we disregard money and the financial sector and concentrate on real indicators alone, the depression is already clearly in the data prior to the stock market crash.

[Figure 6 about here]

We also experimented with combining these series with financial and monetary information in our VARs, however with a striking result: as soon as we included financial variables in the equation, its predictive power decreased sharply. If there was information in the U.S. economy in 1929 about an imminent slump, it was in real activity. Each of the financial monetary variables we included turned out to obscure the facts. We also attempted reducing system size to just three or four series. The main results of 6 still hold if we include only building permits and machine shipments to explain output[7].

In order to see at which point the real economy started to show signs of a major downturn, we let the system stop in March and in June 1929. The lower panel in 6 shows the results of this exercise. Already in March 1929, the real data reveal signs of a major recession in the U.S. economy, almost half a year before the stock market collapsed.

Of course, this is consistent with conventional wisdom on the Great Depression. The fact that a turning point in real activity occurred in mid-1929 is mentioned in almost any major classroom text in economic history (we refer the reader to, e.g., Walton and Rockoff 1998). What is new and needs to be emphasized, though, is that the downturn in real activity was apparently more than just the onset of a normal recession,as Temin (1989) presumed it. Real data predict a severe decline in economic activity already in 1929, which means that most probably, no additional hypotheses are needed to explain why a normal recession turned into a depression.

7 Conclusion

This paper has undertaken a Bayesian VAR analysis for U.S. data to examine the question whether monetary forces caused the Great Depression. Our results confirm the skepticism that has been expressed in much of the literature since Temin (1976) raised this question. We find no evidence that monetary restriction prior to the stock market crash of 1929 produced anything beyond a very mild recession. During the subsequent spread of the depression, interest rate policy had positive output effects, while the contemporaneous decline in money circulation affected output adversely. In the second phase of the depression from late 1931 onwards, the underlying structures become unstable, and the effects of monetary policy appear to more erratic

[7]We still prefer the system shown in Figure 6, as it exhibits stationary eigenvalues: the forecast reverts to the mean if only sufficient time is allowed. Smaller systems had a tendency to yield nonstationary eigenvalues, which means their forecasts would essentially predict a plane crash.

and puzzling.

The most visible feature of our results on monetary forces is their poor forecasting ability. If the Great Depression was largely driven by monetary surprises, incorporating the monetary instruments in a time series model should improve its predictive power. Except for very short time horizons, we do not obtain this. During the downturn of 1930/1, agents attempting to forecast at six month intervals from money instruments in a VAR would consistently overpredict output. We find this evidence to be difficult to reconcile with the concept of monetary surprise shocks.

This does not mean that the Great Depression was impossible to predict. We found very robust evidence that a major downturn was visible in U.S. data already in mid-1929, turning to leading indicators of business activity. Evaluating Temin's (1976) hypothesis that the depression was led by a major slump in residential construction, we combined data on residential building permits and a number of leading indicators on equipment investment with output. We found that these data predict a sharp and lasting decline in U.S. manufacturing production already from May 1929, on. Forecasting power was substantially reduced every time we attempted to include financial and monetary series in the equations.

On a more fundamental level, we were concerned in this paper with the stability of the parameter structures underlying monetary and financial transmission channels. To accommodate these shifts, we employed a Bayesian updating methodology that allows for time-dependent parameters and a flexible treatment of the stationarity problem in the underlying time series. We also extended the updating philosophy to our analysis of the impulse response functions, finding them to become highly unstable as the depression moved into its second phase.

In the light of the Lucas (1976) critique, we consider the instability of the parameters underlying the impulse responses of monetary policy during the Great Depression to be particularly discomforting. If these relationships were in the set of deep parameters of the U.S. economy, they should themselves be time invariant and not be endogenous to changes in the monetary regime. Given this instability and the clearly superior forecasting performance of real indicators, we are deeply skeptical about a standard monetary interpretation of the Great Depression.

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Appendix

Model

We assume an n dimensional VAR of order $p = 12$:[8]

$$\begin{aligned} \mathbf{x}_t &= \mathbf{c} + \sum_{j=1}^{12} \mathbf{A}_j \mathbf{x}_{t-j} + \mathbf{u}_t = \\ &= \underbrace{\begin{pmatrix} \mathbf{c} & \mathbf{A}_1 & \dots & \mathbf{A}_p \end{pmatrix}}_{\mathbf{A}} \underbrace{\begin{pmatrix} 1 \\ \mathbf{x}_{t-1} \\ \vdots \\ \mathbf{x}_{t-p} \end{pmatrix}}_{\mathbf{Z}_{t-1}} + \mathbf{u}_t = \\ &= \mathbf{A}\mathbf{Z}_{t-1} + \mathbf{u}_t. \end{aligned} \tag{3}$$

Equation number j is given by

$$\begin{aligned} x_{t,j} &= \mathbf{Z}'_{t-1} \begin{pmatrix} c_j & a^1_{j1} & \dots & a^1_{jn} & \dots & a^p_{j1} & \dots & a^p_{jn} \end{pmatrix}' + u_{t,j} = \\ &= \mathbf{Z}'_{t-1}\mathbf{a} + u_{t,j}. \end{aligned}$$

We need $\mathbf{a}$ to be time dependent, and end up with the following measurement equation:

$$x_{t,j} = \mathbf{Z}'_{t-1}\mathbf{a}_{t-1} + u_{t,j}. \tag{4}$$

We assume that the variance of $\mathbf{u}_{t,j}$ is given by

$$h = 0.9\hat{\sigma}_{j,j},$$

where the $\hat{\sigma}_{j,j}$ are from an OLS estimation of equation j. The transition equation system is given by

$$\mathbf{a}_t = (1 - \pi_8)\,\bar{\mathbf{a}} + \pi_8 \mathbf{a}_{t-1} + \boldsymbol{\nu}_t. \tag{5}$$

We assume that the initial prior distribution for $\mathbf{a}_1$ is given by

$$\mathbf{a}_1 \sim N\left(\bar{\mathbf{a}}, \mathbf{P}_{1|0}\right).$$

The expected value $\bar{\mathbf{a}}$ is assumed to be a vector of zeros with one as elements corresponding to the own variables $x_{j,t-1}$ at lag 1 for each equation.

$$\mathbf{P}_{1|0} = \begin{pmatrix} g\hat{\tau}_1^2 & \mathbf{0}' \\ \mathbf{0} & (\mathbf{B} \otimes \mathbf{C}) \end{pmatrix},$$

[8] For the following, see Doan et al. (1984), Doan et al. (1986), and Hamilton (1994, p.401-403).

with

$$\mathbf{B} = \begin{pmatrix} \gamma^2 & 0 & 0 & \dots & 0 \\ 0 & \gamma^2/2 & 0 & \dots & 0 \\ 0 & 0 & \gamma^2/3 & \dots & 0 \\ \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & 0 & \dots & \gamma^2/p \end{pmatrix};$$

$$\mathbf{C} = \begin{pmatrix} 1 & 0 & 0 & \dots & 0 \\ 0 & w^2\hat{\tau}_1^2/\hat{\tau}_2^2 & 0 & \dots & 0 \\ 0 & 0 & w^2\hat{\tau}_1^2/\hat{\tau}_3^2 & \dots & 0 \\ \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & 0 & \dots & w^2\hat{\tau}_1^2/\hat{\tau}_n^2 \end{pmatrix}.$$

The variance of $\boldsymbol{\nu}_t$, $\mathbf{Q}$, is given by

$$\mathbf{Q} = \pi_7 \mathbf{P}_{1|0}.$$

We make the following assumptions about the parameter of the model:

$$\gamma^2 = 0.7; w^2 = \frac{1}{74}; g = 360; \pi_7 = 10^{-7}; \pi_8 = 0.999.$$

Data

Series	NBER code	Description:
Prod	m01175	FRB Index of Industrial Production
CPI	m04128	Consumer Price Index
WPI	m04189	Wholesale Price Index for Manufactured Goods
Res	m14064	Total Reserves Held at FRB
Nonb_Res	m14123	Nonborrowed Reserves of the Banking System
Bankfail	m09039	Deposits of Suspended Banks
Mdem	m14144	Money Demand M1
Fed_disc	m13009	Federal Discount Rate
Wages	m04061	FRB Index of Wages in Manufacturing
Hours	m08029	Hours Worked in Manufacturing
Build	m02008	Value of Residential Building Permits
Steel Sheets	m01136	Output of Steel Sheets
Steel Ingots	m01135	Output of Steel Ingots
Machines	m06029	Machine Shipments
P_metal	m04066	Prices of Metal Products

Fig. 1: Forecasting the Great Depression (Out of Sample Forecasts)

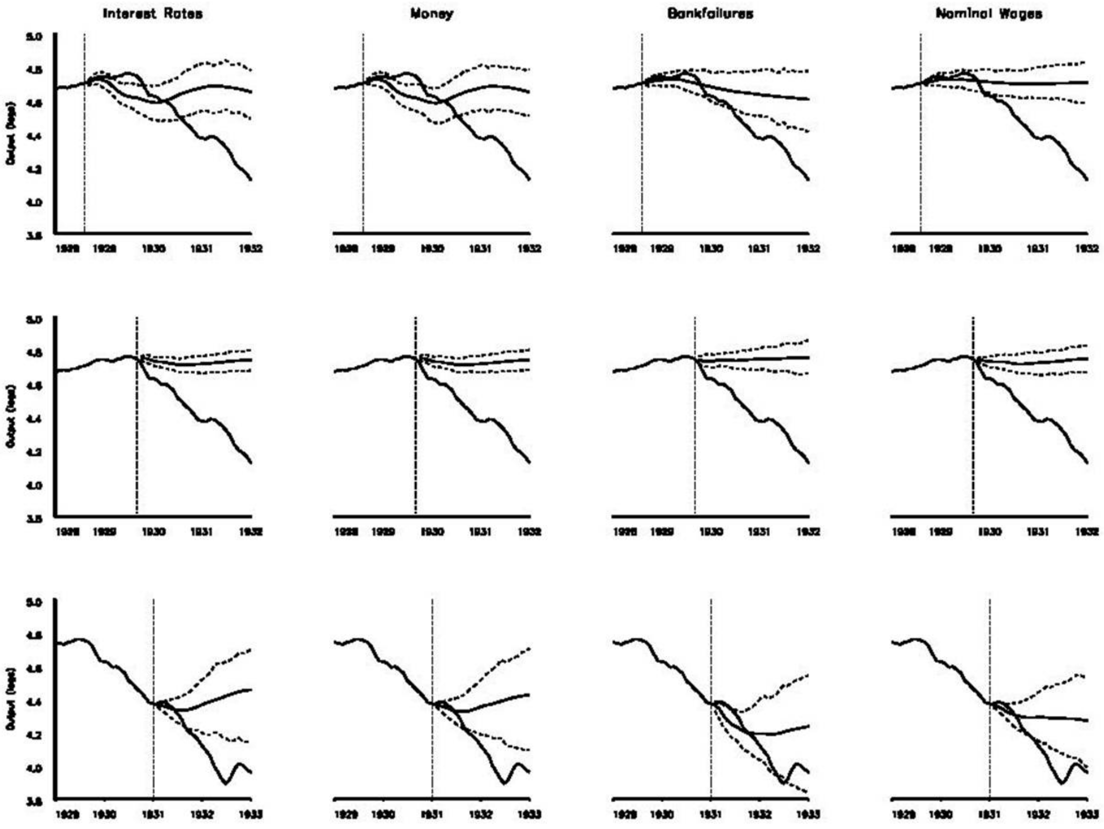
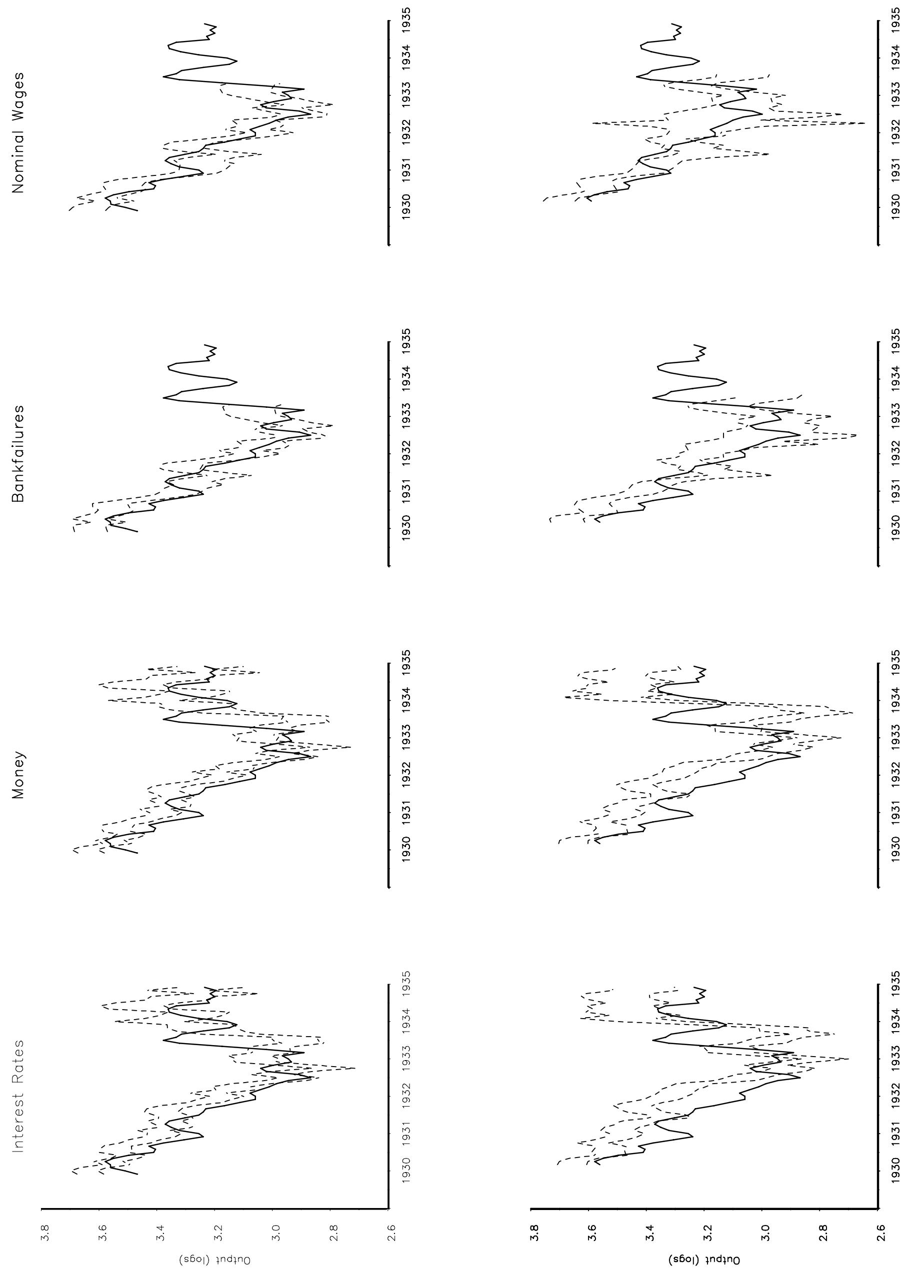
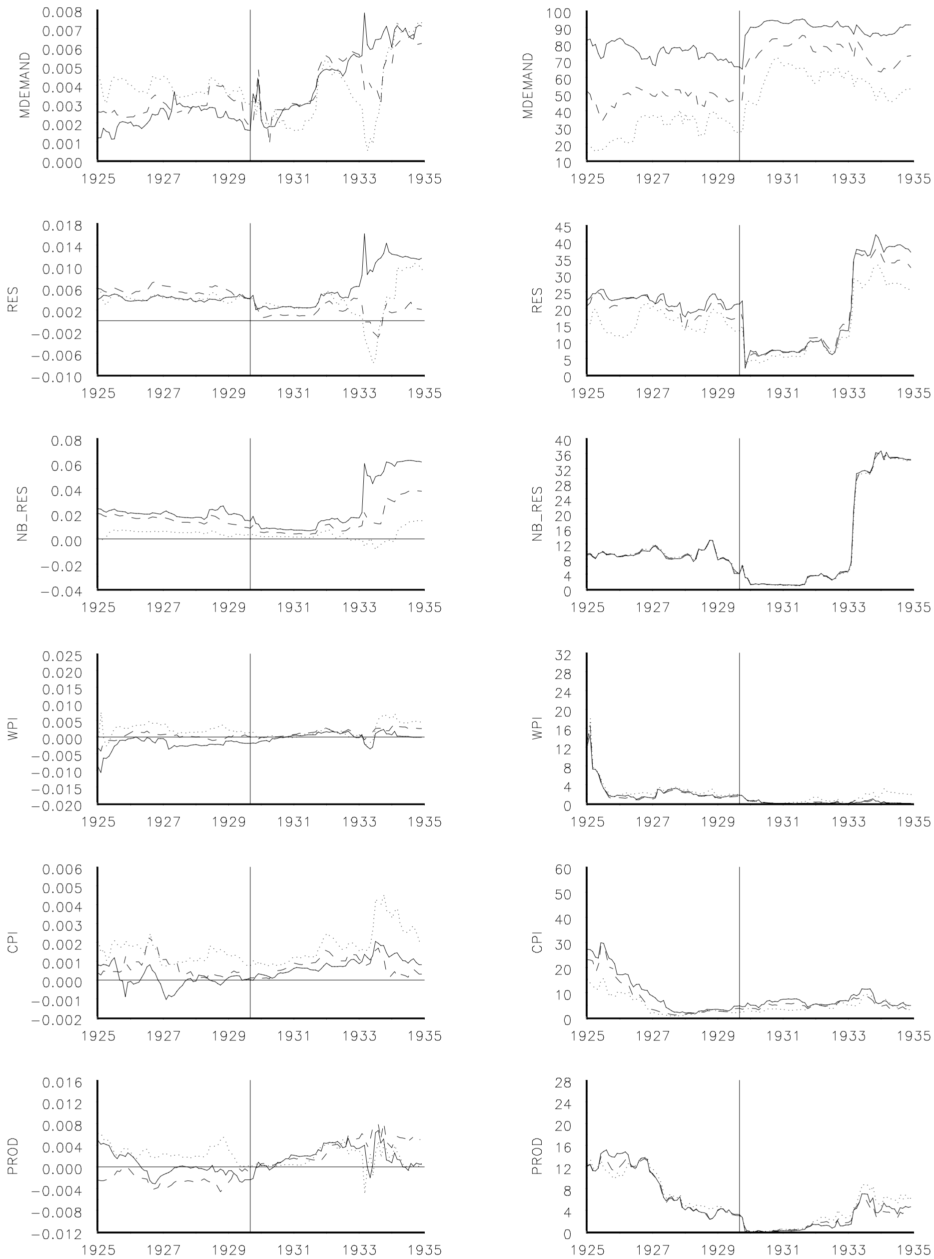


Figure 2: Forecasting the Great Depression, 3 and 6 Months Rolling Forecasts



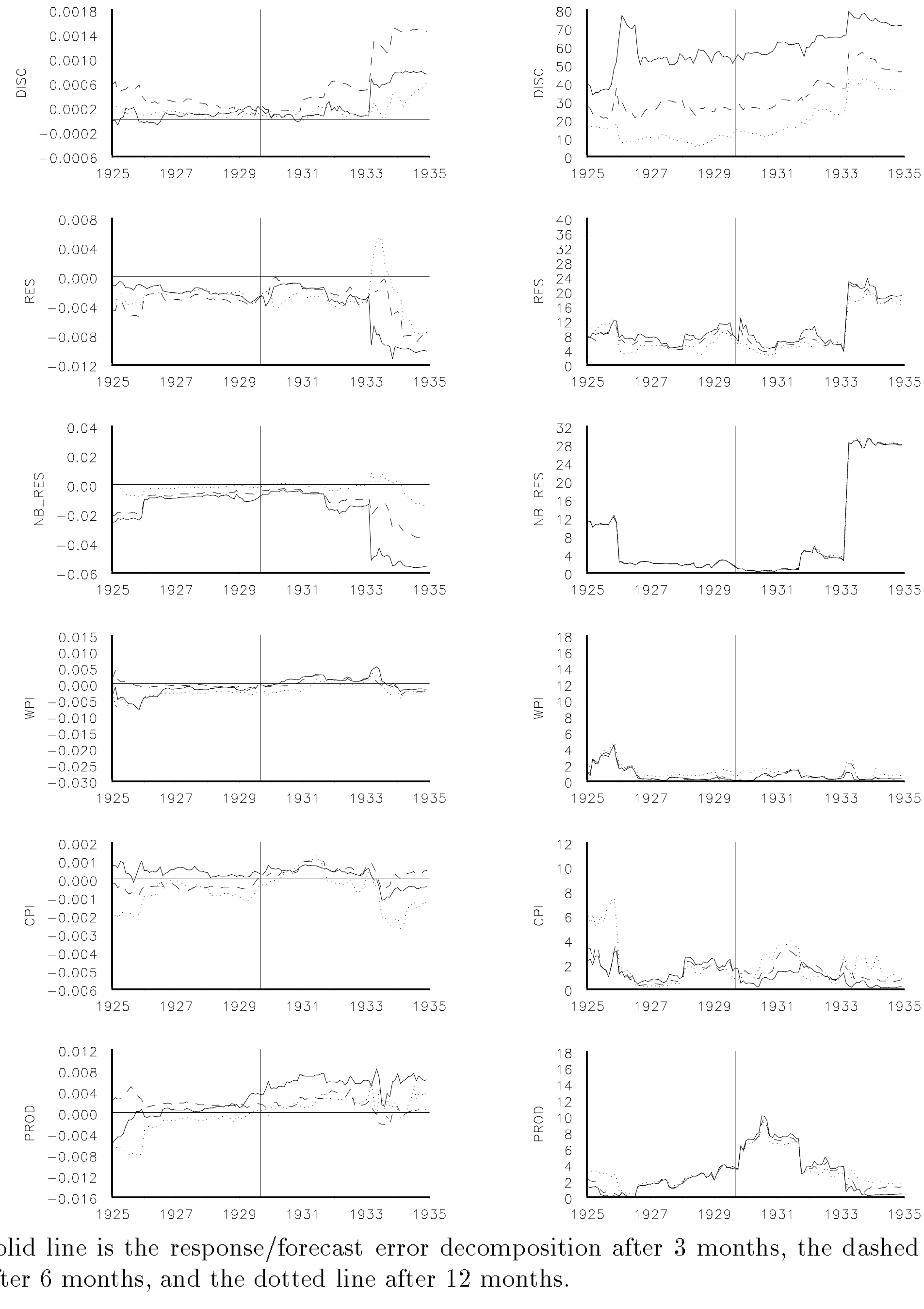
Upper graphs: 3 months rolling forecasts; lower graphs: 6 months rolling forecasts.
The dashed lines are 95 per cent confidence intervals, the solid line is the original series.

Figure 3: Response to Money Shock



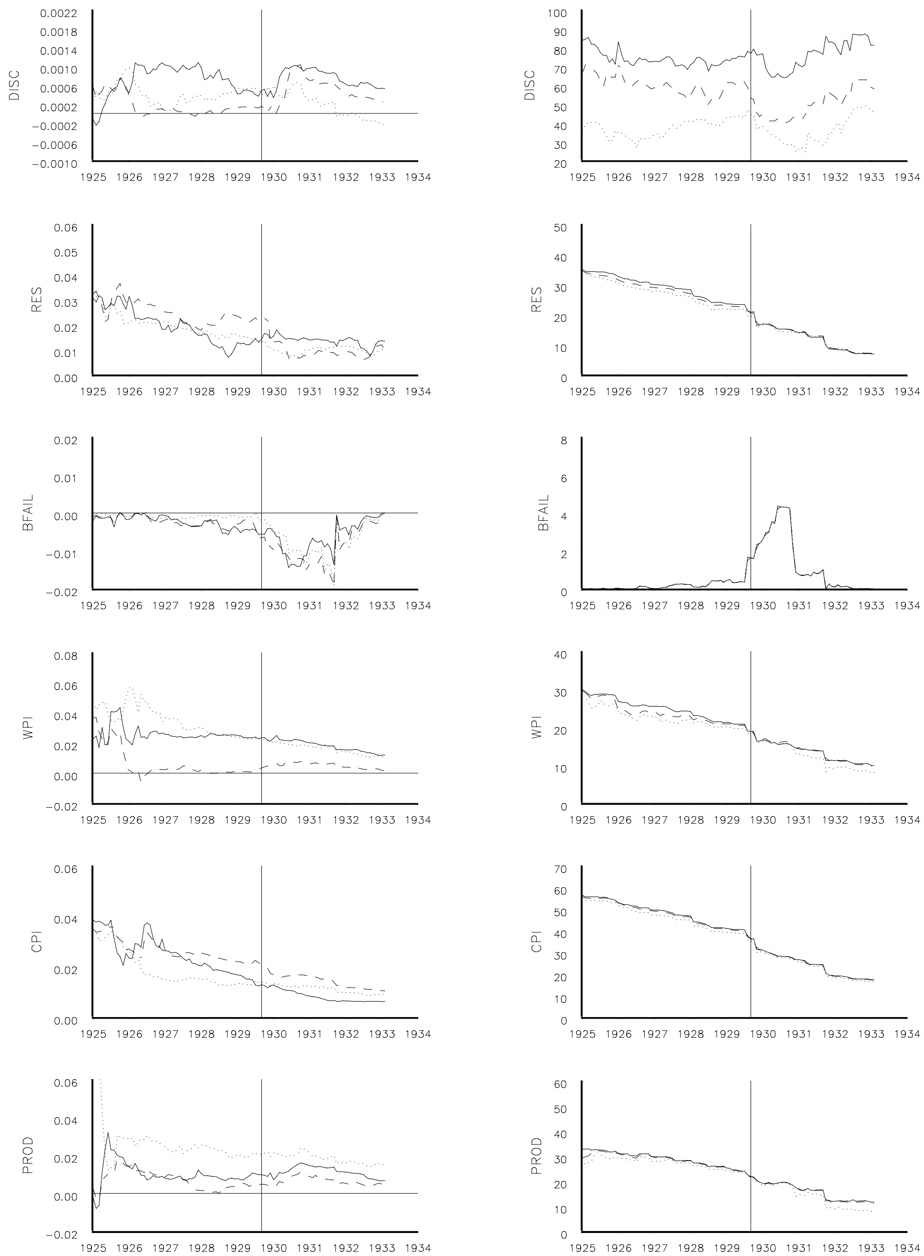
The solid line is the response/forecast error decomposition after 3 months, the dashed line after 6 months, and the dotted line after 12 months.

Figure 4: Response to Discount Rate Shock



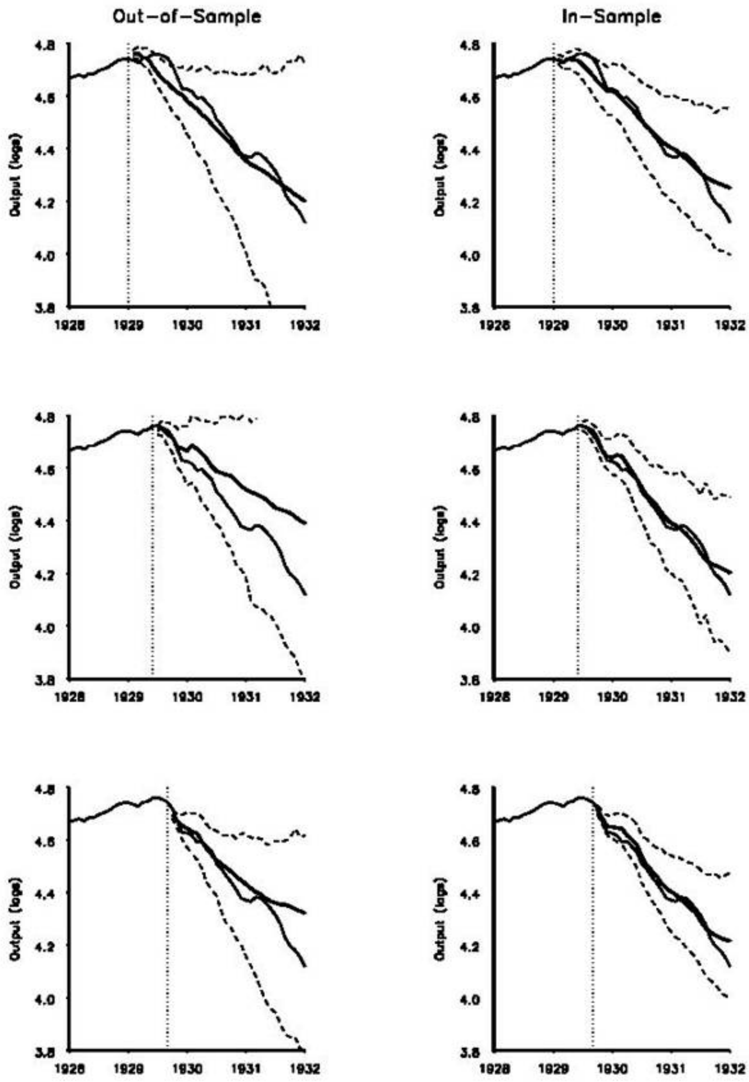
The solid line is the response/forecast error decomposition after 3 months, the dashed line after 6 months, and the dotted line after 12 months.

Figure 5: Response to Discount Rate Shock



The solid line is the response/forecast error decomposition after 3 months, the dashed line after 6 months, and the dotted line after 12 months.

Figure 6: Forecasting the Great Depression, Leading Indicators



The dashed lines are 95 per cent confidence intervals based on 1000 Monte Carlo experiments using the estimate for the final state vector and the covariance matrix. Start of forecast period: January 1929, June 1929, September 1929.