A Companion to "The Origin and Diffusion of Shocks to Regional Interest Rates in the United States, 1880-2002"

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Abstract

This paper is the online companion to "The Origin and Diffusion of Shocks to Regional Interest Rates in the United States, 1880-2002." Included in this paper are all the econometric results and analysis that were not included in the original paper due to space constraints. This paper also includes the data and a description of how the data was constructed.

1 Formal Analysis of the Sources of Interest Rate Shocks

In this section we use the standard vector autoregression (VAR) machinery – impulse response functions and forecast error decompositions – to explore the impact of the shocks hitting the core interest rates and the peripheral interest rates for various sub-periods of our sample. In later periods the core shock can be interpreted as a monetary policy shock. In the earliest period the core shock can be interpreted as the shock that a monetary authority, had it existed, would have had some influence over.

The set of interest rates modelled included each of the regional bank-lending rates and a "national rate," the latter being a potential (nineteenth century) or actual (post World War II) instrument of monetary policy.[1] We divided the

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[1] The national rates that we use are the 3 month New York commercial paper rate, obtained from the Global Financial Database (http://www.globalfindata.com), and the federal funds rate obtained from the FRED II database (http://research.stlouisfed.org/fred2/).

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sample period, based on our reading of the historical literature, into three segments: 1880-1913, 1914-1943, and 1955-2002. This division, we believe, would appear natural to most financial historians. The first segment extends from the start of our data in 1880 to 1913 when the Federal Reserve was established. The second segment includes the disturbed middle decades of the twentieth century: The two world wars and the Great Depression. The last segment begins in 1955, when our data on the Federal Funds rate begins.

Given the relatively small samples, we wish to model the data using as parsimonious a time series model as possible. For (covariance-) stationary time series we know that there is a fundamental vector $MA(\infty)$ representation of the vector of time series and under some regularity conditions this representation can be well approximated by a low-order VAR(p) model. Let $y_t = (y_{1t}, \ldots, y_{nt})'$ represent the vector of covariance-stationary time series to be modeled. Then the (reduced form) VAR(p) model is

$$y_t = \mu + \sum_{j=1}^{p} B_j y_{t-j} + \epsilon_t, \tag{1}$$

where $\epsilon \sim N(0, \Sigma)$ and the coefficients μ, B_j, and Σ are $n \times 1$ and $n \times n$ matrices respectively.

If the times series are not stationary then we need to transform the data to make them all stationary first and then model the stationary data appropriately. If the data are all integrated of order one, I(1), then the appropriate transformation is to take first differences of the data. The next problem we have is to determine how to appropriately model the differenced time series. If the data are cointegrated, that is if there exists a linear combination of the levels of the time series that is stationary, then the appropriate model to use is a vector error correction model (VEC) which is

$$\Delta y_t = c + \alpha\beta' y_{t-1} + \sum_{j=1}^{p-1} C_j \Delta y_{t-j} + \epsilon_t, \tag{2}$$

where the coefficients c, α, β, and C_j are $n \times 1$,$n \times k$,$n \times k$, and $n \times n$ matrices respectively with k representing the number of cointegrating relationships between the time series that make up y_t. If the data are not cointegrated then the appropriate model to use is a VAR in the first differences of the data (DVAR), which is

$$\Delta y_t = c + \sum_{j=1}^{p-1} C_j \Delta y_{t-j} + \epsilon_t, \tag{3}$$

where c, and C_j are $n \times 1$ and $n \times n$ matrices respectively.

Hence, before we identify structural shocks for each period of our sample we need to 1) test for non-stationarity of the individual time series, 2) if we find the series to be non-stationary we then need to test whether they are cointegrated, and then 3) determine the appropriate order of the VAR/VEC/DVAR to estimate. We describe in more detail the tests used for 1) - 3) above and the results below but first we describe how we identify the structural shocks from each of the models described above.

As it is a straightforward extension to construct structural shocks for models (2) and (3) with identical implications to structural shocks for model (1) we will concentrate on describing the process of identifying structural shocks for the levels VAR given in (1). The VAR described in (1) is the reduced form version of a structural VAR of the form

$$A_0 y_t = \tilde{\mu} + \sum_{j=1}^{p} A_j y_{t-j} + u_t, \tag{4}$$

where the structural error , u_t, consists of a set of orthogonal shocks such that $E(u_t u_t') = I_n$ for all time periods. These shocks have a structural interpretation whereas the shocks that hit the reduced form version, (1), are non-linear combinations of the structural shocks and have little structural or economic interpretation. In fact there is a one-to-one relationship between the parameters in (1) and the parameters in (4) given by $\mu = A_0^{-1}\tilde{\mu}$, $B_j = A_0^{-1}A_j$ for $j = 1, \ldots, p$,and $\epsilon_t = A_0^{-1}u_t$.

The parameters of (1) can be consistently estimated by maximum likelihood methods but the above set of non-linear equations cannot be solved for the parameters of (4) without making some identifying restrictions. Our identifying restrictions focus on the contemporaneous impact matrix, A_0^{-1}. We assume a recursive relationship between the variables of our model by imposing the restriction that is lower triangular. This allows us to exactly identify the parameters given in (4) and so allows us to identify a set of orthogonal structural shocks that hit the financial system during our sample.

One implication of this identification scheme is that our results are, potentially, going to be sensitive to the ordering of the time series in y_t. The ordering we used is as follows: 1) the national rate - the commercial paper rate or the Federal Funds rate, 2) the Northeast rate, 3) the Plains rate, 4) the Southern rate, and 5) the Western rate. This ordering was dictated partly by our concern with monetary policy: by ordering the monetary policy variable first we are assuming that the monetary authority is forward-looking. This is opposed to being reactive if we were to order the monetary policy variable after any of the regional rates. The first of the regional rates is the Northeast regional rate. This region contained the eastern financial centers: New York (by far the most important), Boston, and Philadelphia. The order to be chosen for the peripheral regions is less clear-cut. The order we usually worked with was (after the Northeast) the Plains states, the South, and the West. This ordering reflects a nineteenth century view of things; today we would be more likely to put the West second and, perhaps, the Plains last.[2]

Given our ordering of the variables, the identifying restrictions imposed means that we can interpret the shocks in the following way: The national shock is the shock that hits the commercial paper rate or the Federal Funds rate. This shock is likely to contain shocks to the commercial paper rate or the Federal Funds rate that are national in origin and certainly for the Federal Funds rate should include monetary policy shocks. The Northeast shock is the component of the northeast residual that is orthogonal to the national shock, that is, the Northeast shock consists of shocks hitting the Northeast regional bank rate that are not monetary policy shocks or national shocks. The Plains shock is the component of the plains residual orthogonal to both the national shock and the Northeast shock. The South shock is the component of the South residual that is orthogonal to the National, Northeast, and Plains residuals. Finally, the West shock is the shock that hits the West that is orthogonal to all the other shocks.

1.1 Unit Root and Cointegration Tests

Before we estimate our models for each sub-period we test each interest rate time series for the presence of a unit root and if we find that all the series contain a unit root we then test for cointegration. We perform a battery of unit root tests for each interest rate series. The tests used were the standard augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979), the GLS detrended version of the ADF test (ADF-GLS) (Elliott et al., 1996), and the ADF with a structural break (Perron, 1989). All these tests have as their null hypothesis the hypothesis that the time series contains a unit root. Given the small sample size and the fact that these unit root tests are known to have small power we also performed the unit root test suggested by Kwiatkowski et al. (1992), otherwise known as the KPSS test. This test has as its null hypothesis the hypothesis that the time series do not contain a unit root.

Table 1 reports the p-values for each test by series and by period. Evidence in favor of a unit root would be a high p-value for the ADF based tests and a low p-value for the KPSS test. For the first sub-period (1880-1913) the evidence suggests that the interest rate series do not contain a unit root. For the second

[2] While we report results for the ordering in the periphery of the Plains first, the South second and the West last we have done a sensitivity analysis by permuting these last three regions in the VAR. In all cases the national rate is ordered first and the Northeast rate is ordered second. The results, available from the authors upon request, show that the results presented are not sensitive to the ordering of the variables.

sub-period (1914-1943) and third sub-period (1955-2002) the results of all the tests suggest that the interest rate series contain unit roots.

The overall result was that we could only reject the hypothesis that the interest rate series contain a unit root in the first sub-period. On economic grounds this seems reasonable. In this period real rates would be anchored by the productivity of capital and time preference, and the inflation premium would be held in check by the gold standard. However, in the postwar era when the inflation premium becomes an issue, a unit root in nominal rates would be more likely.

The results of these tests suggest that we can estimate a VAR in levels for the first sub-period but for the second and third sub-period we need to estimate a VAR in differences. This brings into play the issue of co-integration. If there is co-integration present the appropriate model to estimate is the Vector Error Correction model which is just the DVAR (VAR in differences) with error correction terms added to each equation. To test for cointegration we used the method of Johansen (1988, 1992) using the sample size corrected critical values suggested by MacKinnon et al. (1999). The p-values for the Johansen trace test are also reported in Table 1. Our results were that in the second sub-period (1914-1943) there was no evidence of cointegration. In the third sub-period there is evidence of one cointegrating relationship between the interest rates in our model. Given these results we proceeded as follows: 1) For period 1880-1913 we estimated a VAR model in levels, 2) for the period 1914-1943 we estimated a VAR in first differences, and 3) for the period 1955-2002 we estimated two VEC models, one with the commercial paper rate as the "national" rate, and a second with the Federal funds rate as the "national" rate.

1.2 Model Specification

The last task left for us to do is to determine the number of lags to include for each model. Given that we have small samples in each of our sub-periods we used an information criterion approach to choose the lag length. We used the Schwarz Bayesian Information Criterion (SBIC) to choose the lag length for each sub-period as this information criterion consistently estimates the correct lag length if the true model is a VAR and does so for stationary and non-stationary models alike.

In all cases the SBIC was minimized for p=1. It should be noted that the models being estimated are a DVAR, for the second sub-period, and a VEC, for the third sub-period. A DVAR and a VEC with one lag included are equivalent to a levels VAR with two lags included. To be consistent across sub-periods we checked whether a VAR(2) in levels was appropriate for the first sub-period by performing a likelihood ratio test of whether the second lag of the endogenous variables are jointly 0 across all equations of the VAR. The result of this test was mixed in that the p-value of the likelihood ratio test was 0.06. Thus we could not reject the hypothesis that the coefficient matrix for a VAR(2) at the 5% level but we could reject at the 10% level. Given the small sample size and the fact that the penalty for adding extraneous variables is only a loss in efficiency compared to the penalty for omitting a relevant variable being estimation bias we decided to estimate a VAR(2) model for the first sub-period rather than a VAR(1). Thus we estimate a VAR(2) for the first sub-period, a DVAR(1) for the second sub-period, and a VEC(1) model for the third sub-period.[3]

1.3 Results

Estimation results for each model are reported in Tables 2–5. All models were estimated using a maximum likelihood estimator. The system wide Wald test that all of the coefficients in each model are jointly 0 can be rejected for all reasonable test sizes. The equation wide Wald tests also show, except for a few equations, that the joint hypothesis that all coefficients, excluding the constant, are jointly 0 can be rejected as well. While there are significant individual coefficients in each model, we find it more instructive to look at the impulse response functions and forecast error variance decompositions implied by our estimates as a check the model's validity because the impulse response functions and forecast error decompositions have natural economic interpretations.

In each of the three sub-periods we computed orthogonalized interest rate impulse response functions according to our identification outlined in Section 1. These impulse response functions are reported in Figures 1 – 4. The confidence intervals that are reported are calculated using the bootstrap method suggested in Lütkepohl and Krätzig (2004). The impulse response functions show that the national interest rate shock has a positive and significant impact on all regional rates in all periods and that for the second and third sub-period this impact is permanent. This suggests that the markets were integrated in the sense that shocks that occurred in one region tended to reverberate through the system. Shocks to rates in the eastern financial markets did affect rates on the periphery. This is a natural definition of integration, although somewhat

[3] The main result of this paper is robust to the choice of lag length. Using different model selection criteria can lead to different model choices but in all cases that we have tried the main results always hold: the influence of the national shock on the periphery is getting stronger over time and the peripheral shocks have important effects in the first two periods but negligible effects in the last period.

different, we should note, than the traditional definition in the literature on regional interest rates that identifies integration with convergence of interest rates in the long run.

The impact of the shocks from the periphery on the National and Northeast interest rate shocks are also of interest. In the first sub-period we see that in general the 90% confidence interval for the impulse response function includes 0 for every period of the impulse response function. However it does appear the Plains shock has a small negative impact on the National rate and the Northeast rate with a lag of one period. We also see that the West shock has a negative impact on the National rate and on the Plains and Northeast rates.

The correlation between shocks in two regions, as these results show, can be negative as well as positive. It is not hard to think of circumstances under which this might be the case. Suppose there was a negative supply shock in the Plains, a financial crisis for example, capital would flow out of the Plains, raising rates in the Plains and lowering rates in other regions, a negative correlation. The Crisis of 1893 illustrates the potential for conflicting effects. Fears about the maintenance of the gold standard produced an external drain of gold that probably put upward pressure on rates in all regions (a national shock), but there was also a wave of bank failures in the West and Southwest that probably resulted from other causes such as the relative decline in agricultural prices. The latter shock, if it led people to move their capital to the eastern financial centers, might have partially offset the effects of the external drain on eastern rates (Sprague, 1968; Friedman and Schwartz, 1963, p. 149, pp.108-109).[4]

In the second sub-period we see that the National and Northeast rates have a positive and significant impact on the rates in the periphery with the Northeast rate having the biggest impact on the periphery rates. It appears here that the Northeast rate is playing the role of the central monetary shock and there is little impact of the shock to the commercial paper rate on the periphery. Our suspicion is that the national shock is being identified via the Northeast shock and not the commercial paper rate in this sub-period. However, when we order the the Northeast shock before the Commercial paper rate we obtain almost identical impulse response functions. It is clear from Figure 1 of the main paper that the Commercial paper rate behaves strangely in the 1930's. According to James (1995) the commercial paper market began to decline in the late 1920s when the large commercial banks began to encroach on its territory, and "essentially stagnated" (p. 248) through most of the 1930s. This may be the reason why we are not identifying a strong national shock from the

[4] We did not try to test for this formally because of the small sample size, but when we deleted data from the early 1890s from the VAR we found that the Impulse Responses in question were no longer significant and were smaller in magnitude.

commercial paper rate in this sub-period. However, if we drop the Commercial paper rate from the VAR we get similar results as before. In this restricted model the national shock (identified only from the Northeast rate) accounts for a large amount of the forecast error variance for all rates. As before though, we still see the peripheral shocks accounting for a significant (more than 25%) proportion of the forecast error variance of the peripheral rates.

What we do see here, though, is that shocks to the periphery are affecting other rates in the periphery. For example shocks to the South and the West positively affect the Plains while shocks to the Plains appear to positively affect the West. We don't see, however, any significant impact of the peripheral shocks on the core (National and Northeast). This is an interesting result because it shows that even after the Fed arrived it did not have complete control of regional rates of the sort that we see in the post WWII era.

In the third sub-period the core shocks (the commercial paper rate or the Federal Funds rate) have significant positive impacts on the peripheral rates. We see also that the most likely candidate for the monetary policy shock, the National shock, appears to have the biggest impact on the regional rates. As for the peripheral shocks we see that the only significant responses are for the peripheral shocks on their own rates. And even in this case the impacts are small relative to the monetary policy shock and appear to be temporary. This is in contrast to the earlier period where it appeared that some of the peripheral shocks had significant and long-lasting effects on other rates in the periphery. We also see that the peripheral shocks have little effect on the core rates with any response being insignificant.

One impulse response that is interesting to note is the impact of the Northeast shock on the National rate. Here we see a negative mean impact which appears to be significant at the first lag. Again, the most likely explanation for a negative impulse response would be a regional financial problem such as the New York City bankruptcy in 1975. This problem involved the banks which were holders of New York City debt. Indeed, when we drop 1975 - 1979 from the sample this negative impulse disappears. Given the other major economic disturbances during this period, and the small sample, we can't say for sure that the New York City Crisis is the cause of the negative impulse, but the test does illustrate that this response may be due to an unusual rather than normal event.

The crucial question here is does the central monetary authority have access to an instrument that dominates interest rates in the periphery? To get at this question we construct forecast error variance decompositions. The variance decompositions show the contribution of each structural shock to the non-forecastable components of each time series (i.e. the random component of each time series once we account for the trend, level, and the relationship to past values of the series). Variance decompositions are more useful for this purpose than impulse-response functions because variance decompositions reflect the size and frequency of the shocks as well as their impact on other variables as described by the VAR equations. The impulse-response chart does not show the size or the frequency of the shocks, but merely what the effect of a standardized shock would be.

The forecast error variance decompositions are reported in Tables 6–9. To better see the change in the impact of each shock on the various interest rates we report in Figures 5 – 9 the contribution of each shock to the forecast error variance for each interest rate in our model. Each line on the sub-figures represents a time period. Figures 5 and 6 report the forecast error variance decomposition (FEVD) for the National rate and the Northeast rate. What we see here is that the National shock contributes by far the largest amount to the FEVD of the National rate with the Northeast shock being the next largest contributor. This is true for all sub-periods. Together the two core shocks contribute almost all of the forecast error variance observed in the data. The role of the peripheral shocks is very small with only the Plains and West shocks having some, albeit small, contribution in the first sub-period.

For the Northeast rate (Figure 6) the contribution of the core rates to the forecast error variance is again the most important but there are some important differences from the National rate. In the early sub-periods we see that there is equal contribution from the National and Northeast rates but in the third sub-period the National shock is making the largest contribution to the forecast error variance. The peripheral rates are again having little impact except for the case of the West shock in the first sub-period. However in the subsequent periods the West shock contributes very little to the forecast error variance of the Northeast rate.

A very different story emerges when we look at the FEVD for the peripheral shocks (Figures 7 – 9). Here the change in the impact of each shock over time is stark. For the Plains (Figure 7) the impact of the peripheral shocks is quite large in the first period. Over 50% of the forecast error variance can be attributed to shocks from the periphery in the first sub-period. In the last sub-period the total impact of all peripheral shocks has fallen to less than 10% of total forecast error variance. Moreover, the impact of the core shocks on the forecast error variance on the Plains rate has dramatically increased from less than 50 percent in the early period to close to 90 percent in the third period.

The same effects can be seen in the South (Figure 8) and the West (Figure 9). In the South the contribution of the peripheral shocks on the forecast error variance in the first period is large (over 50%) while in the second sub-period the contribution is moderately large (around 25%). However for the third sub-period the contribution of the peripheral shocks on the forecast error variance is negligible (less than 5%). The story for the West is very similar. Over 50% of the forecast error variance can be attributed to peripheral shocks in the first and second sub-period for the West rate (Figure 9). This falls to less than 10% in total for the last sub-period.

Thus in the pre-war and interwar years it appears that the core interest rates would not have been a good instrument for monetary policy in that it would have been hard for a monetary authority to use the core rates to counteract shocks in the periphery. This is in contrast to the most recent period where, as might be expected, shocks to the national rate, whether measured by the commercial paper rate or the Federal Funds rate, and the Northeast rate appear to explain most (at least 90 percent) of the variance of the forecast errors for all interest rates. Shocks in the periphery have a very small impact on rates in the periphery and these effects do not linger very long. Thus in the latter period it appears that the monetary authority has access to an instrument that dominates rates from all regions of the country.

The results from the impulse response functions and the variance decompositions, in other words, point to the emergence of a strong central instrument that dominates regional shocks. There are two possible explanations for this. The first is that capital markets have deepened so that regional shocks are quickly absorbed in the national market. An alternative, though not mutually exclusive, explanation for the decline in the role of shocks on the periphery is that the regional shocks have become more correlated over time. [5]

We favor the capital-deepening story for the following reasons: 1) the impulse response functions suggest that the peripheral shocks have little impact on the periphery in the third sub-period and when these shocks are significant they dissipate immediately. This is in contrast to the two earlier sub-periods where the peripheral shocks dissipate slowly, if at all. 2) The history of post-WWII banking reform, for example the appearance of interstate branching, suggests the emergence of a more nationally oriented banking market. We cannot, however, rule out the second interpretation, and believe that it probably played a role.

2 The Data

Banking across state lines was prohibited in the United States for much of our history. Each state had its own banking system. Many states, moreover,

[5] We thank an anonymous referee for pointing this out. Because of the identification of the shocks into orthogonal components, highly correlated regional shocks will be attributed to the national shock.

prohibited branch banking within the state. The result was a myriad of local banks filing reports on their assets and earnings with government regulators. Local lending rates can be derived from this data. If a few large banks with many branches had characterized the United States, as was the case in Canada and other developed countries, local rates would be much harder to establish. They would be recorded in the internal records of the banks, and would not be reported to regulators. As we will see below data for the most recent years in the United States may be contaminated by this problem.

The year 1880 is a natural starting place. In the years immediately following the Civil War the Pacific Coast remained on gold while the East remained on the Greenback. The United States returned to the gold standard in 1879, so our data starts when the U.S. monetary union was reconstituted after the Civil War.

Bodenhorn (1995), followed Smiley (1975) and James (1976a,b), and purged the data originally compiled by Davis (1965) of various revenues and losses in order to arrive at something closer to contractual loan rates. Davis had attributed all bank earnings to loans, and divided that figure by total loans to get a proxy for the rate of interest. Smiley and James removed earnings on bonds and other non-loan earnings from the numerator and various non-loan assets from the denominator. Bodenhorn (1995) extended these estimates to 1960.

Our data for the period after 1966 was derived from income and balance sheet data posted on the FDIC website.[6] This data would appear to be exactly what is needed. The variable we used was the ratio of "Total Interest Income on Loans and Leases" to "Net Loans and Leases." The main problem here is that total interest income and loans are reported by bank and attributed to the home office of the bank. Interregional mergers in recent years have undoubtedly undermined the usefulness of the series as measures of regional interest rates.

To bridge the gap between Bodenhorn's series which ends in 1960 and the FDIC loans and discounts series we interpolated using data from the Annual Report of the Federal Deposit Insurance Corporation. Here a different variable, the ratio of "Interest and Discounts on Loans" to "Loans, Discounts, and Overdrafts" was available. This variable produced somewhat lower rates in the Northeast (especially in New York State), and so this variable was used as an interpolator. We computed percentage deviations from trend values in the FDIC loans, discounts, and overdrafts series and added them to deviations

[6] John C. Driscoll of the Federal Reserve Board kindly shared the regional data that he used in his paper (2004) on bank lending rates. We derived our own series in order to be sure that they were as close as possible to being extensions of the earlier data. As it turned out, our final estimates were extremely close to Driscoll's.

from the trend between the end of the Bodenhorn series and the beginning of the FDIC loans and discounts series. The standard deviations of the resulting series are relatively low during the period 1961 to 1965. However, this is also true of other rates such as the corporate bond rate. Therefore, we did not try to adjust the interpolator for a potential difference in its underlying volatility. The resulting series are reported in the following table.

3 Tables and Figures

Table 1
Summary of Unit Root and Cointegration Tests

Unit Root Tests

Test	Commercial	Northeast	Plains	South	West	Fed Funds
1880-1913						
ADF	0.00	0.01	0.03	0.62	0.11	
ADF-GLS	< 0.01	< 0.01	< 0.01	> 0.1	> 0.1	
KPSS	< 0.1	< 0.05	> 0.1	> 0.1	> 0.1	
Perron	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
1914-1943						
ADF	0.44	0.85	0.44	0.92	0.36	
ADF-GLS	> 0.1	> 0.1	> 0.1	> 0.1	> 0.1	
KPSS	< 0.1	< 0.05	< 0.05	< 0.05	> 0.1	
1955-2002						
ADF	0.83	0.95	0.96	0.98	0.96	0.96
ADF-GLS	> 0.1	> 0.1	> 0.1	> 0.1	> 0.1	> 0.1
KPSS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Perron	> 0.1	> 0.1	> 0.1	> 0.1	> 0.1	> 0.1

Johansen Cointegration Tests

	Number of CI Relationships				
Period	None	≤ 1	≤ 2	≤ 3	≤ 4
1914-1943	0.59	0.77	0.88	0.93	0.98
1955-2002 (Comm.)	0.00	0.28	0.39	0.43	0.13
1955-2002 (Fed Funds)	0.00	0.30	0.74	0.65	0.41

Note: Values reported are p-values.

Table 2
Estimates of VAR (1880-1913)

	Equations				
Regressors	$r^{nat.}$	r^{NE}	r^{P}	r^{S}	r^{W}
$r^{nat.}_{t-1}$	0.320	0.346	0.440	0.207	0.259
	(0.338)	(0.199)	(0.338)	(0.195)	(0.485)
$r^{nat.}_{t-2}$	-0.396	-0.303	-0.245	-0.042	-0.192
	(0.291)	(0.171)	(0.292)	(0.168)	(0.419)
r^{NE}_{t-1}	-0.236	-0.030	-0.411	-0.063	-0.657
	(0.589)	(0.347)	(0.590)	(0.340)	(0.847)
r^{NE}_{t-2}	0.254	0.068	0.129	-0.233	-0.071
	(0.535)	(0.315)	(0.536)	(0.309)	(0.769)
r^{P}_{t-1}	-0.409	-0.149	0.057	-0.140	-0.211
	(0.425)	(0.250)	(0.426)	(0.245)	(0.612)
r^{P}_{t-2}	0.501	0.523	0.704	0.509	0.628
	(0.413)	(0.243)	(0.413)	(0.238)	(0.594)
r^{S}_{t-1}	0.385	0.321	0.622	0.314	0.906
	(0.642)	(0.378)	(0.642)	(0.370)	(0.923)
r^{S}_{t-2}	-0.019	-0.057	0.348	0.242	0.394
	(0.593)	(0.349)	(0.594)	(0.342)	(0.853)
r^{W}_{t-1}	-0.242	-0.216	-0.184	0.015	0.102
	(0.211)	(0.124)	(0.211)	(0.122)	(0.303)
r^{W}_{t-2}	-0.103	-0.116	-0.312	-0.103	-0.136
	(0.234)	(0.138)	(0.234)	(0.135)	(0.336)
Constant	4.462	2.926	-0.515	1.821	-0.870
	(2.654)	(1.562)	(2.658)	(1.531)	(3.817)
R^2	0.282	0.472	0.599	0.681	0.564
Wald	0.60	0.04	0.00	0.00	0.00
Joint Wald	0.00				

Note: p-values reported for Wald tests.

Table 3
Estimates of DVAR (1914-1943)

	Equations				
Regressors	$\Delta r^{nat.}$	Δr^{NE}	Δr^{P}	Δr^{S}	Δr^{W}
$\Delta r^{nat.}_{t-1}$	0.050	0.333	0.523	0.211	0.279
	(0.177)	(0.124)	(0.126)	(0.113)	(0.140)
Δr^{NE}_{t-1}	0.182	-0.239	0.027	0.439	-0.011
	(0.512)	(0.357)	(0.363)	(0.326)	(0.404)
Δr^{P}_{t-1}	-1.004	-0.255	-0.630	-0.284	0.353
	(0.369)	(0.257)	(0.261)	(0.235)	(0.291)
Δr^{S}_{t-1}	0.219	0.254	0.542	-0.184	0.019
	(0.502)	(0.350)	(0.356)	(0.320)	(0.397)
Δr^{W}_{t-1}	0.288	0.180	0.044	0.044	-0.703
	(0.246)	(0.172)	(0.175)	(0.157)	(0.194)
Constant	-0.235	-0.145	-0.161	-0.146	-0.114
	(0.156)	(0.109)	(0.111)	(0.100)	(0.123)
R^2	0.342	0.277	0.537	0.247	0.506
Wald	0.03	0.10	0.00	0.16	0.00
Joint Wald	0.00				

Note: p-values reported for Wald tests.

Table 4

Estimates of VEC: 1955-2002 (Commercial Paper as National Rate)

Co-integrating Equation

$r^{nat.}$	r^{NE}	r^{P}	r^{S}	r^{W}	Constant
1.000	1.592	0.846	-4.296	0.570	4.792
	(0.275)	(0.634)	(0.747)	(0.401)	

Equations

	$\Delta r^{nat.}$	Δr^{NE}	Δr^{P}	Δr^{S}	Δr^{W}
ecm_{t-1}	-0.056	-0.349	0.050	0.073	-0.185
	(0.369)	(0.226)	(0.166)	(0.149)	(0.207)
$\Delta r^{nat.}_{t-1}$	0.767	0.450	0.395	0.373	0.417
	(0.242)	(0.148)	(0.109)	(0.098)	(0.136)
Δr^{NE}_{t-1}	0.309	0.295	0.182	0.080	0.266
	(0.719)	(0.440)	(0.324)	(0.291)	(0.404)
Δr^{P}_{t-1}	1.303	-0.059	0.105	0.271	0.017
	(1.298)	(0.794)	(0.586)	(0.525)	(0.730)
Δr^{S}_{t-1}	-2.625	-0.074	-0.356	-0.430	0.005
	(1.384)	(0.847)	(0.625)	(0.560)	(0.778)
Δr^{W}_{t-1}	-0.582	-0.177	-0.317	-0.251	-0.442
	(0.771)	(0.471)	(0.348)	(0.311)	(0.433)
Constant	0.076	0.044	0.065	0.044	0.034
	(0.215)	(0.132)	(0.097)	(0.087)	(0.121)
R^2	0.303	0.235	0.420	0.485	0.285
Wald	0.00	0.00	0.00	0.00	0.00
Joint Wald	0.00				

Note: p-values reported for Wald tests.

Table 5
Estimates of VEC: 1955-2002(Fed Funds as National Rate)

Co-integrating Equation

$r^{nat.}$	r^{NE}	r^{P}	r^{S}	r^{W}	Constant
1.000	1.889	0.409	-4.246	0.513	6.142
	(0.367)	(0.844)	(1.003)	(0.540)	

Equations

	$\Delta r^{nat.}$	Δr^{NE}	Δr^{P}	Δr^{S}	Δr^{W}
ecm_{t-1}	-0.306	-0.359	-0.027	-0.005	-0.235
	(0.368)	(0.191)	(0.144)	(0.131)	(0.176)
$\Delta r^{nat.}_{t-1}$	0.735	0.378	0.344	0.319	0.352
	(0.255)	(0.132)	(0.100)	(0.090)	(0.122)
Δr^{NE}_{t-1}	0.629	0.359	0.216	0.121	0.362
	(0.886)	(0.459)	(0.346)	(0.315)	(0.424)
Δr^{P}_{t-1}	1.509	-0.192	0.038	0.233	-0.107
	(1.596)	(0.827)	(0.623)	(0.567)	(0.765)
Δr^{S}_{t-1}	-2.581	0.173	-0.163	-0.255	0.265
	(1.680)	(0.871)	(0.656)	(0.596)	(0.805)
Δr^{W}_{t-1}	-0.940	-0.250	-0.354	-0.297	-0.540
	(0.951)	(0.493)	(0.371)	(0.337)	(0.455)
Constant	0.024	0.027	0.046	0.025	0.029
	(0.266)	(0.138)	(0.104)	(0.095)	(0.128)
R^2	0.264	0.231	0.390	0.444	0.270
Wald	0.02	0.05	0.01	0.00	0.02
Joint Wald	0.00				

Note: p-values reported for Wald tests.

Table 6
Variance Decomposition: 1880-1913

	Period	shock to Comm.	NE	Plains	South	West
	1	100.00	0.00	0.00	0.00	0.00
Comm.	2	81.68	3.53	9.84	0.00	4.94
	5	76.81	7.07	9.49	0.73	5.90
	1	53.26	46.74	0.00	0.00	0.00
NE	2	51.58	33.21	5.46	0.02	9.73
	5	45.96	29.36	6.28	1.75	16.65
	1	36.39	12.69	50.91	0.00	0.00
Plains	2	42.84	10.55	43.37	0.38	2.87
	5	41.62	10.94	33.37	0.32	13.75
	1	16.06	19.44	50.17	14.33	0.00
South	2	22.43	17.52	45.61	14.38	0.06
	5	26.60	12.01	48.61	8.30	4.48
	1	2.90	3.50	37.06	6.63	49.92
West	2	2.99	3.52	38.41	8.58	46.49
	5	9.90	4.63	44.48	7.14	33.85

Table 7
Variance Decomposition: 1914-1943

		shock to				
	Period	Comm.	NE	Plains	South	West
	1	100.00	0.00	0.00	0.00	0.00
Comm.	2	88.79	3.22	5.12	0.98	1.89
	5	85.09	2.73	5.37	4.57	2.24
	1	0.64	99.36	0.00	0.00	0.00
NE	2	19.30	77.42	0.07	1.83	1.38
	5	20.28	74.15	1.30	2.41	1.86
	1	10.19	68.39	21.43	0.00	0.00
Plains	2	47.90	35.18	13.19	3.69	0.05
	5	48.34	32.56	13.90	4.51	0.70
	1	0.15	69.07	2.07	28.71	0.00
South	2	17.39	55.50	3.61	23.39	0.10
	5	17.79	54.52	3.49	23.04	1.15
	1	3.37	43.58	7.51	2.12	43.42
West	2	12.63	33.72	5.46	2.13	46.06
	5	14.66	24.99	5.11	8.45	46.80

Table 8
Variance Decomposition: 1955-2002 (Commercial)

		shock to				
	Period	Comm.	NE	Plains	South	West
Comm.	1	100.00	0.00	0.00	0.00	0.00
/ FF	2	94.10	3.54	0.00	1.80	0.56
	5	83.13	12.34	0.02	3.38	1.12
	1	47.89	52.11	0.00	0.00	0.00
NE	2	64.12	34.45	0.04	0.80	0.59
	5	74.59	22.31	0.51	0.79	1.80
	1	73.34	12.89	13.78	0.00	0.00
Plains	2	87.47	5.18	6.39	0.51	0.45
	5	88.61	2.16	5.91	2.14	1.18
	1	77.78	15.46	3.21	3.55	0.00
South	2	91.68	5.70	1.42	0.93	0.27
	5	94.73	2.30	1.17	0.89	0.90
	1	42.01	43.34	1.22	1.09	12.35
West	2	65.46	26.11	0.99	1.42	6.01
	5	77.61	15.86	1.65	0.88	4.01

Table 9
Variance Decomposition: 1955-2002 (Fed Funds)

		shock to				
	Period	Comm.	NE	Plains	South	West
Comm.	1	100.00	0.00	0.00	0.00	0.00
/ FF	2	94.18	3.56	0.10	0.83	1.33
	5	82.09	13.50	0.54	1.58	2.29
	1	50.61	49.39	0.00	0.00	0.00
NE	2	64.29	33.08	0.32	1.54	0.77
	5	73.66	19.83	2.26	2.09	2.17
	1	76.34	10.99	12.67	0.00	0.00
Plains	2	88.46	4.33	6.43	0.08	0.70
	5	88.19	1.84	7.34	0.69	1.93
	1	78.36	13.85	3.69	4.10	0.00
South	2	90.88	5.15	1.99	1.45	0.52
	5	93.08	2.05	2.54	0.58	1.75
	1	47.65	38.30	1.14	0.95	11.96
West	2	67.61	23.21	1.45	2.37	5.36
	5	78.77	12.54	3.63	2.14	2.92

Fig. 1. Impulse Response Functions: 1880-1913

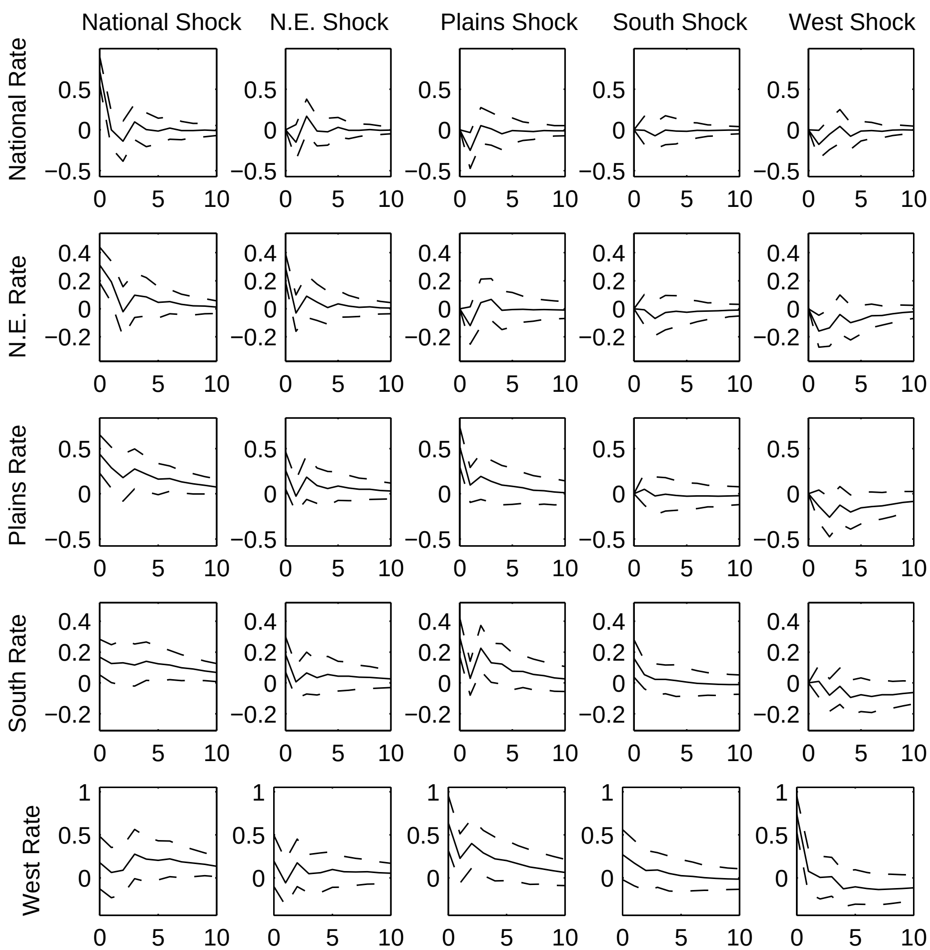

Fig. 2. Impulse Response Functions: 1914-1943

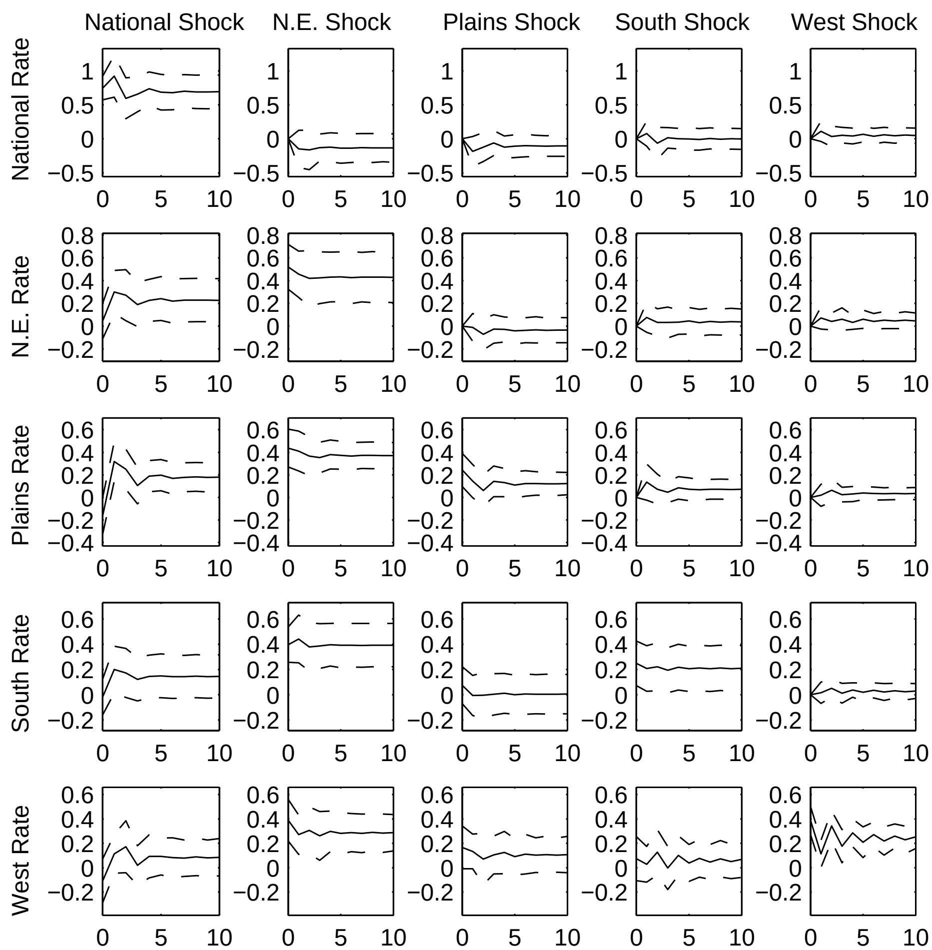

Fig. 3. Impulse Response Functions: 1955-2002 (Commercial)

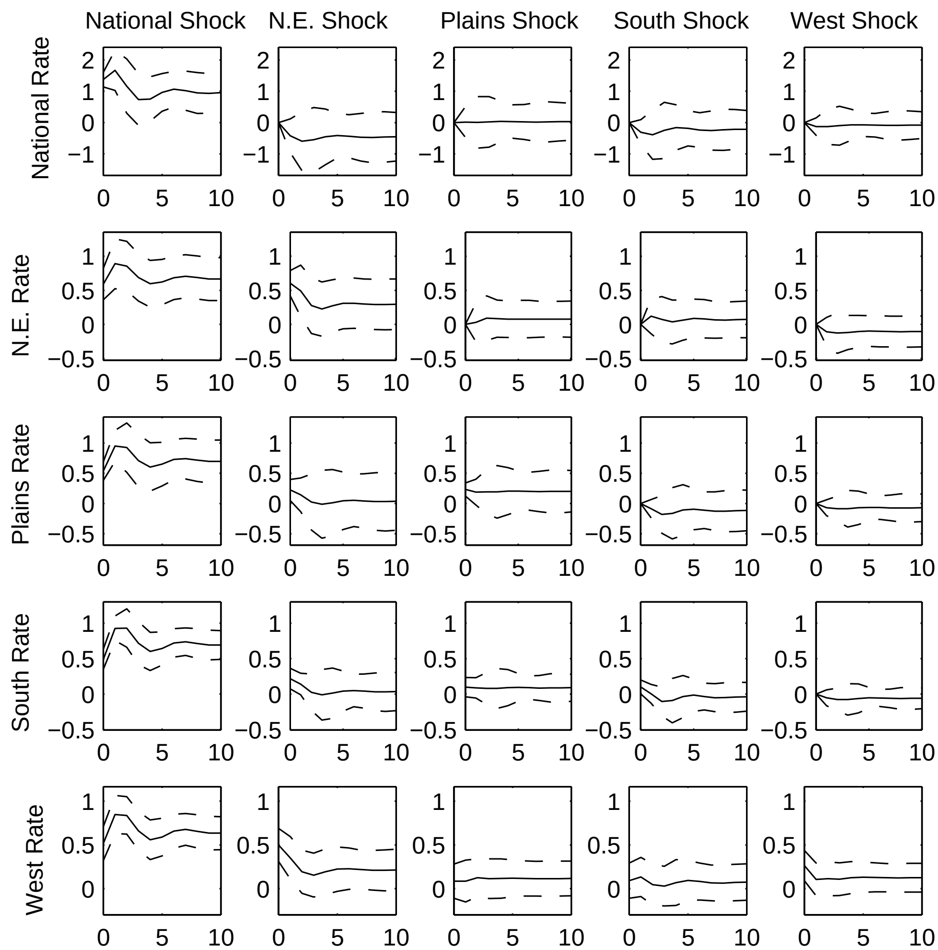

Fig. 4. Impulse Response Functions: 1955-2002 (Fed Funds)

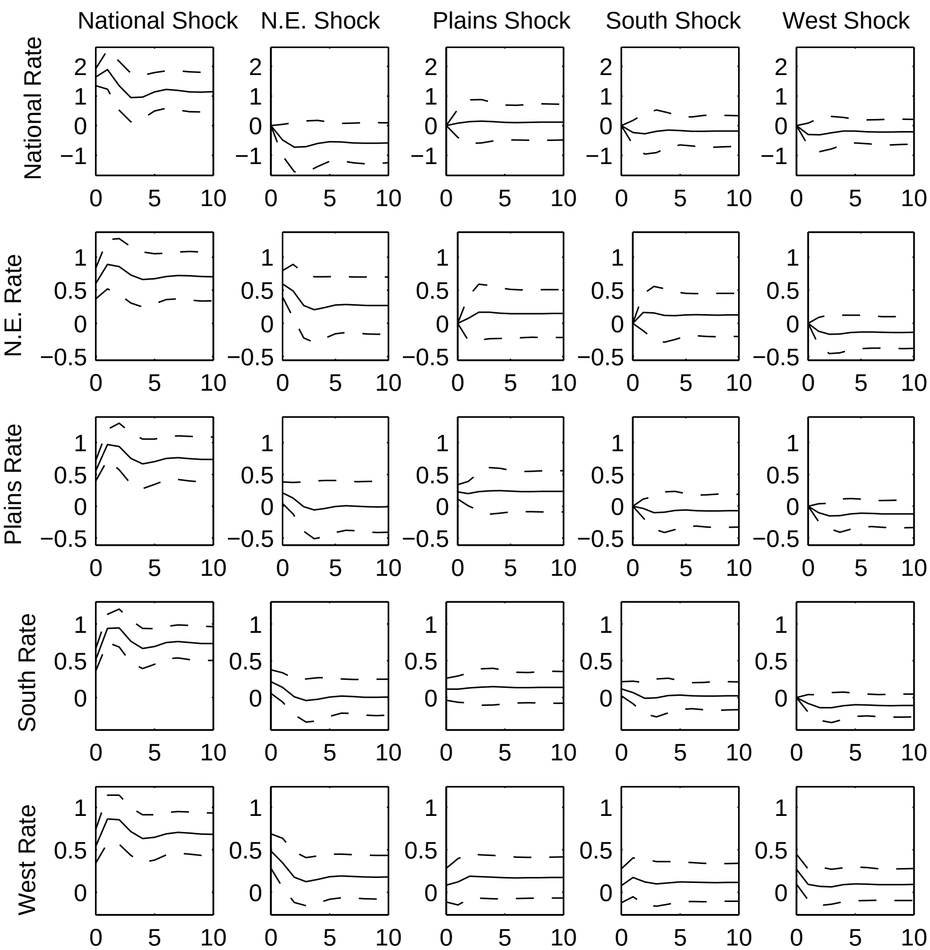

Fig. 5. Forecast Error Variance Decomposition: National Rate

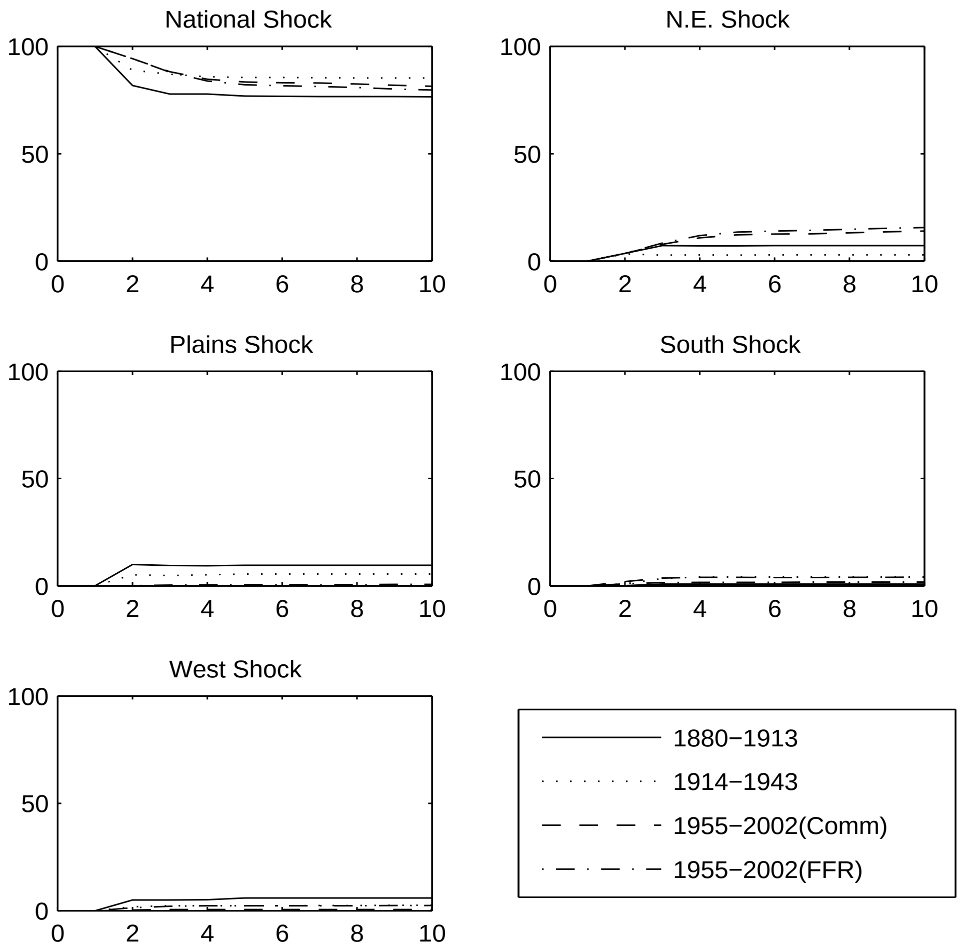

Fig. 6. Forecast Error Variance Decomposition: Northeast Rate

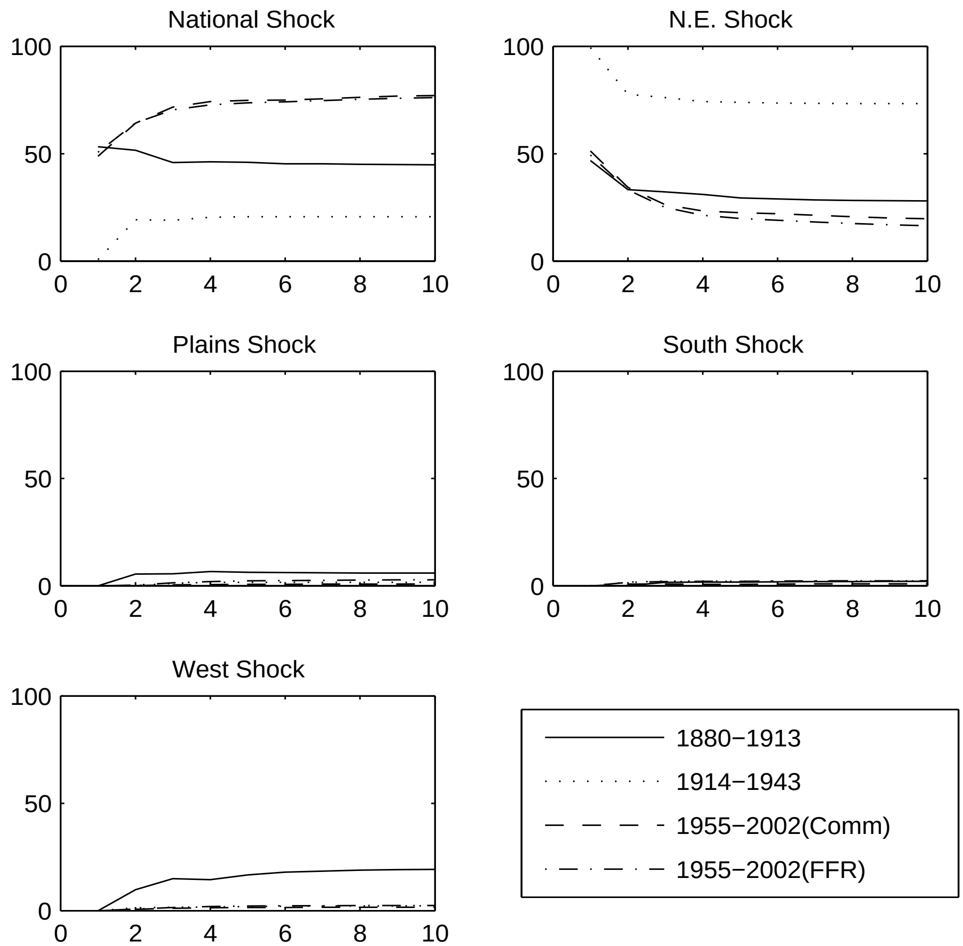

Fig. 7. Forecast Error Variance Decomposition: Plains Rate

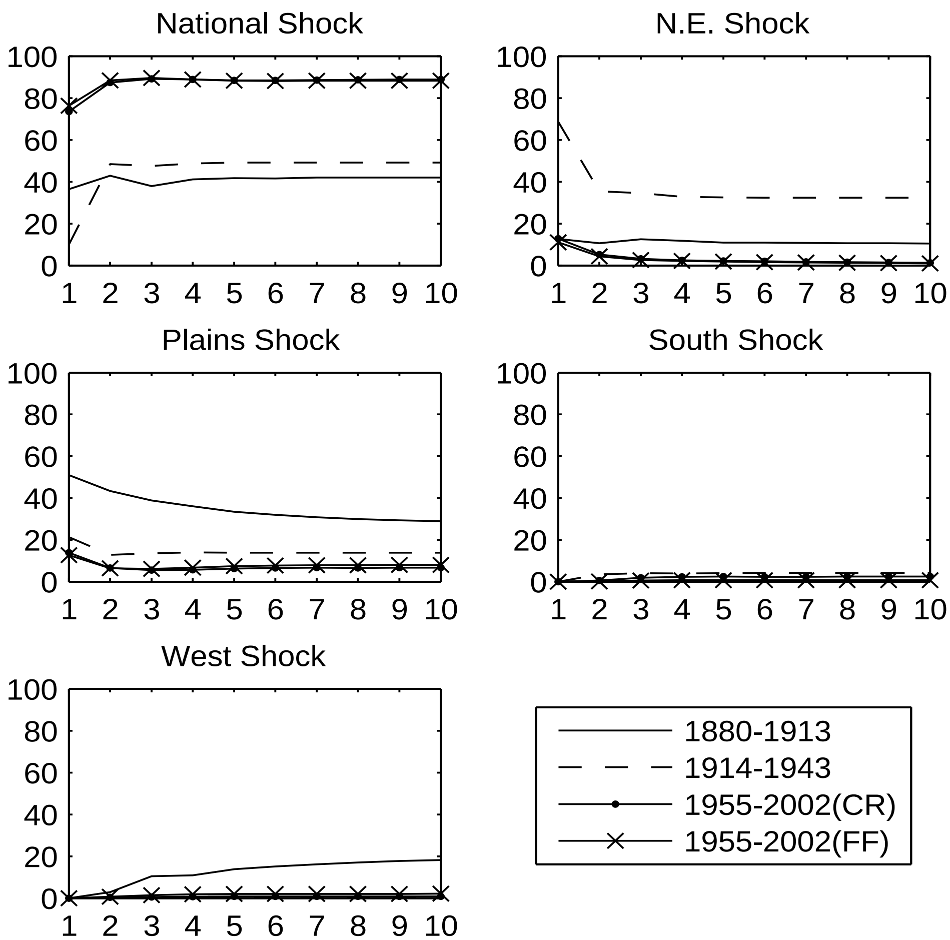

Fig. 8. Forecast Error Variance Decomposition: South Rate

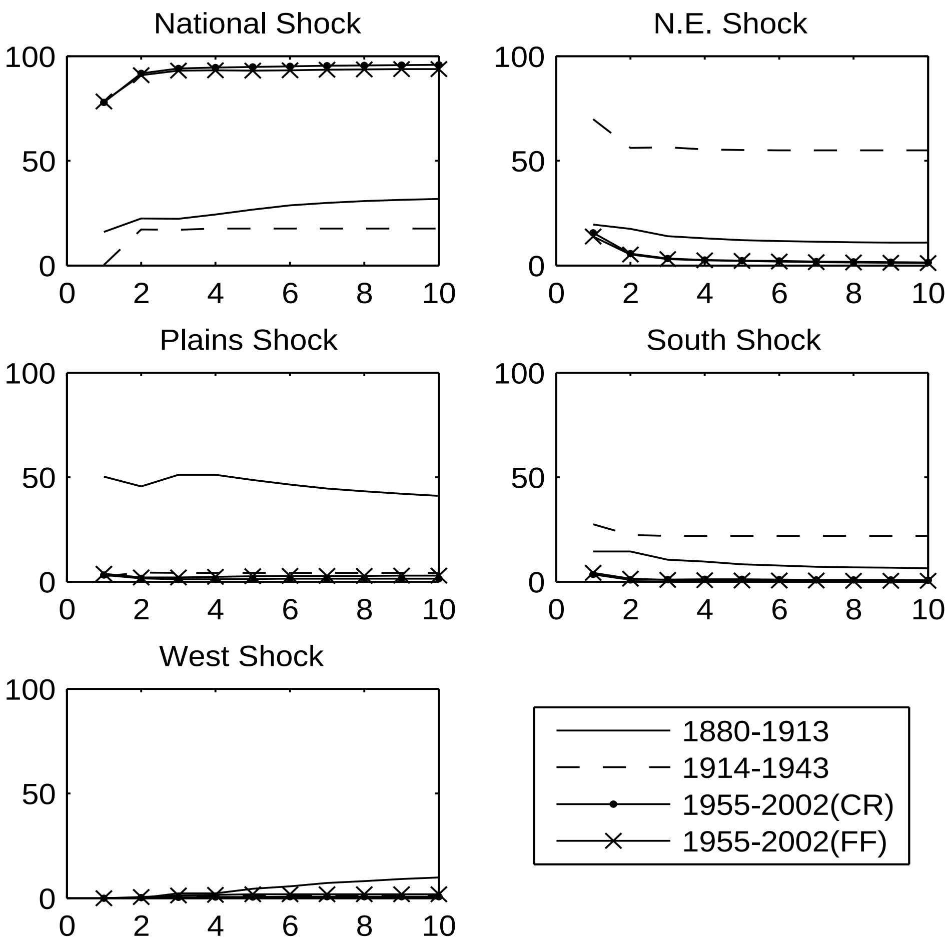

Fig. 9. Forecast Error Variance Decomposition: West Rate

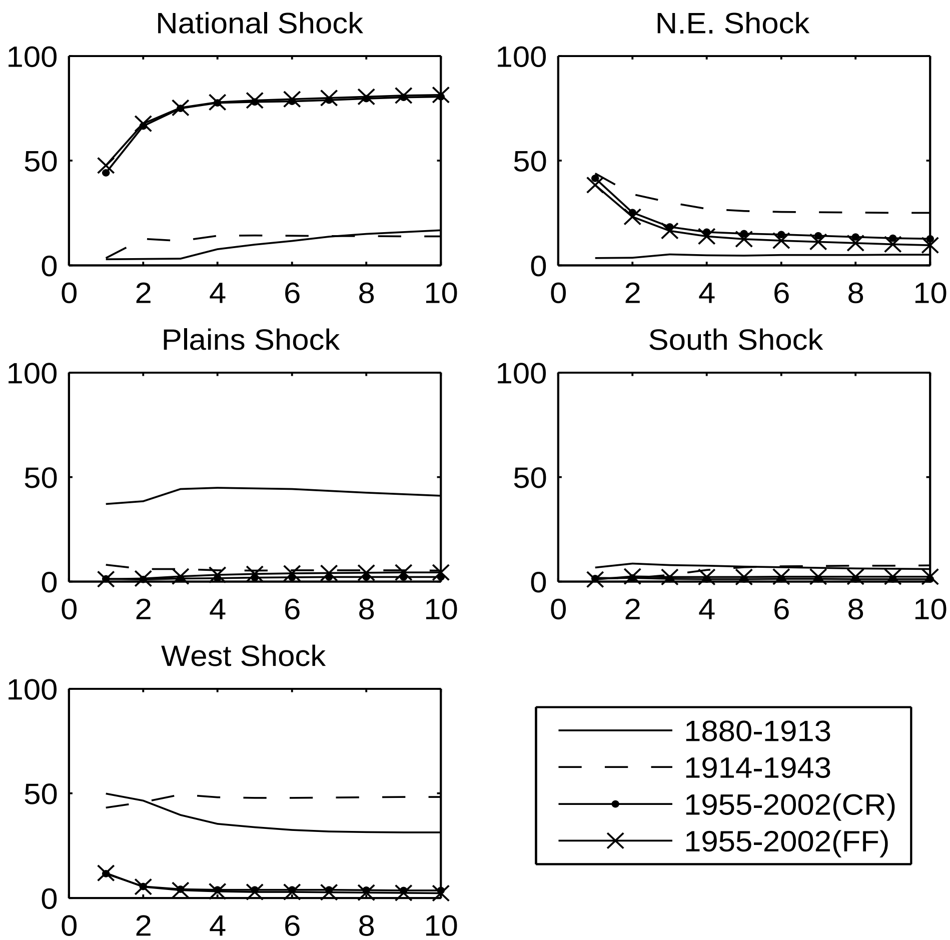

Table 10: Regional Bank Lending Rates, 1880-2002

Year	Northeast	Plains	South	West
1880	6.41	9.35	8.30	9.89
1881	6.30	9.24	9.32	11.12
1882	6.12	9.26	8.03	8.46
1883	6.13	8.96	7.83	8.26
1884	5.94	10.43	8.63	9.95
1885	5.72	9.41	7.73	10.11
1886	5.75	9.25	8.22	7.95
1887	6.51	9.30	7.89	7.58
1888	6.21	9.71	8.01	9.57
1889	5.83	9.24	7.76	9.01
1890	6.48	8.04	7.38	8.89
1891	6.19	8.97	8.26	9.84
1892	5.41	8.42	7.61	9.24
1893	6.54	10.94	9.08	11.42
1894	5.37	8.88	7.96	9.44
1895	5.12	8.24	8.24	9.48
1896	6.00	9.38	8.25	12.13
1897	5.20	8.24	8.10	8.85
1898	4.90	8.11	7.87	9.94
1899	4.60	7.38	7.43	9.76
1900	5.68	7.83	7.50	8.77
1901	4.76	6.20	6.55	7.17
1902	5.31	7.12	6.60	7.22
1903	5.30	7.06	6.35	6.64
1904	5.19	6.91	6.40	7.11
1905	4.50	6.71	6.28	6.49

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Year	Northeast	Plains	South	West
1906	4.87	6.51	6.16	5.53
1907	6.80	8.42	7.56	7.76
1908	5.58	7.12	6.69	5.81
1909	5.03	6.75	6.61	6.73
1910	5.80	7.52	6.70	6.08
1911	5.79	7.72	7.20	7.16
1912	5.73	7.81	6.96	6.88
1913	6.25	8.88	7.25	7.46
1914	6.12	8.46	7.38	7.67
1915	5.76	8.37	7.54	7.62
1916	6.23	7.88	7.23	7.43
1917	5.69	7.52	7.19	6.45
1918	6.01	7.81	6.87	6.70
1919	6.29	7.72	7.01	7.31
1920	6.38	7.35	7.40	6.74
1921	7.46	9.83	8.09	8.60
1922	6.27	7.93	7.19	7.17
1923	5.64	7.19	6.40	6.34
1924	5.69	7.57	6.67	7.09
1925	5.19	6.75	5.82	6.19
1926	5.56	7.06	6.77	6.86
1927	5.17	6.72	6.30	5.17
1928	4.93	6.17	6.32	6.76
1929	5.99	7.11	6.64	5.41
1930	5.61	7.50	6.91	6.52
1931	5.38	7.09	6.64	6.36
1932	5.78	7.36	6.66	6.46
1933	5.63	7.23	6.37	6.54

Continued on next page

Year	Northeast	Plains	South	West
1934	4.92	6.51	5.92	5.75
1935	4.49	5.46	5.39	5.12
1936	3.94	5.53	5.33	4.93
1937	3.63	5.18	4.88	4.75
1938	4.09	5.49	4.92	5.07
1939	3.90	5.05	4.76	5.22
1940	3.73	4.97	4.83	5.11
1941	3.45	4.48	4.65	4.86
1942	1.37	2.80	2.64	3.80
1943	1.21	2.50	2.17	3.27
1944	2.94	3.58	3.57	4.18
1945	2.54	3.19	2.88	3.69
1946	2.68	3.41	3.25	3.39
1947	2.95	3.74	3.71	3.96
1948	3.42	4.02	4.12	4.39
1949	3.70	4.22	4.42	4.88
1950	3.39	4.08	4.25	4.56
1951	3.74	4.50	4.70	4.69
1952	3.95	4.67	4.78	4.83
1953	4.30	4.82	4.95	5.46
1954	4.30	4.62	4.87	5.28
1955	4.34	4.65	4.95	4.92
1956	4.64	5.10	5.22	5.15
1957	5.13	5.32	5.61	5.52
1958	5.09	5.22	5.55	5.66
1959	5.16	5.55	5.71	5.71
1960	5.57	5.79	6.06	6.34
1961	5.46	5.69	5.98	6.22

Continued on next page

Year	Northeast	Plains	South	West
1962	5.46	5.75	6.00	6.08
1963	5.59	5.97	6.10	6.20
1964	5.69	6.11	6.27	6.44
1965	5.86	6.22	6.38	6.57
1966	5.93	6.31	6.45	6.62
1967	6.06	6.46	6.65	6.73
1968	6.42	6.73	6.89	6.92
1969	7.22	7.40	7.61	7.87
1970	7.72	7.83	8.12	8.27
1971	6.94	7.40	7.59	7.40
1972	6.40	7.12	7.24	6.91
1973	7.72	7.97	8.04	7.94
1974	9.41	9.30	9.58	9.93
1975	8.68	8.75	9.14	9.08
1976	10.50	8.68	9.07	10.79
1977	10.65	8.69	8.94	10.69
1978	9.06	9.30	9.54	9.54
1979	11.00	10.91	11.02	11.26
1980	12.75	12.78	12.47	12.94
1981	14.81	14.82	14.41	14.77
1982	13.83	14.27	14.13	13.97
1983	11.68	11.84	12.07	12.08
1984	12.25	12.37	12.06	12.58
1985	11.26	11.71	11.38	11.69
1986	9.82	10.69	10.35	10.68
1987	10.12	10.12	9.90	10.54
1988	10.96	10.27	10.25	10.50
1989	12.36	11.25	11.15	11.48

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Year	Northeast	Plains	South	West
1990	12.16	11.01	11.06	11.08
1991	10.87	10.38	10.34	10.80
1992	9.69	8.63	8.94	9.23
1993	8.89	7.99	7.93	8.42
1994	8.51	7.97	7.91	8.00
1995	8.94	8.79	8.71	9.11
1996	8.59	8.92	8.59	8.82
1997	8.79	8.75	8.67	9.13
1998	8.69	8.59	8.43	8.67
1999	8.07	8.25	8.05	8.97
2000	8.74	8.79	8.68	9.45
2001	8.07	8.24	7.98	8.80
2002	6.90	7.01	6.42	6.88

Note: All interest rates are reported as percentages

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