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Regional Interest Rates within a Monetary Union: Lessons from the United States

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Abstract

This paper uses econometric and traditional historical methods to look at the United States monetary union in three distinct phases of its history: the period from 1880 to 1913 when the United States had a currency union, but no central bank; the period from 1914 to 1943 when the newly created Federal Reserve had to meet a number of unexpected and difficult challenges; and the postwar era during which the Federal Funds rate emerged as a dominant monetary instrument. A vector autoregression on regional interest rates is used to identify structural shocks. Symmetric and asymmetric shocks are distinguished depending on whether shocks hit all regions in the same way or different regions in different ways. Examples of both symmetric and asymmetric shocks are found throughout the period we examine. However, the incidence of asymmetric shocks on the periphery diminished over time. We discuss how the United States has coped with the problem of asymmetric shocks, and find examples where alternative instruments were created to deal with asymmetric shocks and examples where the problem was allowed to burn out without intervention. We also discuss the reforms of the banking system that appear to us to have contributed to the decline in the importance of asymmetric shocks on the periphery.

1. Symmetric and Asymmetric Shocks

This paper uses econometric and traditional historical methods to look at the United States monetary union in three distinct phases of its history: the period from 1880 to 1913 when the United States had a currency union, but no central bank; the period from 1914 to 1943 when the newly created Federal Reserve had to meet a number of unexpected and difficult challenges; and the postwar era during which the Federal Funds rate emerged as a dominant monetary instrument. At least since Mundell (1961) economists have recognized that monetary policy will normally be easier to formulate for a monetary union when all regions are experiencing the same kind of shock than when different regions are experiencing different kinds of shocks. If all regions, for example, are experiencing a housing boom that the monetary authority regards as dangerous then the monetary authority may well choose a contractionary policy to combat the boom. On the other hand, if one region is experiencing a housing boom, while another is in the midst of a contraction, the problem becomes more difficult to solve. Many monetary economists, of course, would recommend that the monetary authority ignore short-term shocks and instead focus on maintaining long-run price stability. Clearly, however, dealing with a situation in which all regions are experiencing the same type of housing boom, the case we refer to as a symmetric shock, will be easier than dealing with a situation in which one region is experiencing a housing boom while other regions are not, the situation we refer to as an asymmetric shock. Here we will explore U.S. monetary history to see whether in fact asymmetric shocks have been a problem, whether the problem of asymmetric shocks has grown or diminished over time, and how the United States has coped with the problem of asymmetric shocks.

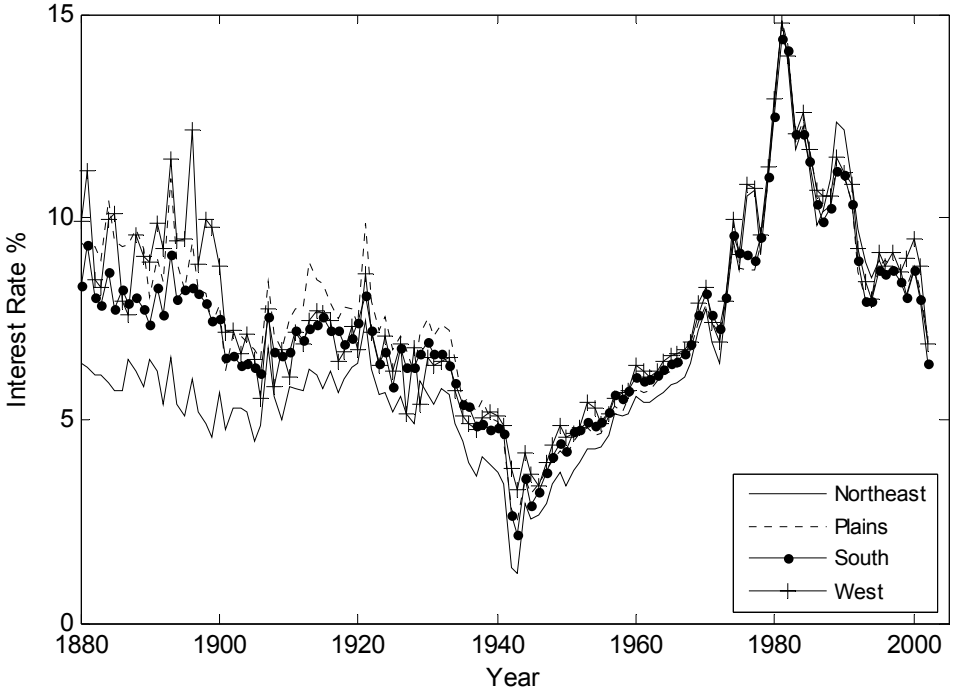
We will try to identify regional shocks by looking at regional bank lending rates. These are the right rates to use because they reflect the actual conditions facing borrowers and lenders in each region of the United States. We will work with four regions: the Northeast, the Plains, the South and the West.[1] Figure 1 shows our basic bank lending rates in our four regions for the period 1880-2002. As you can see there are a number of occasions in which rates diverge, presumably due to underlying shifts in the supply of or demand for bank loans. There is a clear tendency over the long run for the rates to converge, but even in recent decades when the regional bank lending rates move closely together there are periods of a year or more when the rates diverge.

To identify the locus of the shocks hitting the U.S. economy we estimate a VAR model, described in the next section. In subsequent sections we compare the pattern of shocks uncovered by our econometric model with the shocks identified in traditional narrative histories of the American monetary system. For the most part our two sources reinforce each other: When our econometric model identifies a major shock we usually find a convincing story in the traditional literature, and vice versa. In a few cases our econometric results identify regional shocks that have not received much attention in the traditional literature, and suggest the need for further research.

In each case separately our attributions of particular interest rate shocks to particular events have to be considered tentative conjectures. It would take a great deal of digging to trace out the links that we hypothesize between, say, regional banking panics

[1]The Northeast includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Pennsylvania, Maryland, Ohio, Indiana, Illinois, Michigan, and Wisconsin. The South includes Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Kentucky, and Arkansas. The Plains includes Minnesota, Iowa, Missouri, Oklahoma, Texas, Kansas, Nebraska, North Dakota, New Mexico, Montana, Wyoming, and Colorado. The West includes Arizona, Idaho, Utah, Nevada, California, Oregon, and Washington.

Figure 1: Regional Interest Rates (1880-2002)



and regional bank lending rates. The cases do, however, add up and suggest that our identification of shocks makes sense.

In the end, it is clear that the U.S. economy was struck repeatedly by both symmetric shocks – shocks hitting the core and the periphery – and by asymmetric shocks – shocks hitting only the core or the periphery, or opposed shocks hitting the core and the periphery. It is the latter pattern that creates the most difficult problem for an activist monetary policy agenda. It also appears that the problem of asymmetric shocks diminished in the postwar era.

2. The Econometric Exercise

To identify shocks more precisely, we estimated a VAR system that included a national interest rate (the commercial paper rate or the Federal Funds rate) and the bank lending rates in our four regions. We then used the VAR system to estimate the independent shocks hitting each region. In this section we provide an overview of our approach; in the following sections, which look in detail at sub-periods, we provide additional information about our methods and estimates.

We started with a simple model of the national and regional rates:

$$(1) \qquad A_0 y_t = \mu + \sum_{j=1}^{p} A_j y_{t-j} + u_t$$

where y is a vector of interest rates and where $u_t \sim N(0, I)$. This system is assumed to be "structural" in the sense that the shocks to each equation are mutually independent of each other and have some economic "meaning." The problem with this model is that we cannot estimate this system using OLS because each equation contains (depending on the exact makeup of A_0) endogenous variables.

We can , however, estimate the reduced form version of this model, which is

$$(2) \qquad y_t = c + \sum_{j=1}^{p} B_j y_{t-j} + \varepsilon_t$$

where $\varepsilon_t \sim N(0, \Sigma)$. The relationship between the reduced form and the structural form is

$$
\begin{aligned}
& c = A_0^{-1}\mu \\
& B_j = A_0^{-1}A_j,\ j = 1,\ldots p, \\
& \Sigma = A_0^{-1}A_0^{-1\prime} \\
& \varepsilon_t = A_0^{-1}u_t \\
& or \\
& u_t = A_0\varepsilon_t
\end{aligned}
\tag{3}
$$

The reduced form can be estimated consistently with equation-by-equation OLS. The problem, as usual, is going from the reduced form to the structural form. To identify the structural model, and hence identify orthogonal structural errors we assume that A_0 is lower triangular, a common solution to the problem. This allows us to uniquely identify A_0 by noting that the variance-covariance matrix of the reduced form residuals (Σ) is the product of a lower triangular matrix and its transpose. This is the Cholesky decomposition. So we now have an estimate of A_0 which means we can uniquely identify the parameters that make up the structural VAR.

Thus to compute estimates of the structural residuals (shocks) we use

$$u_t = A_0\varepsilon_t = P^{-1}\varepsilon_t \tag{4}$$

where P is the Cholesky factor (lower triangular) of Σ. The structural shocks that we identify have the following interpretation: The first shock is a shock to the national interest rate (commercial paper rate or Federal Funds Rate). The next shock is a shock to the Northeast regional rate that is orthogonal to the shock identified that impacts the national rate. The third shock is a shock that impacts the Plains regional bank rate that is orthogonal to both the national shock and the Northeast regional shock. The fourth shock is a shock that impacts the South regional bank rate that is orthogonal to the national, Northeast and Plains shocks while the last shock is a shock that impacts the West that is

orthogonal to all the other structural shocks. Such an identification is convenient in that the peripheral shocks are orthogonal to the national or core shocks which implies that large shocks that are identified in the periphery are not caused by crises emanating from the core.

This type of identification is sensitive to the ordering of our variables. The ordering we used was to order the core interest rates first (the national rate followed by the Northeast regional rate) followed then by the rates from the periphery. The ordering of the periphery is not so clear cut but we chose to order the Plains first, the South second and the West last. This ordering is a natural ordering for the early part of out sample but may not be the natural ordering later in the sample. We tested the sensitivity of our results by changing the ordering of the peripheral rates and found that our conclusions were not sensitive to how we ordered the peripheral rates.

The structural shocks that were identified were constructed to have unit variance. This is not the only approach we could have taken but normalizing the shocks to have unit variance is useful in determining which shocks were large. Clearly shocks bigger in magnitude than two are large shocks in a probabilistic sense (under the assumption of Normal errors). Under this normalization scheme we are therefore able to identify shocks to the core and peripheral bank rates as well as their relative magnitudes.

Before discussing the structural shocks that we identified using our procedure we first describe the models that we estimate and the general result we obtain. We found it useful to divide the long period shown in Figure 1 into three sub-periods, 1880-1913, 1914-1943, and 1955 to 2002. These three periods neatly breaks the sample period into a period where the United States did not have a central monetary authority but was on the

gold standard (1880-1913), a period where the United States had just obtained a central monetary authority (1914-1943), and a period where the central monetary authority had been in existence for a long time (1955-2002).

The VAR model described in (2) can only be estimated consistently by ordinary least squares (OLS) if all the variables in the model are stationary. If the regional interest rate series are all stationary then we estimate (2) and use the identification restrictions described in (3) to identify the structural coefficients in (1). If the time series are non-stationary then we test for cointegration to decide whether to estimate (2) in A) first differences, in the case that there is no cointegration or B) as a vector error correction model, in the case where the time series are cointegrated.

Given the small sample size a battery of unit root tests were used. 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) (Elliot 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.

The results for these tests are reported in Table 1. In the first period (1880-1913) we find that there is little evidence that the time series contain a unit root. However for the subsequent two periods we find evidence that all time series contain unit roots. Given these results we proceed to test for cointegration using the method of Johansen (1988, 1992) with sample size corrected test statistic suggested by MacKinnon et al. (1999).

These results (p-values) are also reported in Table 1 and they suggest that there is no evidence of cointegration in the second sub-period (1914-1943) but there is evidence of one cointegrating relationship in the last sub-period (1955-2002). With these tests in mind we estimated a VAR in levels for the first subperiod, a VAR in first differences for the second sub-period, and a Vector Error Correction model for the last sub-period (1955-2002).

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 VAR in levels 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 $B_2 = 0$ 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

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 (Commercial)	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.

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.[2]

We estimated each model and then used the estimates and the identification conditions described above to compute structural impulse response functions and variance decompositions. We do not report the individual estimation results here, for the sake of brevity, but these can be obtained from Landon-Lane and Rockoff (2006). We are

[2]The main results of this paper are 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.

more interested in the impulse response functions, the variance decompositions and the structural shocks as we think these are more natural objects to look at when considering the ability of the central monetary authority to pursue monetary policy over the time of the sample.

The impulse response functions are reported in Figures 6 – 9 in the appendix. 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 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. We also see that shocks to the periphery had some effect to other peripheral regions in the first two subperiods.

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.

Table 2 reports the variance decomposition results for the three sub-periods. We see that there has been an increase over time of the dominance of the national shock. In the first sub-period the national shock did not have a great impact on some of the peripheral rates. This is particularly evident when we look at the effect of the national shock on the West bank rate. Here we see that the national shock only accounted for 10 percent of the forecast error variance in the first period. In contrast the largest contributor to the forecast error variance in this period was the shock to the Plains and the West itself. This shows how the peripheral shocks were important in the early period. The Plains shock had considerable effect on the South and Plains as well. By the second sub-period (1914-1943) the national shock is starting to have a bigger effect on the periphery. Add the national shock to the Northeast shock we see that it contributes a large proportion of the forecast error variance for the peripheral shocks. However the "own" shocks still appear to have a large impact on their own time series. By that we mean the plains shock is impacting the Plains rate substantially, the South shock is impacting the South rate, and the West shock is impacting the West rate substantially in this second sub-period (1914-1943). It is only in the last sub-period (1955-2002) that we see that the national shock is clearly dominating all regional rates. The core shocks are clearly accounting for over 90 percent of all forecast error variance in this last period.

What these results show is that over time the central monetary authority gained strong control over the regional rates in the periphery but that this did not happen

Table 2: Variance Decomposition

		1880-1913 Shock to					1914-1943 Shock to				
	Period	Comm.	NE	Plains	South	West	Comm.	NE	Plains	South	West
	1	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
	2	81.68	3.53	9.84	0.00	4.94	88.79	3.22	5.12	0.98	1.89
Comm.	5	76.81	7.07	9.49	0.73	5.90	85.09	2.73	5.37	4.57	2.24
	1	53.26	46.74	0.00	0.00	0.00	0.64	99.36	0.00	0.00	0.00
	2	51.58	33.21	5.46	0.02	9.73	19.30	77.42	0.07	1.83	1.38
NE	5	45.96	29.36	6.28	1.75	16.65	20.28	74.15	1.30	2.41	1.86
	1	36.39	12.69	50.91	0.00	0.00	10.19	68.39	21.43	0.00	0.00
	2	42.84	10.55	43.37	0.38	2.87	47.90	35.18	13.19	3.69	0.05
Plains	5	41.62	10.94	33.37	0.32	13.75	48.34	32.56	13.90	4.51	0.70
	1	16.06	19.44	50.17	14.33	0.00	0.15	69.07	2.07	28.71	0.00
	2	22.43	17.52	45.61	14.38	0.06	17.39	55.50	3.61	23.39	0.10
South	5	26.60	12.01	48.61	8.30	4.48	17.79	54.52	3.49	23.04	1.15
	1	2.90	3.50	37.06	6.63	49.92	3.37	43.58	7.51	2.12	43.42
	2	2.99	3.52	38.41	8.58	46.49	12.63	33.72	5.46	2.13	46.06
West	5	9.90	4.63	44.48	7.14	33.85	14.66	24.99	5.11	8.45	46.80

		1955-2002 (Commercial) Shock to					1955-2002 (Fed Funds) Shock to				
		Comm.	NE	Plains	South	West	Fed Funds	NE	Plains	South	West
Comm.	1	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
/ FF	2	94.10	3.54	0.00	1.80	0.56	94.18	3.56	0.10	0.83	1.33
	5	83.13	12.34	0.02	3.38	1.12	82.09	13.50	0.54	1.58	2.29
	1	47.89	52.11	0.00	0.00	0.00	50.61	49.39	0.00	0.00	0.00
	2	64.12	34.45	0.04	0.80	0.59	64.29	33.08	0.32	1.54	0.77
NE	5	74.59	22.31	0.51	0.79	1.80	73.66	19.83	2.26	2.09	2.17
	1	73.34	12.89	13.78	0.00	0.00	76.34	10.99	12.67	0.00	0.00
	2	87.47	5.18	6.39	0.51	0.45	88.46	4.33	6.43	0.08	0.70
Plains	5	88.61	2.16	5.91	2.14	1.18	88.19	1.84	7.34	0.69	1.93
	1	77.78	15.46	3.21	3.55	0.00	78.36	13.85	3.69	4.10	0.00
	2	91.68	5.70	1.42	0.93	0.27	90.88	5.15	1.99	1.45	0.52
South	5	94.73	2.30	1.17	0.89	0.90	93.08	2.05	2.54	0.58	1.75
	1	42.01	43.34	1.22	1.09	12.35	47.65	38.30	1.14	0.95	11.96
	2	65.46	26.11	0.99	1.42	6.01	67.61	23.21	1.45	2.37	5.36
West	5	77.61	15.86	1.65	0.88	4.01	78.77	12.54	3.63	2.14	2.92

Note: Each column in the table refers to the proportion of the forecast error of the model that is attributable to that shock. For example, if we look at the first sub-period, then 91.3% of the error in forecasting the national interest rate (in this case the commercial paper rate) is attributed to the shock hitting the national interest rate.

overnight. What these results do not tell us, however, is the nature of the shocks that hit the core and the periphery during these periods and how these shocks affected the rates individually. To do this we look more closely at the identified structural shocks for each

region and for each sub-period and use history to bring these shocks into focus. However, it should be noted that each regional shock is normalized to have unit variance, which is very useful for determining which shocks were large but it should be remembered from the variance decompositions that the impact of the peripheral shocks on the actual regional interest rates have substantially diminished over time.

3. Before the Federal Reserve: 1880-1913

The Civil War (1861-1865) divided the United States into three distinct currency areas. The Eastern part of the loyal states left the gold standard and adopted the Greenback, a fiat paper money, as its monetary base. The South also left the gold standard, and adopted the Confederate dollar, a fiat paper money, as its monetary base. The Pacific Coast of the United States, however, remained on the gold standard: Gold coins continued to circulate from hand to hand. In the East gold dollars were foreign exchange and sold at a premium in terms of the greenback dollar. In the West greenbacks were foreign exchange and traded at a discount (equal but opposite to the eastern premium) in terms of the gold dollar. (Greenfield and Rockoff 1996) The United States even created a dual system of banks. National banks intended for the East were allowed to issue bank notes and deposits convertible into greenbacks. National Gold banks, however, intended for the West Coast, issued bank notes and deposits convertible into gold. This anomalous state of affairs – one country, two currencies – continued until the United States returned to the gold standard in 1879.

Thus our first sub-period (1880-1913) marks a distinct period in terms of institutional history of the United States: there was a monetary union based on gold, but

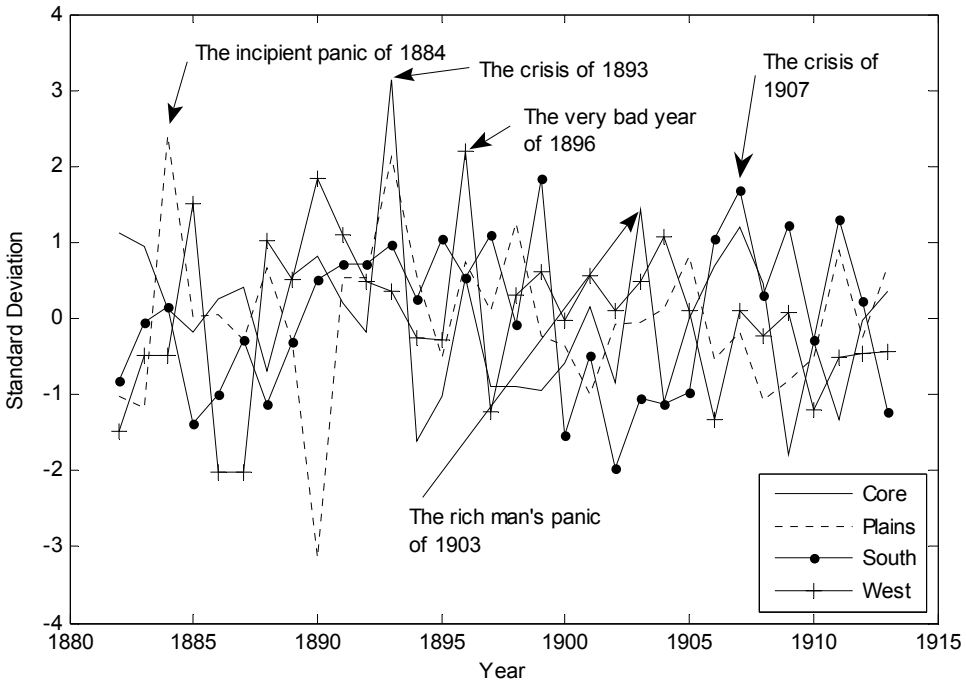
no central monetary authority. Figure 2 plots the structural shocks to the commercial paper rate (the national shock) and to the periphery (an average of the shocks in the Plains, the South and the West). A number of crises that have been pointed out by historians relying on traditional narrative methods also show up in our estimates of structural shocks.

(1) The incipient panic of May 1884 is usually viewed as a New York centered event. The liquidation of securities by foreign holders alarmed by railroad failures and the Bland Allison silver purchase Act, it is said, led to large declines in share prices and loss of gold from bank reserves. The failure of a major brokerage house, Grant and Ward, on May 8 led to the failure of several banks and to what Elmus Wicker (2000) has referred to as an *incipient* panic. The prompt issue of clearing house loan certificates (a form of emergency currency issued by the private clearing house association) quickly brought the banking panic to an end. Oddly enough this event shows up in our estimates as an asymmetric shock, but the region affected is on the periphery. The region affected according to our estimates was the Plains. We do not yet have a good explanation of the origins of this shock to the banking system of the Plains states or the relationship between this shock and the incipient panic.

(2) The severe Crisis of 1893 clearly stands out in our estimates as a major crisis resulting from symmetric shocks to the core and periphery. It makes sense, of course, that severe crises would be the result of multiple symmetric shocks.

In this case the multiple origins of the crisis have long been recognized by economic historians. Friedman and Schwartz (1963, 108-109) and subsequent writers provide an account of the Crisis of 1893 based on two negative shocks. First, there were fears about

Figure 2: Shocks to Regional and National Interest Rates (1882-1913)



the willingness of the United States to maintain the gold standard based on the popularity of the free silver movement in the Midwest that was strong enough to produce legislation monetizing some silver. This fear produced an outflow of gold from the United States financed in part by the liquidation of foreign owned stocks. The failure of a stock market favorite in May 1893 touched off a stock market crash, and soon triggered a banking crisis. The banking crisis was also produced by a wave of bank failures in the South and West where silver was popular and fears about maintenance of the gold standard may not have been the crucial issue. These failures resulted from fears about the solvency of the banks produced by deflation, especially in agricultural prices. Friedman and Schwartz (1963, 108, ftn. 109) summarized the origins of the crisis of 1893 this way.

> "In short, two sets of forces were responsible for the two different drains: distrust of the Treasury's ability to maintain silver at parity with gold caused the external drain; distrust of the solvency of banks, particularly western institutions, caused the internal drain."

(3) The year 1896 also shows up in Figure 2 as a twin-shock crisis, with shocks hitting both the core and peripheral regions. However, 1896 is not included in the standard list of nineteenth-century crises.[3] The reason is that there was no banking crisis, in the sense that the banks suspended the convertibility of bank notes or deposits into gold, as happened in the standard "crisis" years. However, 1896 was a very bad year for the U.S. economy. After recovering incompletely from the previous recession, the economy reached a peak in December of 1895, according to the NBER chronology, and then entered a slide that lasted until June of 1897.[4] The rate of unemployment was high, and the Populist movement, which advocated radical economic reform, was at its zenith.

(4) The stock market slide of 1903, sometimes referred to as the "trust panic" or the "rich man's panic" shows up on our chart as an asymmetric shock. The core was affected, but not the periphery.[5] This is the sort of event that often raises questions for monetary policy. Should the monetary authority respond to a slide in asset prices, when a general monetary instrument, say by lowering a target short-term interest rate, when the rest of the economy has not be affected?

(5) The severe crisis of 1907, which led to the appointment of the National Monetary Commission and to the establishment of the Federal Reserve System, however,

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[3] The classic description of the monetary crises before the Federal Reserve is O.M.W. Sprague's *History of Crises Under the National Banking System* (1910), which was one of the monographs written for the National Monetary Commission. Sprague identifies four crises between the re-establishment of the gold standard in 1879 and the end of his period, 1910: (1) "the panic of May 1884;" (2) the "financial stringency in 1890;" (3) the "crisis of 1893;" and (4) the "crisis of 1907."

[4] http://www.nber.org/cycles.html/

[5] The term "rich man's panic" later was also applied to the stock market crash in 1907.

was produced by symmetric shocks. Traditionally, financial and monetary historians discussed only one shock arising in New York, but our results suggest that there were also shocks on the periphery. New York had seen a rapid growth of Trust companies, financial institutions that operated as banks but were not subject to the strict regulations that applied to institutions with traditional state or national bank charters, and which were not members of the New York Clearinghouse, the only institution capable of issuing emergency currency. The issue of Clearinghouse loan certificates met the failure of several large commercial banks in the fall of 1907. The failure of the Knickerbocker Trust Company, however, was not met in this way and it sparked a run on the Trust Companies and eventually on the banking system as a whole, despite efforts to stem the panic by J.P. Morgan and the Federal Treasury. Speculative activities by the Trust companies, including an attempt to corner the copper market, are often seen as the root of the crisis.

We had expected to find that a large peripheral shock hitting the West because recent research by Odell and Weidenmier (2006) attributes an important role to the San Francisco earthquake of 1906. Our rate for the West, however, does not show a large surge in 1907. There was a negative shock in the West in 1906, perhaps associated with a decline in economic activity produced by the earthquake, but not the surge in rates associated with rebuilding that we had expected to see.

Odell and Weidenmier (2006), however, see the earthquake working in a roundabout way. The fire in San Francisco that followed the earthquake destroyed much of San Francisco (assets equivalent to about 1 percent of U.S. GDP) and forced British insurers to pay out large amounts of gold. This created a drain on British banks that

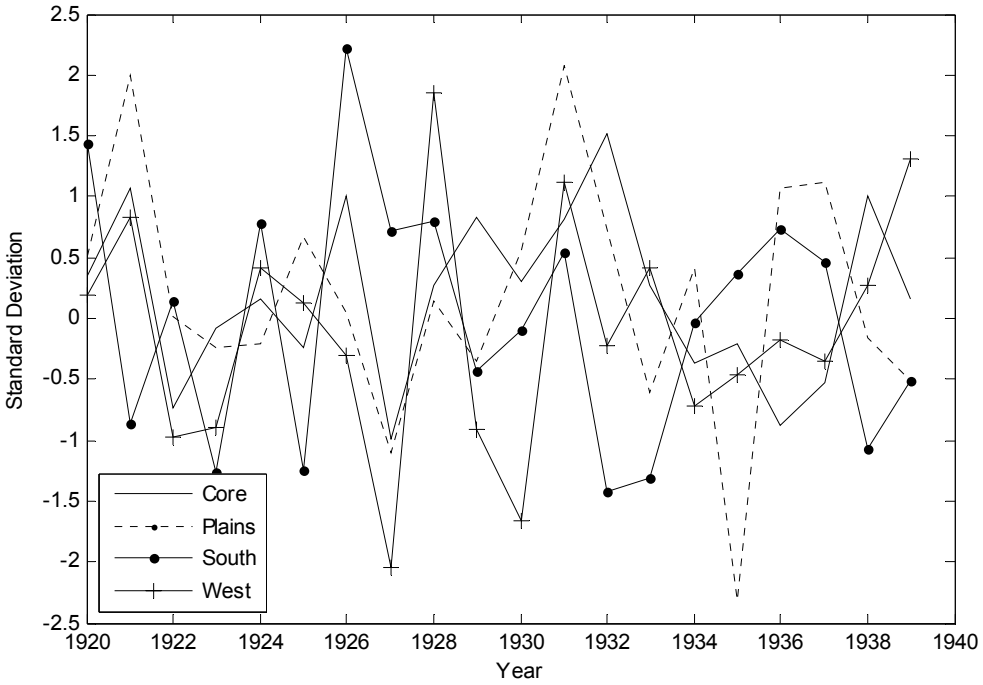
induced the Bank of England to raise its discount rate. The increase in the Bank of England's discount rate in turn produced an increase in rates in London and New York. The peripheral region that seems to have been hit hardest during the Crisis of 1907, by our reckoning, was the South. The traditional literature, however, as far as we are aware, has not identified a separate southern shock.

4. The Federal Reserve Comes of Age: 1914-1943

The second segment we examined was the troubled period that included World War I, the Twenties, and the Great Depression. The Federal Reserve, founded at the end of 1913, was just finding its way during this period. Figure 3 shows the shocks to bank lending rates during this period. We consider four episodes in more detail: the surge in rates in all regions, except the South, in 1921; the anomalous behavior of rates in the South in the mid-1920s; the Great Contraction in the early 1930s; and the doubling of reserve ratios in 1936-1937.

(1) The recession of 1920-1921 was deep, although brief. One factor that intensified the contraction was the decision by the Federal Reserve to raise its discount rate. The rapid inflation experienced during World War I in the United States accelerated after the Armistice, and the Federal Reserve became concerned about the rise in prices and the possible loss of its gold reserves. In late 1919 the Federal Reserve began raising its discount rate in an effort to stem the tide. The last increase, from 4.75 percent to 6 percent, took place in January and February 1920. It was the largest increase in the history of the Federal Reserve. It is not surprising, therefore, that the Northeastern bank lending rate shows strong positive shock in 1921.

Figure 3: Shocks to Regional and National Interest Rates (1920-1939)



Our econometric machinery also identifies strong positive bank lending rate shocks in the Plains and the West in 1921. This matches with the traditional narrative histories of the recession. During World War I American farmers, especially wheat farmers, had borrowed heavily to expand production. After the war, as European producers came back into full production, agricultural prices fell, and economic and financial distress rose in American agricultural regions. Livestock producers apparently had a particularly difficult time repaying loans.[6] (Meltzer 2003, 114-117). One result of the crisis was that a World War I agency, the War Finance Corporation, was pressed into service to make loans to individuals and financial institutions in agriculture. This was, according to Gerald Nash (1959), an important precedent for the Reconstruction Finance Corporation and more

[6] Most agricultural prices seem to have tumbled in 1921. The price of Wheat fell 62 percent between 1920 and 1921; the price of cotton fell 81 percent; and the price of hogs fell 53 percent; while consumer prices were falling about 11 percent. Cotton, however, seems to have bounced back a bit. By 1923 only the price of cotton had drawn even in real terms with the 1920 level. (U.S. Bureau of the Census 1975, series E

importantly for our purposes the agricultural initiatives of the New Deal that established a system for agricultural lending.

The United States, to put it differently, was hit by two shocks, inflation and postwar readjustment in the agricultural sector, and so required two instruments to deal with them. A policy of high interest rates that might have been appropriate to deal with the inflation problem (although it was pushed too far even for that) was clearly the wrong policy to deal with the financial distress caused by the postwar agricultural readjustments. The U.S. responded by developing a second instrument, loans to the agricultural sector by the War Finance Corporation, to deal with the second problem.

(2) The only event that we have identified that might explain the shock to Southern bank lending rates in 1926 is the Florida land boom. The boom, which took place mainly in 1924 and reached a peak in late 1925 or early 1926 was a classic case of over-the-top real estate speculation: speculators trying to sell undeveloped swampland to unwary investors. Homer Vanderblue (1927) and William Frazer and John J. Guthrie (1995) provides a excellent account of the economic dimensions of the boom. The Marx brothers catch the spirit of the boom in Coconuts (1929), their first movie. The boom was clearly a localized event, although it was sufficiently large to have an impact on the level of bank debits in the Atlanta Federal Reserve District. Matthews and Eckler (1928, 146). The collapse of the boom produced a localized banking panic and localized recession. The Federal Reserve did not respond either to the boom or the collapse with changes to its interest rate policies. In the banking crisis that followed the bursting of the land bubble the Federal Reserve did extend aid to a few southern banks, but decided that most of the banks that suspended operations were small banks that had engaged in speculative

behavior and it was just as well if they closed permanently.[7] The Florida land boom, to sum up, was an asymmetric shock on the periphery. Contractionary monetary policies sufficient to stop the boom might have played havoc with the rest of the economy. The policy then was to let the boom burn out on its own. In the late 1920s the economy of Florida looked to be totally devastated. But as Vanderblue recognized at the time, sooner or later, large-scale development would begin again.

(3) More has been written about the Great Contraction from 1929 to 1932 than any other episode in American financial history. It is therefore worth looking at this short period in some detail. In neither 1929 nor in 1930 is there any evidence of a dominating banking crisis – an increase in interest rates produced by a decline in loanable funds. The commercial paper rate and the western bank lending rates are hit by negative shocks, perhaps a decrease in the demand for loans produced by the recession that was intensified by the stock market crash of 1929. In 1930 the picture is mixed.

In 1931 we do see evidence of positive shocks to rates in all sections of the periphery. The Plains shock is about two standard deviations.[8] So in 1931 we have evidence of the banking panics reducing the supply of loanable funds and raising rates. This finding reinforces standard accounts of the banking crises of the early 1930s. The problem of banking panics began in the Plains and the West and then made its way East. In 1932 the banking system of the United States was shut down by a series of "banking holidays" in which state governors ordered the closing of the banks to protect their reserves and give panicky depositors time to calm down. New York was among the last

[7] "National Banks not Involved." *New York Times*, July 16, 1926, p. 29.

[8] To some extent the precise estimate of the shock in the Plains depends on our ordering of the regions which places the plains before the South and the West.

states to succumb to the wave of holidays. The pattern of shocks to rates that we detect – first the periphery, then the Northeast – is consistent with the story of the bank holidays.

A great deal has been written about the failure of the Federal Reserve to respond appropriately to the unfolding catastrophe. Many theories have been offered about why the Federal Reserve failed to act more aggressively from internal power struggles within the Federal Reserve, to mistakes about the appropriate indicators of monetary policy, to excessive concern about maintenance of the gold standard. Milton Friedman and Anna Schwartz have argued that policymakers could have followed the appropriate policy if they had heeded the ideas laid down in Bagehot's *Lombard Street*. Figure 3 suggests that the regional pattern of shocks may have played a role in the failure of policymakers to recognize the crisis as one requiring action by the lender of last resort. First, until 1931 there is no clear indication in our data of the increase in rates that had marked earlier crises, such as the Crisis of 1893 and the Crisis of 1907. Policymakers who were looking for the sort of panic described by Walter Bagehot in *Lombard Street* (1873), when bill brokers were scrambling for loans and willing to pay high interest rates, would not have found it. Rates were higher in 1931, but the shocks were greatest on the periphery. Again policymakers looking for a Bagehot style crisis would have been looking for a panic in New York – after all, Lombard Street is in London, and the subtitle of Bagehot's great work was *A Description of the Money Market* – but the problem was most acute on the periphery.

(4) One of the most controversial monetary actions undertaken in the 1930s was the Federal Reserve's decision in late 1936 and early 1937 to double legal reserve requirements for banks. Economic historians debate both the motives for the policy and

the consequences for the economy. The central claim is Milton Friedman and Anna Schwartz's contention that the Federal Reserve action, although undertaken mainly to prevent a future inflation, contributed to the severe recession of 1937-1938. (Friedman and Schwartz 1963, 543-45). Recently Allan Meltzer (2003, 490-534) has presented a detailed reexamination of the controversy sparked by the Friedman-and-Schwartz contention based on both the literature that developed in the intervening years and internal Federal Reserve documents. In the end Meltzer (2002, 521) agrees that the decision to double reserves did play a role, although other factors, including changes in fiscal policy, helped produce the recession.[9]

One of the reasons that policymakers at the time thought that the doubling of reserve ratios had not contributed to the recession is that short-term interest rates remained fairly stable. There were some upward movement in the commercial paper rate in 1937, but the rate remained under one percent on an annual basis. It might be of interest, therefore, to see whether our apparatus, which is designed to detect shocks to rates, reveals anything of interest. As Figure 3 shows, our apparatus does pick out 1936 and 1937 as periods with positive shocks to rates, possibly the result of changes in lending policies by banks. But as in the first recession in the 1930s, the shock seems to have occurred first on the periphery.

[9] Friedman and Schwartz (1963, 541) also used language that left roles open for other factors in the story of the recession. Their claim was that Federal Reserve action had "significantly intensified the severity of the decline and also probably caused it to occur earlier than otherwise."

5. The Postwar Era: 1955-2002

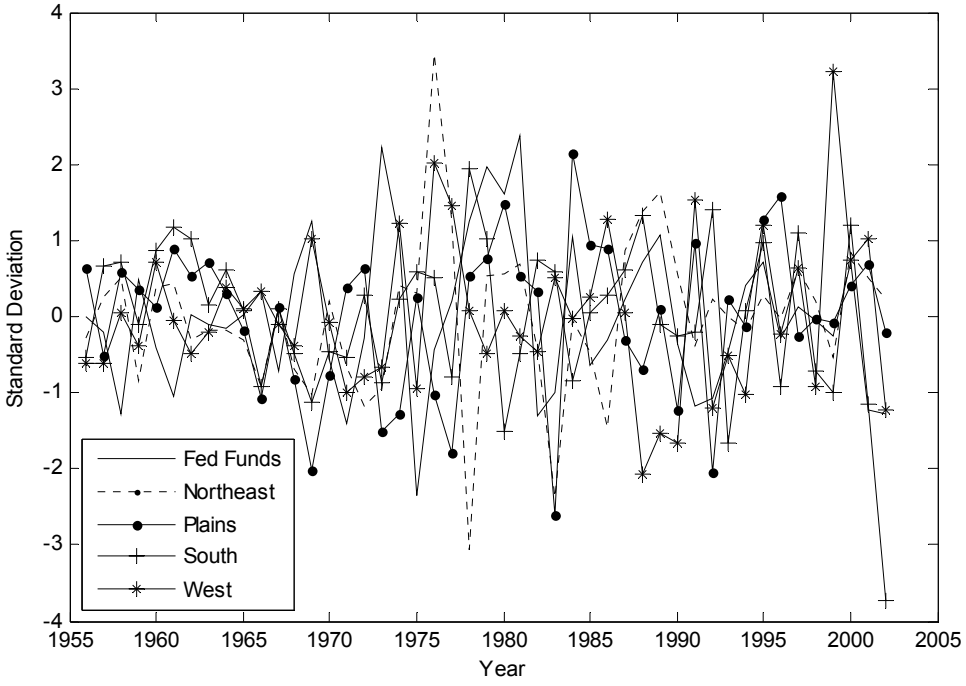
We began in 1955 because this is when our data for the Federal Funds Rate begins, and we wanted to use the Federal Funds Rate, the rate at which banks lend reserves to each other on a short-term basis, as our core rate, because it has become the standard instrument of Federal Reserve policy. We also tried the commercial paper rate as the national rate, with very similar results.

The results for this period are displayed in Figure 4. Evidently, the most important shocks during this segment were the shocks hitting the Federal Funds rate. The two largest shocks occurred in 1973 and in 1979-1981. Both resulted from attempts by the Federal Reserve to repress inflation. These episodes are well known and do not require extensive comment here. In 1974, as a result of an expansionary monetary policy and other factors such as the lifting of the Nixon Administration's wage and price controls inflation surged. The Federal Reserve Board then decided to embark on a contractionary policy in order to reduce inflation and inflationary expectations. The 1979-1981 shocks are the "Volcker disinflation." There was widespread agreement by 1979 that inflation and interest rates were "out of control," and so the Federal Reserve under Paul Volcker adopted a contractionary policy.[10]

The shocks to the periphery are somewhat harder for us to identify. As shown in Figure 4 there were shocks to the Northeast in 1976, to the Plains in 1984, and to the West in 1999. The only one for which we can offer even a conjecture is the Northeast shock which might be identified with the New York City financial crisis. Many New York City banks were affected by the threat to the City's solvency because they held New

[10] Romer and Romer (1989) identify a number of cases in the postwar era in which the Federal Reserve adopted a new policy in order to bring inflation under control. All of there episodes can be identified with Federal Funds rate shocks identified by our VARs.

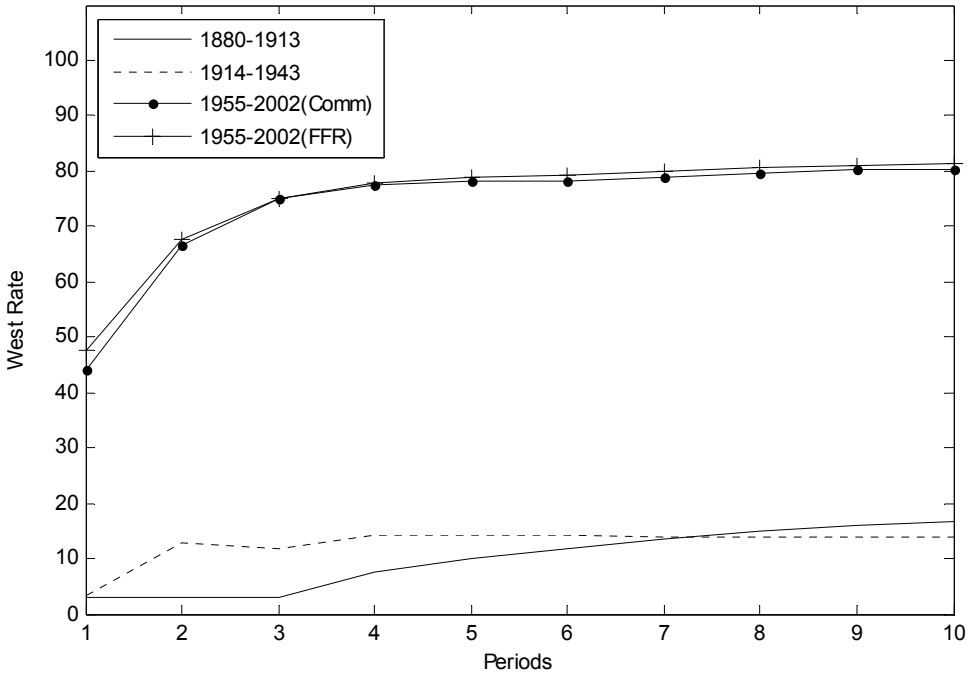
Figure 4: Shocks to Regional and National Interest Rates (1955-2002)



York City bonds. Eventually, a Federal loan helped resolve the problem. This is another example of a regional shocks addressed by creating a new instrument, separate from the monetary authority, to deal with the problem. Neither of the alternatives, attempting to deal with the problem through a general increase in liquidity or allowing the problem to burn out without government intervention, were politically acceptable.

Although the regional bank lending rates continue to show the effects of asymmetric regional shocks in the postwar era, the importance of regional shocks appears to have declined. This can be seen best by looking at the variance decompositions of the variables. Figure 5, which is typical, shows the effects of the National Rate on the West. In both 1880-1913 and 1914-1943 shocks to the national shock (the commercial paper rate) explain very little of the variation in the Western bank lending rate. In fact most of the variation is accounted for by shocks hitting in the West. In 1955 to 2002, however,

Figure 5: Variance Decomposition of the Effect of a shock to the National Rate on the Western Lending Rate



most of the variation, about 70 percent, is accounted for by shocks to the commercial paper rate or the Federal Funds rate.

6. Summary and Conclusions

In this paper we use Vector Autoregressions to identifying shocks to national and regional interest rates in the United States over the period 1880-2002. By shocks we mean independent events – shifts to the supply of or demand for loanable funds – that produced changes in interest rates that then reverberated through the economy. Our results lead us to a number of tentative conclusions.

(1) We find numerous examples of both symmetric shocks – shocks of the same type hitting both the core and the periphery – and asymmetric shocks – shocks hitting

only one region, or opposite shocks hitting both regions. Not surprisingly, some of the most severe crises in U.S. economic history, such as the crisis of 1893 and the Great Contraction of 1929 to 1932, appear to have been the result of symmetric shocks hitting the core and the periphery simultaneously. We also find examples of asymmetric shocks, such as the "rich man's panic of 1903" that seems to have affected mainly the Northeast, and the Florida land boom of the mid 1920s, that seems to have affected mainly the South.

(2) The problem of asymmetric regional shocks raises the issue of the appropriate number of policy instruments. In several cases the United States addressed the problem of asymmetric shocks, for better or worse, by devising alternative instruments to deal with them. Agriculture is the classic example, and the 1920-21 contraction the starting point. The United States faced what appeared to policymakers to be asymmetric shocks in the sense that they called for different responses, although policymakers may not have thought of in these terms: nationwide inflation, which called for higher interest rates; and an agricultural depression, which called for lower rates. In the end the solution was to raise the discount rate to fight the inflation and reactivate the War Finance Corporation, a World War I agency, to provide loans to the agricultural sector. In later legislation in the 1920s and 1930s the commitment of the Federal government to the agricultural sector was strengthened. The extension of Federal loans to New York City in its fiscal crisis in the 1970s is a more recent example. In other cases, however, the United States followed a policy of simply allowing regional problems to burn out their own. The Florida land boom, with the minor exception of a few loans to distressed banks, is an example from the 1920s.

(3) Although we find examples of asymmetric shocks throughout the period we examine, the problem of asymmetric shocks on the periphery appears to have gradually diminished. One way of seeing this is to look at the variance decompositions of the vector autoregressions. In the late nineteenth century shocks to peripheral rates were a major source of the variance in the bank lending rates on the periphery. This remained true, although to a lesser degree, in the first half of the twentieth century. We still observe asymmetric shocks in the postwar era, but they are far less important than in earlier periods. Most of the variance in the rates on the periphery is now explained by shocks to the national rates.[11]

(4) One reason that we observe smaller interest-rate shocks on the periphery in the postwar era was, most likely, the reformation of the American banking system that began in the Great Depression and continued in the postwar years. A number of the asymmetci shocks on the periphery before the Depression were the result of local banking crises. Two institutional reforms – Federal Deposit Insurance and the growth of interstate branch banking – appear to us to have played the key roles.[12]

Federal Deposit Insurance was introduced in 1934. Deposit insurance reduced the incidence of bank failures, and almost eliminated the localized banking panics that had frequently occurred earlier. The failure of one bank in a region no longer produced runs on other banks in the same region because depositors knew that their deposits were

[11] One caveat is that smaller interest rate shocks could be consistent with equal or more intense underlying shocks to the supply of or demand for capital. In a small banking market with an upward sloping supply of bank loans, for example, an increase in the demand for loans due, say, to a housing boom will produce an increase in interest rates that reduces demand. In an integrated market in which the supply curve is nearly perfectly elastic the increase in rates will be smaller, but the increase in the amount of loans going into housing, and the housing boom, will be larger. Complementary research on the quantity of bank loans and other variables would be needed to show that the incidence of underlying shocks had declined.

[12] There may also have been a change in attitude at the Federal Reserve toward local bank failures as a result of the Depression and subsequent criticism of the Federal Reserve.

ultimately insured by the Federal government. Deposit insurance, moreover, made it easier to move deposits from one part of the country to another, or for an investor in one region to buy stock issued by a bank in another region. As long as the return was good, one could invest without worrying about the risk of bank failure.

The lifting of the restrictions on intrastate and interstate branch banking in the postwar era also contributed to the integration of capital markets and the reduction of asymmetric shocks on the periphery. Before World War II each American state had its own banking system protected by state and federal laws that prevented outside banks from competing with banks controlled by local interests. Many states, moreover, limited branching within the state. The process of moving from a system of separate state banking systems to a national system dominated by large branch banks proved to be a long drawn out affair. As early as the 1950s there were attempts to circumvent branch-banking laws with bank holding companies: companies that owned legally independent banks in different states. In particular Bank of America's A,P.Giannini began using his Transamerica corporation as a way of acquiring banks outside California. The Bank Holding Company Act of 1956, however, reined in Transamerica and other bank holding companies.

The logic of interstate branching, however, and pressure from companies such as Bank of America, gradually undermined the state centered system. Deregulation began in earnest in the 1970s. There were, according to Randall Kroszner and Philip Strahan (1999), several phases. (i) First, states permitted bank holding companies from outside the state to enter and purchase banks, but required that the newly purchased banks be operated as stand-alone institutions. (ii) Then states allowed multi-bank holding

companies from outside to purchase banks and operate them as branches. Kroszner and Strahan (1999) believe this was the most important phase in the transition. (iii) Finally, states passed laws that allowed multi-bank holding companies from the outside to start their own branches – not just buy them. The Federal Riegle-Neal Interstate Branching and Efficiency Act of 1994 codified what was happening at the state level, and allowed the conversion to a nationwide banking system to continue at a rapid pace.

Moving from individual state systems to a national system was slow because of the clash of political interests. Banks within states, especially smaller banks, feared, with good reason, the competition that would come from the branches of large nation-wide banks, and the local banks lobbied vigorously against any relaxation of the restraints on interstate branching. In the end, however, the pressures from local banking interests were overcome. The relaxation of restraints on interstate branching not only improved the banking services available to individual Americans, but also contributed to the integration of the bank loan market, and ultimately to the simplification of the array of problems facing the Federal Reserve. Perhaps there is a lesson here for Europe.

7. Appendix

Figure 6: Impulse Response Function (1880-1913)

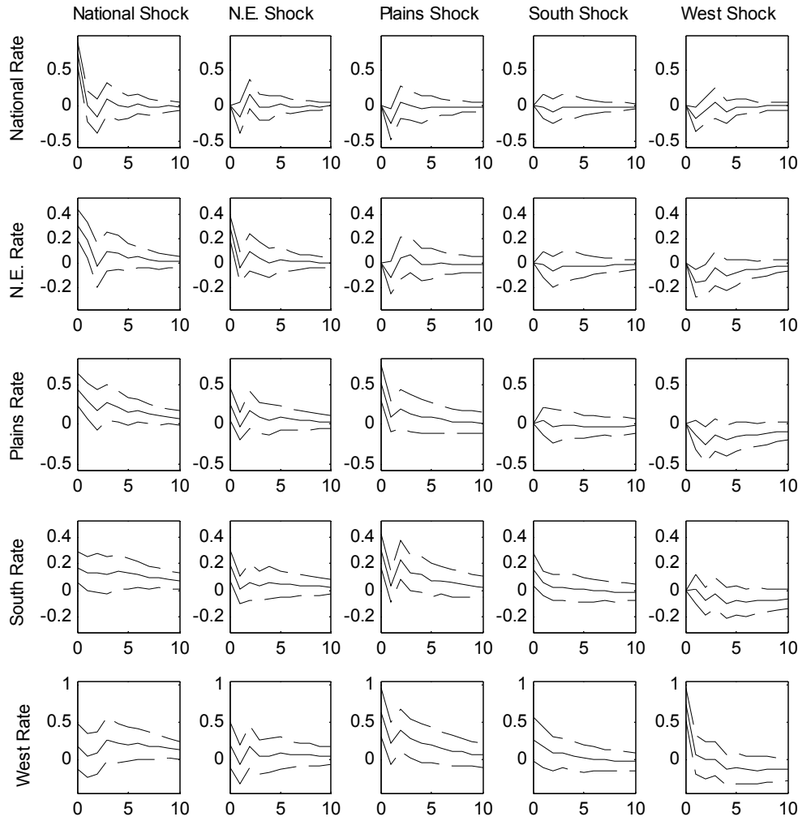


Figure 7: Impulse Response Function (1914-1943)

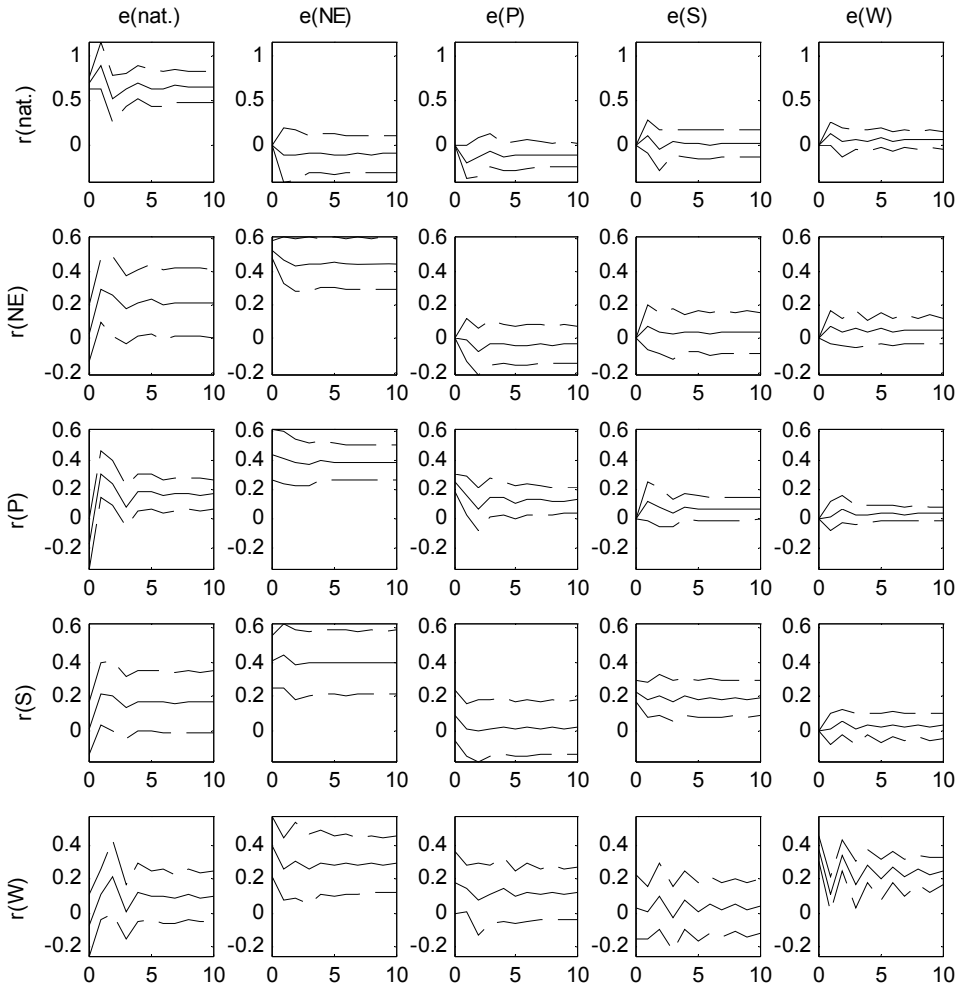


Figure 8: Impulse Response Function (1955-2002: Commercial rate)

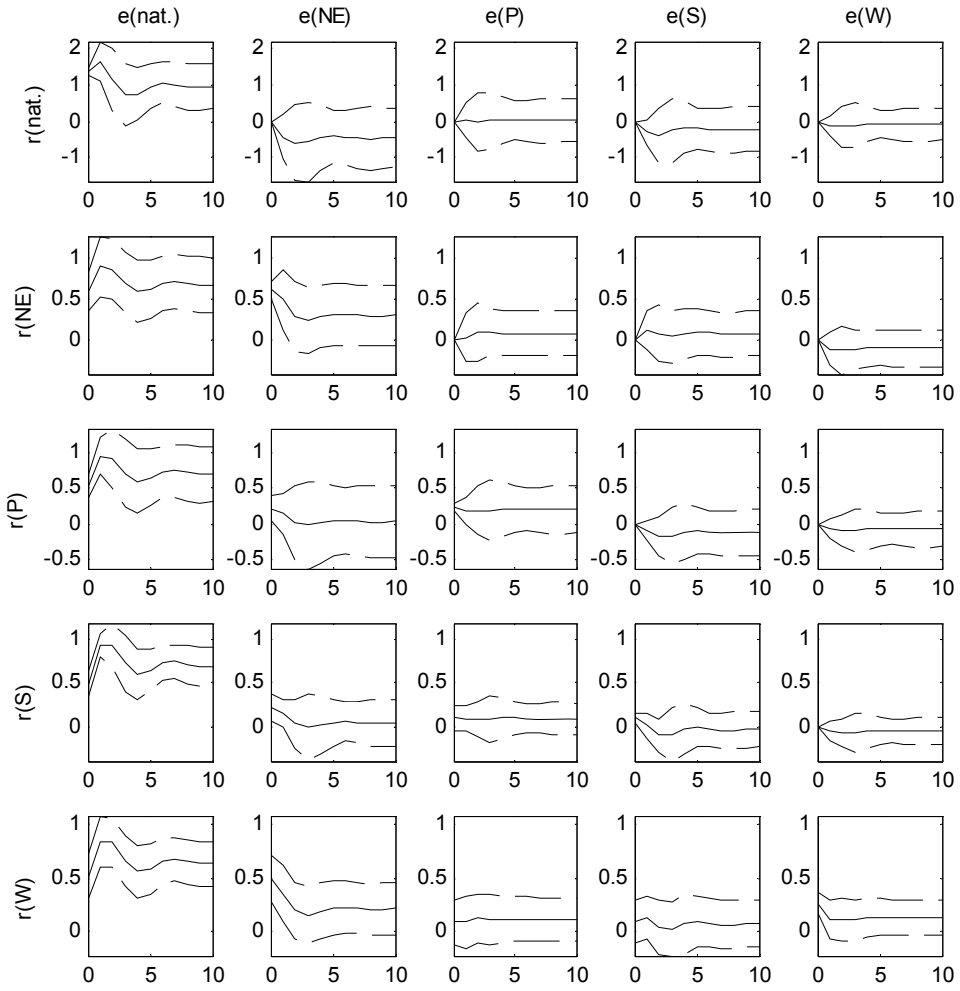
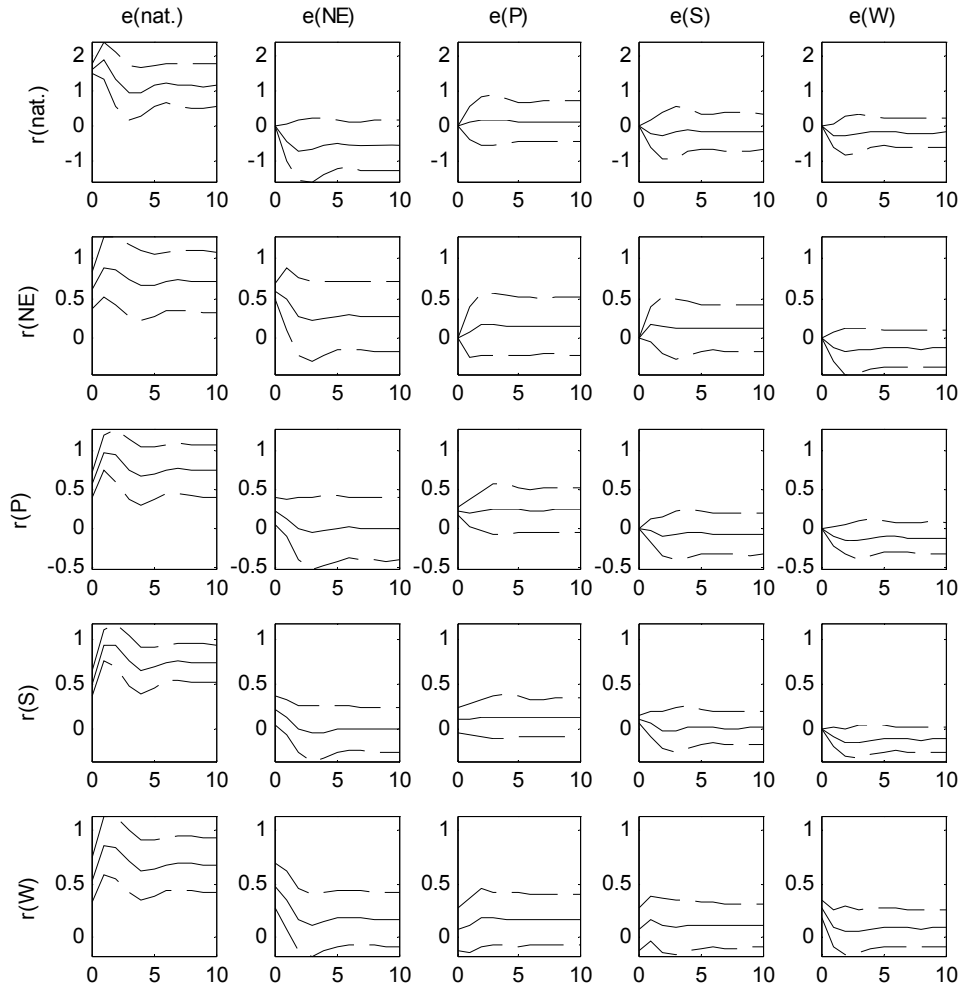


Figure 9: Impulse Response Function (1955-2002: Federal Funds rate)



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