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EXCESS RESERVES IN THE GREAT DEPRESSION

James A. Wilcox

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ABSTRACT

This article assesses the extent to which government-administered financial shocks and lower interest rates can account for the massive accumulation of bank excess reserves in the Great Depression. Both factors are shown to be statistically significant. Financial shocks did exert a statistically detectable influence on the demand for excess reserves but those shocks at best can account for a step-like increase in the level of reserves held, an increase which was completed in less than a year. Financial shocks can explain no more than 1 percent of the variation in excess reserves during the Great Depression. We demonstrate that the most statistically appropriate form of the demand function is one which flattened rapidly as interest rates fell. The fall in interest rates can account for 80 percent of the movement of excess reserves during the Great Depression.

James A. Wilcox
350 Barrows Hall
U.C. Berkeley
Berkeley, CA 94720
(415) 642-3535

I. INTRODUCTION

The unprecedented accumulation of excess reserves during the Great Depression fostered the view that the Federal Reserve might not have been able to raise the money supply. The demand by banks for excess reserves might have been so flat at low nominal interest rates that increases in the supply of high-powered money would flow almost exclusively into excess reserves, all but completely stifling expansion of the stock of credit and money. Attempts to raise the money supply by buying bonds "would simply increase the reserves of the banking system by the amount of government bonds which were purchased with currency. The currency would go out, . . . but [it] would immediately go into the banks and from the banks into the Federal Reserve Banks . . . and you would just have additional reserves, additional excess reserves." (U.S. Congress, 1935) That the banking system, for all practical purposes, had fallen into a liquidity trap due to the lack of supply of earning assets was the majority view for years. On this interpretation, the historical data listed in table 1 primarily reflect the tracing of a stationary excess reserves demand curve ($\overline{DD}$) by a shifting supply curve, as shown in figure 1.

The principal alternative explanation of the buildup is the Friedman-Schwartz (1963) shock hypothesis, which claims that banks demanded more excess reserves in the aftermath of financial crises. As the shock receded in time, banks began to revise downward their desired stock of excess reserves. The observed accumulation resulted from a demand curve that remained relatively steep but was "shocked" rightward by the jarring financial market disturbances of the 1930s. Such shifts, coupled with rightward supply schedule shifts, masked that steepness and the concomitant ability of the Fed to raise the money supply. To wit, the

> observed inverse correlation between the . . . deposit-reserve ratio and high-powered money during the period under consideration is a coincidence. . . . In our view, that behavior is to be interpreted as the result of two successive shifts in the preferences of banks for reserve funds, and the adaptation of portfolio positions to the changed preferences. The first shift occurred as a result of the experience during 1929-33, and the adaptation took about three years, from 1933 to 1936. The second occurred as a result of the successive rises in reserve requirements, reinforced by the occurrence of a severe contraction that was a stern reminder of the earlier experience. The adaptation to it took about the same length of time, from 1937 to 1940. In both cases, the adaptations occurred in an environment of generally declining interest rates which, even with stable preferences, would have induced banks to hold larger reserves. (Friedman and Schwartz 1963, pp. 538-539)

Thus, the huge stocks of excess reserves held long after the passing of each shock are accounted for by the sluggish adjustment of bank portfolios.

Most nonmonetarists admit that such shocks might raise bank demands for excess reserves, but they do not necessarily believe the shifts took place in the manner outlined by Friedman and Schwartz. Tobin, for instance, argues that there was no reason

> why shifts in liquidity preference resulting from discrete events should proceed so smoothly, and in particular with such striking negative correlation with the growth of high-powered money. Did bankers never take heart again, even when the deposit-currency ratio was rising and bank runs seemed to be a thing of the past? It may be that the introduction of variation of reserve requirements into the Federal Reserve's tool kit occasioned an increase in the demand for excess reserves. If so, it would be more reasonable to expect this to occur in 1935 when the legislation was passed but the powers were yet to be used, rather than after 1937 when requirements were already at, or very near, the maximumm permitted by Congress. (Tobin 1965, p. 480)

On this view, banks realized by mid-1937 that the Fed had no further authority to convert excess into required reserves. Banks were therefore unlikely to hold excess reserves as a precaution against an outlawed eventuality. Further, by the late 1930s, the public seemed unlikely to suddenly attempt to convert deposits into currency. In crises prior to the inception of federal deposit insurance in 1934, customers reduced bank liquidity drastically, even catastrophically, by withdrawing high-powered money out of fear that their deposits would evaporate in a financial panic. After the creation of the FDIC, there were almost no bank runs. It seems likely that bankers realized that "federal deposit insurance (had) been accompanied by a dramatic change in commercial bank failures and in losses borne by depositors in banks that fail." (Friedman and Schwartz 1963, p. 437)[1] If they believed that their customers believed in the efficacy of deposit insurance, bankers would not hold massive stocks of excess reserves to guard against these runs after 1934. Nonmonetarists thus view these two major sources of reserve outflows as inoperative starting in the mid-1930s, the period when excess reserve accumulation was so dramatic. Bankers may have reasonably held excess reserves as a precaution against larger reserve requirements and as a precaution against reserve withdrawals by a public that feared bank failures. But, by the end of 1937, both of these stimuli to excess reserve demand had been eliminated.

Despite the wide divergence between these explanations and in the policy recommendations that follow, we still know little about how much of observed excess reserve behavior each can account for. This paper seeks to fill that gap. We use estimates of bank asset demands to evaluate the magnitude and timing of excess reserve movements associated with each. We first address estimation issues and then direct our attention to the appropriate functional form of the interest rate term in the demand for excess reserves. Though the bivariate relation between excess reserves and interest rates is clearly nonlinear, we allow the data to determine whether the demand function flattened appreciably as rates fell or whether it remained steep but was shifted rightward by financial shocks.

Next we examine the empirical case for the hypothesis that financial shocks in the form of "liquidity crises" caused the excess reserve demand function to shift rightward. In particular we look at the effect of Great Britain's departure from the gold standard, of bank runs, and of increases in required reserve ratios on the demand for excess reserves, and evaluate whether demand rose appreciably in response to these shocks. We distinguish between the statistical significance of these shocks as measured by t-statistics and their economic or practical importance as measured by the proportion of additional excess reserves holdings which the shock effect can account for. After similarly assessing the impact of declining interest rates brought about by weakening asset supplies, we evaluate the relative contribution of these two sets of factors in different stages of the Great Depression. The concluding section assesses the policy implications of our findings.

II. BANK ASSET DEMAND AND SUPPLY

Banks are assumed to maximize expected, discounted, real profits subject to uncertainty and adjustment costs. Given a stock of free assets (total assets less required reserves), each bank allocates it among three available asset classes (loans, investments, and excess reserves) as a function of relative risks and returns:[2]

$$A^* = \begin{pmatrix} E^* \\ I^* \\ L^* \end{pmatrix} = \beta X = \begin{pmatrix} \beta_{EC} & \beta_{ER} & \beta_{EW} \cdots \\ \beta_{IC} & \beta_{IR} & \beta_{IW} \cdots \\ \beta_{LC} & \beta_{LR} & \beta_{LW} \cdots \end{pmatrix} \begin{pmatrix} C \\ R \\ W \\ \vdots \end{pmatrix} \tag{1}$$

A^* is the vector of desired asset stocks, whose elements are the desired stocks of excess reserves (E^*), investments (I^*), and loans (L^*). X is the vector of K explanatory variables common to each asset. Among its elements are a constant term, an interest rate term (R), and the stock of free assets or allocable wealth (W). The matrix of long-run coefficients is denoted by β.

The difference in real returns between excess reserves, which paid no interest, and investments and loans is the nominal interest rate. We include a variable, R, the nominal rate on short-term government securities as a proxy for that return differential.[3] The stock of each asset held also depends on the size of the portfolio of allocable assets, W.

The adding-up constraints stressed by Brainard and Tobin (1968) imply that neither a discrepancy between actual and desired asset stocks nor the consequent portfolio adjustment will be confined generally to a single asset. To the extent that banks incur adjustment costs that rise as a function of the speed of adjustment, their portfolios will adjust less than instantaneously. Though interest rates may adjust without lags, the existence of outstanding, multiperiod loans and long-term relations between banks and their customers may keep portfolios from adjusting completely within one quarter. To allow for this possibility we incorporate a partial adjustment mechanism. The change in actual stocks is a function of the difference between all desired and actual stocks:

$$\Delta A = A - A_{-1} = \begin{pmatrix} E-E_{-1} \\ I-I_{-1} \\ L-L_{-1} \end{pmatrix} = \theta\cdot(A^{*}-A_{-1}) = \begin{pmatrix} \theta_{EE} & \theta_{EI} & \theta_{EL} \\ \theta_{IE} & \theta_{II} & \theta_{IL} \\ \theta_{LE} & \theta_{LI} & \theta_{LL} \end{pmatrix} \begin{pmatrix} E^{*}-E_{-1} \\ I^{*}-I_{-1} \\ L^{*}-L_{-1} \end{pmatrix} \qquad (2)$$

where subscripts are used for dating and θ is the multiasset adjustment coefficient matrix. Substituting (1) into (2) gives:

$$A = \theta\cdot\beta\cdot X + (I-\theta)A_{-1}. \qquad (3)$$

The top row of A is:

$$E = (\theta_{EE}\beta_{EO}+\theta_{EI}\beta_{IO}+\theta_{EL}\beta_{LO}) + (\theta_{EE}\beta_{ER}+\theta_{EI}\beta_{IR}+\theta_{EL}\beta_{LR})\cdot R +$$
$$(\theta_{EE}\beta_{EW}+\theta_{EI}\beta_{IW}+\theta_{EL}\beta_{LW})W + \ldots + (1-\theta_{EE})E_{-1} - \theta_{EI}I_{-1} - \theta_{EL}L_{-1}. \qquad (4)$$

The shock model claims that the liquidity crises of the 1930s shifted banks' excess reserve demand functions rightward. To capture this effect, we have constructed a proxy variable, FS:

$$FS = FS1^{\alpha} + FS2^{\alpha} + FS3^{\alpha} \tag{5}$$

where FS1, FS2, and FS3 are, respectively, the reciprocal of the number of quarters since the last quarter of 1931, the first quarter of 1933, and the first quarter of 1937 and α, which allows the expectations of future shocks to decay with time, is set equal to 0.4. These periods correspond to the major financial shocks of the period identified by Friedman and Schwartz (the withdrawal of reserves associated with Great Britain's departure from the gold standard, bank runs, and the increase in reserve requirements) and are the same dates used by Morrison (1966). FS then traces out the declining impact of past crisis experience on crisis expectations. The individual components have been raised to the power of 0.4 to generate a proxy that closely approximates the shock variable Morrison employed.[4]

A variable, TOBIN, has been constructed to test for James Tobin's (1965) suggestion that banks adjusted their portfolios as a function of the legal ability of the Fed to alter required reserves. Until passage of the Banking Act of 1935, required reserve ratios had been specified by an amendment to the Federal Reserve Act. These ratios were first effective on June 21, 1917. The Banking Act of 1935, which became law in August 1935, empowered the Fed to raise the ratios up to double the previous percentages after that. That is, the legal-maximum time deposit ratios rose from 3 to 6 percent and the central reserve city demand deposit ratio rose from 13 to 26 percent.

The Fed did not immediately double these ratios but it was then that it first received the legal authority to raise them. To the extent that it had not raised ratios to double their previous level after it received the authority to do so, the Fed retained the ability to raise them in the future. Once the ratios were raised to the new legal-maxima, the Fed could exert no further contractionary impulse from that particular direction. Tobin questioned Friedman and Schwartz's contention that excess reserves were held after the 1937-38 contraction to provide a cushion against the Fed's further raising of reserve requirements since the Fed did not have the authority to raise them further.

TOBIN is calculated as the constant-dollar difference between required reserves, given demand and time deposits, calculated at the legal-maximum reserve ratios and at those ratios which actually prevailed at time t. Thus,

$$TOBIN_t = (RRMAXDD_t - RRDD_t)(NETDD_t) + (RRMAXTD_t - RRTD_t)(TD_t) \qquad (6)$$

where RRMAXDD = the legal maximum reserve ratio for net demand deposits, RRDD = the prevailing reserve ratio for net demand deposits, RRMAXTD = the legal maximum reserve ratio for time deposits, and RRTD = the prevailing reserve ratio for time deposits.[5]

When required reserve ratios are less than the legal maxima established by Congress, TOBIN is positive and the Fed retains the power to exert further contractionary influence by raising the ratios. When requirements equal their maxima, TOBIN will be identically zero, there being no further conversion of excess to required reserves legally possible.

We also include IP, the ratio of industrial production to its own 1921-1941 trend. IP is basically a cyclical variable that attempts to capture the changes of loan supply (to banks by individuals and firms) not mirrored in reported interest rates. Including these variables, (4) becomes:

$$E = \alpha_0 + \alpha_1 E_{-1} + \alpha_2 I_{-1} + \alpha_3 L_{-1} + \alpha_4 W + \alpha_5 R + \alpha_6 FS + \alpha_7 IP + e. \qquad (7)$$

We expect our estimated coefficients to exhibit the following signs. Higher rates raise the cost of holding funds idle. Thus, α_1 will be negative. Both shock variables, FS and TOBIN, increase the desire to hold excess reserves and accordingly carry positive coefficients. Since larger banks have larger (in absolute terms) risks of withdrawal and default, the scale variable, W, will have a positive effect on excess reserves. As output rises, banks may accommodate their customers' requests for funds without allowing the interest rate to ration these funds entirely. The variable, IP, then captures a cyclical effect and will negatively affect excess reserve holdings. The own-lagged asset term, E_{-1}, will be positive while the coefficients on the other lagged assets, which are the negative of the speed of adjustment of excess reserves to disequilibria in investments and loans, will be negative.

This formulation embodies the constraints implied by portfolio theory generally, in each short run period and in the long run. Asset demands are homogeneous of degree zero with respect to prices. The net change across assets due to a change in interest rates or any other nonscale variable is zero. The sum of individual asset reactions to a one-dollar change in portfolio size is unity. The response of each asset to a differential-preserving change in interest rates is zero. All adjustment patterns are consistent in that the sum of asset holdings implied by the model during adjustment to equilibrium equals the actual stock.

Both the interest rate, R, and the size of the allocable portfolio, W, become endogenous regressors in a simultaneous equation system characterized by fractional reserve banking.[6] This endogeneity renders ordinary least squares (OLS) estimates of (7) inconsistent. Below we estimate both supply and reduced-form equations for each asset to support our contention that the candidate variables to be used as instruments are likely, in practice, to identify the demand parameters and serve usefully in two-stage least squares (TSLS) estimation.

The supply of excess reserves depends on two types of factors. First it depends on the exogenous government-controlled factors, high-powered money (H) and required reserve ratios (RRR). As more high-powered money is provided or lower required reserve ratios are instituted, more reserves are held. The second set of factors are those that measure the competition for reserves. Given the stock of high-powered money, the larger the supply of loans and investments (to banks), the lower the stock of excess reserves. For instance, if higher government spending increases the supply of bonds, banks react in part by reducing their excess reserves and holding more bonds at the higher interest rate. Since excess reserves act not only as a defense against withdrawal and reserve requirement risk but also as a temporary abode of loanable funds, factors that drive up the supply of other assets will tend to sharpen the competition for the remaining excess reserves.

> No doubt changes in the demand for loans (by the banks' customers) and in the supply of investments, and the large increase in available reserves produced by the gold inflows--all of which constituted changes in the supply of assets for banks to hold--played a role in the shifts in asset composition. (Friedman and Schwartz 1963, p. 453)

As loans and investments rise in response to increased output, each bank reduces its excess reserves. With H and RRR fixed, excess reserves fall.

In addition to H, RRR, and IP, we hypothesize that five other exogenous factors appreciably affect the supply of assets to banks: HHS, DP, KEXP, GSP, and TAX. HHS is standardized households; DP is the dividend-price ratio; KEXP is real capital expenditures in manufacturing; GSP is real federal government expenditure; TAX is real federal government receipts. HHS influences the supply of mortgages and other building loans. DP reflects the price to firms of obtaining funds directly through capital markets by issuing stock. KEXP reflects businesses' needs for financing of capital investment. GSP and TAX measure the extent to which the federal government will increase or decrease its stock of outstanding bonds.

Allowing for lagged adjustment on the supply side, then, yields an excess reserve supply function:

$$E = \beta_0 + \beta_1 E_{-1} + \beta_2 I_{-1} + \beta_3 L_{-1} + \beta_4 R + \beta_5 DP + \beta_6 GSP + \beta_7 TAX + \beta_8 KEXP + \beta_9 HHS + \beta_{10} IP + \beta_{11} H + \beta_{12} RRR + e. \quad (8)$$

The demand and the supply functions can then be solved jointly to obtain reduced-form expressions for E, I, and L as linear functions only of exogenous variables:

$$A = \delta_0 + \delta_1 A_{-1} + \delta_2 IP + \delta_3 FS + \delta_4 DP + \delta_5 GSP + \delta_6 TAX + \delta_7 KEXP + \delta_8 HHS + \delta_9 H + \delta_{10} RRR + e \quad (9)$$

where A is the three-element vector of asset stocks (E, I, and L) and each δ is a vector of like size. The coefficients in each of the expressions in (9) are combinations of structural parameters. The demand parameters are each overidentified. This can be verified by noting that the number of variables excluded from the demand functions (DP, GSP, TAX, KEXP, HHS, H, RRR) exceeds the number of included, endogenous variables (R, W, and E, I, or L) minus one. The supply parameters are just-identified. The number of excluded, exogenous variables (FS) just equals the number of included, endogenous variables (R and E, I, or L) minus one.

Our sample begins in 1921 in order to allow the effects of the Treasury's financing of World War I to dissipate. The sample ends in 1941. Extending the sample further backward or forward increases the chances that the war-specific portfolio allocations would contaminate the sample. All data are seasonally adjusted and quarterly.[7] The sample covers weekly reporting, New York City, member banks. These banks account for about 90 percent of total New York City member deposits. The sample excludes nonmember and non-New York City banks in order to prevent distributional shifts of deposits between member and nonmember banks and between various classes of member banks from generating changes in required, and thus in excess, reserves.[8]

The dependent variable in all excess reserve functions is "effective" excess reserves. Since only reserves held at the Fed were considered legal reserves, vault cash was excluded from the Fed's measures of legal and thus excess reserves. If banks considered vault cash to serve equally well as deposits at the Fed their behavior will be reflected more accurately by effective excess reserves. Thus we add vault cash to legal excess reserves, obtaining effective excess reserves. As a measure of the foregone income associated with holding excess reserves, we use the interest rate on default-free short-term Treasury securities.

Table 2 presents estimates of excess reserve and earning-asset supply functions. Each of the hypothesized factors, except DP which is henceforth dropped, significantly influences the supply of excess reserves. The reduced form estimates for each bank asset appear in table 3. In all, six of these variables (HHS, KEXP, GSP, TAX, H, and RRR) are statistically significant in the determination of excess reserves. These estimated reduced form parameters are complicated combinations of our structural parameters and tell us little about the long-run parameter estimates directly. Nonetheless, taken as estimates of short-run reduced form parameters, they do provide some insight into issues of interest. First, neither government spending, taxation, nor changes in required reserve ratios seem to have exerted noticeable impact on either investments or loans. There is no evidence of crowding out in this sense. Consistent with the investment and loan equations, the estimates imply that changes in GSP, TAX, and RRR (as well as KEXP) had a large impact on excess reserves.

These are the results we would expect if the demand function for excess reserves flattened appreciably as rates fell.

Also notable is the failure of changes in required reserve ratios to reduce holdings of any asset except excess reserves. The estimates imply that in the 1930s only excess reserves were statistically significantly affected by changes in required reserve ratios. Investments also were reduced by these changes but the effect is not strong enough to pass conventional significance tests. Since a large portion of the investment portfolio in this era consisted of short-run government notes and bills, the effect on private credit was probably small indeed. The reduced form evidence then suggests that banks were "loose" in the sense that changes in reserve requirements, as well as changes in high-powered money, primarily produced changes in excess reserves and not in credit. These supply changes did not alter the quantity demanded significantly: the demand functions were relatively flat. As Tobin (1966) claimed, raising reserve requirements may have been a mistake but it was probably a relatively harmless one.

Thus, theory and the results from tables 2 and 3 support the suggested exogenous supply variables (GSP, TAX, KEXP, HHS, H, RRR) as candidates for being instruments. In particular, they have been shown to be relevant to a "nearby" part of the economy and to have strongly influenced the supply of excess reserves in this period.

III. DID THE EXCESS RESERVE DEMAND CURVE FLATTEN?

To test whether the demand for excess reserves depends linearly on interest rates or flattens (or steepens) as rates fall, we search over integer exponents for R from -2 to +2.[9] Table 4 points to the log of R as the best-fitting specification for excess reserves and for loans. The reciprocal of R, which also flattens rapidly as rates fall, is optimal for investments. To test whether the fit using one functional form is statistically superior to the alternative forms, we calculate chi-square statistics with one degree of freedom for each asset.[10] The functional form that delivers the best fit is denoted by an asterisk. Chi-square values exceeding the critical value for the 95-percent level of confidence are associated with forms that fit significantly worse than that minimum s.e.e. form. According to this criterion, the log of rates in the excess reserves and in the loan demand functions is a statistically superior specification to each of the four alternatives considered. The reciprocal form performs significantly better than the alternatives in the investment demand function. On this evidence, we reject the hypothesis that any of these demand functions remained steep as rates fell. To enable us to easily impose cross-equation constraints, we take the log transformation of interest rates as the optimal specification for each of the asset demand functions. The log specification does imply a decreasing elasticity of demand with respect to rates. However, the demand function still rapidly approaches (but never reaches) the horizontal since the slope in this specification is proportional to the level of interest rates. Since rates fell in the late 1930s to about one-hundredth of their late 1920s values, so did the slope of the demand function.

Based on that specification of the interest rate term, we present our asset demand estimates in table 5. The parameter constraints implied by general portfolio theory discussed in Section II are automatically imposed here since the same explanatory variables enter each demand function, wealth is included as one of the explanatory variables, and the functions are linear in the parameters (though nonlinear in the variables) (see Smith(1975)). Two-stage least squares estimation is applied, equation by equation, using instruments we have shown to be relevant to this market. In addition, the estimates do not appear to be plagued by residual autocorrelation (the normally distributed Durbin h-statistics are undefined) and Chow-type stability tests performed over a sample split at 1931:02 do not suggest unstable parameters. These features raise our confidence that our estimates are consistent. Nearly all (nineteen out of twenty-one) coefficient estimates are statistically significant. Only the effect of lagged investments and of financial shocks in the loan equation are not. About \$0.50 of each additional allocable dollar banks receive flows into investments in that first quarter. The remainder (\$1.00-\$0.467) is split almost equally between loans and excess reserves. The interest rate effect operates in the expected direction for each asset. Higher rates lead to fewer excess reserves, more investments, and more loans. Financial shocks lead to larger holdings of excess reserves, smaller holdings of investments, but only a negligible change in loans initially.

There are significant lags in the adjustment of the asset holdings. Given own- and cross-asset adjustments, the lag lengths are not readily seen. In general, they appear to be shorter than the three years suggested by Friedman and Schwartz. The adjustment to a financial shock, for example, is approximately half completed in four quarters and virtually complete in two years. (Technically, of course, lagged dependent variable models imply that adjustment is never complete.) Table 6 presents the long-run responses of each asset to changes in the explanatory variables. The vast majority of additions to the portfolio eventually seeps into loans, as we would expect. As rates rise, in the long run, loans expand while both excess reserves and investments fall. Perhaps most interesting, though a shock lowers loans by little initially, the estimated long run impact of a permanent financial shock would have been to raise excess reserves, and to a smaller extent raise investments, but reduce loans by a large amount. Initially, banks dump investments, but to a much lesser extent due to their illiquidity, they reduce loans when a financial shock strikes. As time proceeds, banks raise their excess reserve holdings substantially and attain a net positive change in excess reserves and in investments, all at the expense of loans. Thus, the estimates imply that the effect of a financial shock is to drive banks to portfolios that are more liquid, just as Friedman and Schwartz suggested.[11]

IV. SHOCKS AND INTEREST RATES: SIGNIFICANCE VS. IMPORTANCE

In the previous sections we provided evidence on the effect of both financial shocks and interest rates on the demand for excess reserves. Each exerts a statistically detectable short-run influence and an even larger long-run influence on the quantity of excess reserves held by banks during the Great Depression. The estimates thus support the Friedman and Schwartz contention that such shocks did shift banks' desire to hold cash. The previous section also established the superiority of an interest rate specification that flattened rapidly as rates fell. We selected the log of rates as the statistically most appropriate and were able to rule out forms that did not flatten. This is consistent with the suggestion that "banks were by the mid-thirties moving along a fairly flat liquidity preference curve." (Tobin 1965, p. 480)

Statistical significance does not estabish the practical or economic impact of either rates or of financial shocks on excess reserve holdings. To do that, we employ a simulation technique. Using the estimates from table 5, we first simulate values for each asset. Starting from an initial period (1931:2), we fix all explanatory variables at their levels for the initial period, allowing only interest rates (and the lagged, simulated value for each asset) to change. This simulated series then captures the reaction of excess reserves over the 1931:2-1941:4 period to the actual changes in rates. The procedure is repeated to generate simulated values with only the shock proxy, FS, taking on its actual values. The historical values for excess reserves (E), the series attributable to interest rate movements (ER), and that due to shocks (EFS) are plotted in figure 2. As a test of model validity, we have also simulated, but not plotted, an excess reserve series allowing all variables to take on their actual values (except lagged dependent variables). Table 7 shows that, overall, this dynamic simulation faithfully reproduces the historical data quite well.

The statistical significance of the shock term belies its relatively insignificant practical role in explaining the accumulation of excess reserves during the 1930s. Shocks just cannot explain the build-up in the late or mid-1930s. FS can account for, even overexplain, the rise in the early 1930s. The shock proxy predicts the rise in excess reserves of about a billion dollars by 1935 but implies decumulation thereafter. It was after 1934, and in particular after 1937, however, that actual excess reserves really began to pile up. The shock variable indicates no such pattern, even after allowing for lagged adjustment. Thus Friedman and Schwartz's claim that the buildups after 1933 and after 1937 each lasted for three years finds little support. Neither the 1935-36 nor the 1938-40 accumlation reflects the adjustment of excess reserve stocks to shocks to the banking system. Nor can the inability of FS to explain the accumulation of excess reserves be attributed to a specification that implies an implausibly short memory, especially in light of the structural changes (such as the advent of the FDIC) and the institutional constraints (such as the effective reserve requirement ceiling) in place by the latter 1930s, for FS declines quite slowly, still retaining half of its immediate post-shock value nearly six quarters after the shock and 40 percent after almost ten quarters.

Interest rates do better. Though they predict a decline in the early 1930s and account for but a small portion of the variation through 1935 (see table 7), rates can explain about half the increase in excess reserves up until the first rise in reserve requirements in 1936. They also explain about one-third of the rise from 1937 until their peak in 1940.[12] By the end of 1941, the interest-rate-propelled simulated series is right on track.

These simulations reveal that, in spite of the strong statistical showing of both shocks and interest rates, only rates add appreciably to the explanation of excess reserves in the latter 1930s. Financial shocks did perceptibly shift the demand for excess reserves rightward. The accumulation due to this shift, however, pales in comparison to the accumulation due to falling interest rates. Rates and shocks each mattered. Rates mattered more.

V. CONCLUSION

During its latter stages and in the two decades that followed the Great Depression, there was a consensus that the Fed was unable to push the economy out of the slump. The hegemony of this interpretation was shattered in the early 1960s when Friedman and Schwartz fired the opening salvo in the "monetarist counterrevolution." They argued that the appearance of a flat excess reserve demand function was the result of shocks to the financial sector that drove that demand curve sharply rightward, corresponding incidentally with the rightward supply shift. We demonstrate that such shocks to demand did exert a detectable influence on holdings of excess reserves. Our estimates show, however, that though such demand side shocks can account for the rise in excess reserves in the early 1930s, they cannot explain the continuing rise after 1935 or 1937, nor the sharp downturn in the early 1940s.

Our results indicate that the decline in interest rates had a much larger impact on bank portfolios. Statistical tests decisively reject the hypothesis that the demand for excess reserves remained steep. On the contrary, it became extremely flat at low rates. Visual inspection of the plots of actual excess reserves and the simulated paths due to interest rates alone and to shocks alone show that interest rates were far more important in determining excess reserves in the 1930s than were financial shocks. The summary statistics in table 7 clearly illustrate the economic or practical importance of lower rates and the near-zero contribution of shocks to rising excess reserves after mid-1935. The simulations also indicate that the effect of shocks was transitory in that it resulted in a rise to a higher excess reserve ratio and then a decline. Continually falling rates, on the other hand, led to a continually rising excess reserve-wealth ratio and corresponding continual fall in the money supply multiplier in the latter 1930s.

Consistent with this supply-dominated determination of excess reserves is the weak impact of high-powered money in reduced form expressions for investments and loans in this period. Our estimates imply that high-powered money increases of the type that nonsterilized gold flows initiated in the late 1930s and early 1940s would not raise investment or loan holdings appreciably. Witness the huge rise in high-powered money and the virtually constant level of private credit that existed in that period.

Though our estimates do not imply that the demand curve became perfectly flat, its slope did decrease dramatically. The money supply multiplier was not zero and therefore monetary policy was not totally impotent. The low level of rates was, however, associated with near-zero values for the excess reserve demand function slope and for the multiplier. Why did excess reserves suddenly plummet in the early 1940s? The passing of the shock effect cannot account for more than 1 percent of the decline. The rise in interest rates, though small in levels, was relatively large in logarithms (i.e., proportionally) and accounts for 8 percent of the $2 to $3 billion drop. The rest is explained primarily by supply factors. Government spending and the accompanying deficit revved up in the early 1940s, of course, and this exogenous source drove up the supply of public and private loans of bonds to banks. The halting of gold flows from abroad at this time (due to the initiation of the Lend-Lease program) curtailed the rising supply of high-powered money. The resulting leftward shift in the excess reserve supply function produced a precipitous fall in the stock of excess reserves.

FOOTNOTES

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[1]The loss rate dropped by over 99 percent in the first year of the FDIC's existence.

[2]This approach draws upon the work of Bisignano (1971), Frost (1971), Morrison (1966), Niehans (1978), and Pierce (1967). Without uncertainty or adjustment costs, excess reserves are not held, being dominated by riskless, net interest-bearing assets. Recorded interest rates are assumed not to capture all aspects of the relative attractiveness of various assets due to considerations like long-run, customer relations between banks and borrowers, for example. The liability side of banks' balance sheets are taken as given here.

[3]The risk of capital gain or loss for this maturity is very small. Omitting a separate loan rate should not importantly affect the estimates since that rate differs from the government rate by a default-risk premium leaving the risk-adjusted differential at zero. Williams (1964) notes that Treasury notes could be used to purchase Treasury bonds at par at least in the latter 1930s. Since bonds sold above par then, the "above par" value accrued to the price of notes, driving their yields below zero for a long time. The yield we use after 1930 is that for bills, which came with no such bond price option. These bill yields are always positive.

[4]We found 0.4 to be the statistically optimal power for FS when FS is the sum of nonexponentiated individual shock proxies.

[5]Required reserves were based on net demand deposits which differ from total demand deposits approximately by federal government deposits and float.

[6]The exogeneity of R and of W are strongly rejected according to the Nakamura and Nakamura (1981) criterion. The F-statistics associated with the null hypothesis of exogeneity are 44, 169, and 428 for excess reserves, investments, and loans, respectively.

[7]The discount rate and the shock variables are not seasonally adjusted. A data appendix with detailed descriptions and sources of all variables is available upon request.

[8]These shifts, along with shifts between demand and time deposits, account for about 40 percent of the change in the aggregate, total reserve-deposit ratio in the 1930s. Cagan (1965), pp. 180-181.

[9]This closely approximates searching over λ in $(R^{\lambda}-1)/\lambda$. As λ approaches zero, that expression approaches the log of R. We use the log of R as the relevant transformation when the exponent is zero.

[10]The chi-square test statistic is calculated as $(N)(\log(SSR_A/SSR_0))$ where N is the number of observations, and SSR_A and SSR_0 are the sums of squared residuals for the alternative and the best-fitting functional forms, respectively.

[11]The estimated long-run responses also produce some anomalies. Chief among them are those for the output proxy in the excess reserve and loan equations. The negative interest rate coefficient for investments is also surprising. Whether any of these is statistically different from zero is not obvious. Though the actual long-run coefficients for wealth are presumably between zero and one, some of our estimates lie outside that range. The nonlinear derivation of these coefficients may make the long-run estimates very sensitive to the short-run estimates.

[12]A simulation begun in 1938:2 implies that interest rates account for about two-thirds and shocks one-third of the accumulation of excess reserves after that point.

LITERATURE CITED

Bisignano, Joseph. "Adjustment and Disequilibrium Costs and the Estimated Brainard-Tobin Model." Board of Governors of the Federal Reserve System, Staff Economic Studies Paper, No. 62, July 1971.

Board of Governors of the Federal Reserve System. Banking and Monetary Statistics, 1914-1941. Washington: U.S. Government Printing Office, 1943.

________. Industrial Production. 1971 edition. Washington: U.S. Government Printing Office, 1972.

Brainard, William, and Tobin, James. "Pitfalls in Financial Model Building." American Economic Review 58 (May 1968), 99-122.

Cagan, Phillip. Determinants and Effects of Changes in the Stock of Money, 1875-1960. New York: Columbia University Press, 1965.

Chawner, Lowell J. "Capital Expenditures for Manufacturing Plant and Equipment--1915-1940." Survey of Current Business (March 1941), 1-15.

Firestone, John M. Federal Receipts and Expenditures During Business Cycles, 1879-1958. New York: Princeton University Press, 1960.

Friedman, Milton, and Schwartz, Anna J. A Monetary History of the United States, 1867-1960. Princeton: Princeton University Press, 1963.

Frost, Peter A. "Banks' Demand for Excess Reserves." Journal of Political Economy 79 (July 1971), 805-825.

Gilbert, Milton. National Income Supplement to Survey of Current Business. Washington: U.S. Government Printing Office, 1947.

Hickman, Bert G. "What Became of the Building Cycle?" In Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz, edited by Paul David and Melvin Reder. New York: Academic Press, 1973.

Morrison, George R. Liquidity Preferences of Commercial Banks. Chicago: University of Chicago Press, 1966.

Nakamura, Alice, and Nakamura, Masao. "On the Relationships among Several Specification Error Tests Presented by Durbin, Wu, and Hausman." Econometrica 49 (November 1981), 1583-1588.

Niehans, Jurg. The Theory of Money. Baltimore: Johns Hopkins, 1978.

Pierce, James L. "An Empirical Model of Commercial Bank Portfolio Management." In Studies in Portfolio Behavior, Cowles Monograph, No. 20, edited by D. Hester and J. Tobin. New York: Wiley, 1967.

Smith, Gary. "Pitfalls in Financial Model Building: A Clarification." American Economic Review 65 (June 1975), 510-516.

Tobin, James. "The Monetary Interpretation of History." American Economic Review 55 (June 1965), 464-485.

U.S. Congress, House Committee on Banking and Currency. Hearings on H.R. 5357, Banking Act of 1935. 74th Congress, 1st Session, 1935.

U.S. Department of Commerce. The National Income and Product Accounts of the United States, 1929-1974. Washington: U.S. Government Printing Office, 1976.

Williams, John Burr. The Theory of Investment Value. Amsterdam: North-Holland, 1964.

TABLE 1

THE NOMINAL INTEREST RATE ON SHORT-TERM GOVERNMENT DEBT (RS)
AND THE RATIO OF EXCESS RESERVES (E) TO BANKS' ALLOCABLE WEALTH (W)
ANNUALLY, 1929-1941

Year	E/W	RS
1929	0.01	4.42
1930	0.01	2.23
1931	0.01	1.39
1932	0.02	0.88
1933	0.02	0.52
1934	0.06	0.28
1935	0.12	0.17
1936	0.10	0.17
1937	0.05	0.27
1938	0.13	0.07
1939	0.23	0.05
1940	0.26	0.03
1941	0.16	0.09

Note: The stock of allocable wealth, W, is the sum of bank holdings of excess reserves, loans, and investments.

TABLE 2

ASSET SUPPLY ESTIMATES
COCHRANE-ORCUTT ESTIMATION METHOD
QUARTERLY, 1921:3-1941:4
(t-Statistics in Parentheses)

Dependent Variable	Constant	R	E_{-1}	I_{-1}	L_{-1}	GSP	TAX	KEXP	HHS	IP	H	RRR	$\hat{\rho}$	R^2	D.W.	S.E.E.	S.E.E./$\bar{A}$
E	481.7 (3.04)	-79.5 (2.34)	0.504 (4.95)	-0.335 (9.94)	-0.039 (-0.96)	-0.529 (-4.64)	1.449 (4.10)	-1.009 (-5.47)	0.071 (2.73)	612.3 (3.83)	0.220 (5.27)	-9340 (-5.50)	-0.35 (-3.41)	.9898	1.93	128.6	0.164
I	412.9 (1.27)	-122.7 (-2.45)	-- --	0.791 (11.84)	-0.109 (-1.27)	0.136 (0.83)	-0.063 (-0.14)	0.834 (3.28)	0.071 (1.20)	-882.7 (-3.33)	-- --	-- --	0.44 (4.39)	.9949	2.03	184.8	0.047
L	338.0 (1.69)	44.5 (1.09)	-- --	0.008 (0.20)	0.917 (16.90)	-0.010 (-0.08)	-0.453 (1.39)	-0.044 (-0.24)	0.032 (0.91)	552.7 (3.05)	--	--	0.04 (0.35)	.9651	1.98	150.6	0.034

TABLE 3

REDUCED FORMS FOR EXCESS RESERVES (E),
INVESTMENTS (I), AND LOANS (L)
ORDINARY LEAST SQUARES
QUARTERLY, 1921:3-1941:4
(t-Statistics in Parenthesis)

Dependent Variable	Constant	E_{-1}	I_{-1}	L_{-1}	HHS	KEXP	GSP	TAX	FS	TOBIN	IP	H	RRR	R^2	D.W.	S.E.E.	S.E.E./$\bar{A}$
E	371.4 (1.88)	0.345 (2.95)	-0.396 (-8.10)	-0.096 (-1.82)	0.103 (3.23)	-0.819 (-4.28)	-0.616 (4.93)	1.272 (3.44)	-37.2 (-0.41)	0.188 (2.61)	312. (1.56)	0.280 (5.85)	-10,373. (-5.22)	.9893	2.08	131.6	0.168
I	368.8 (1.74)	0.229 (1.74)	0.847 (15.41)	-0.127 (-2.16)	0.125 (3.51)	0.647 (3.01)	0.055 (0.39)	0.329 (0.79)	-339.5 (-3.32)	0.031 (0.38)	-1379. (-6.14)	-0.022 (-0.40)	-1050. (-0.47)	.9969	1.97	148.0	0.038
L	577.3 (2.60)	0.201 (1.53)	0.047 (0.80)	0.888 (15.10)	0.060 (1.69)	0.178 (0.83)	0.104 (0.75)	-0.304 (-0.73)	-5.4 (-0.05)	-0.017 (0.21)	412. (1.84)	-0.095 (-1.76)	1915. (0.86)	.9682	1.98	147.5	0.034

TABLE 4

GOODNESS-OF-FIT MEASURES FOR VARIOUS TRANSFORMATIONS OF THE INTEREST RATE TERM

	Asset					
	E		I		L	
Exponent of R	$1-R^2$	S.E.E.	$1-R^2$	S.E.E.	$1-R^2$	S.E.E.
-2	.0277	205.0	.0030	141.7	.0429	165.6
-1	.0203	175.4	.0028	135.6	.0383	156.4
0 (=log(R))	.0147	149.2	.0032	145.8	.0274	132.2
+1	.0266	200.9	.0046	175.4	.0348	149.2
+2	.0362	234.1	.0066	209.5	.0347	149.0

TABLE 5

ESTIMATES OF BANK DEMAND FOR EXCESS RESERVES,
INVESTMENTS, AND LOANS
TWO-STAGE LEAST SQUARES,
QUARTERLY, 1921:3-1941:4
(t-statistics in parentheses)

Independent Variable	Asset: E	Asset: I	Asset: L	Sum
C	509. (3.02)	-379. (-2.30)	-130. (-0.87)	0.0
E_{-1}	0.634 (4.15)	-0.339 (-2.27)	-0.295 (-2.18)	0.0
I_{-1}	-0.481 (-5.11)	0.625 (6.79)	-0.144 (-1.73)	0.0
L_{-1}	-0.290 (-2.20)	-0.437 (-3.39)	0.727 (6.23)	0.0
W	0.297 (2.35)	0.467 (3.78)	0.237 (2.11)	1.0
R	-244.2 (-4.13)	128.4 (2.22)	115.8 (2.21)	0.0
FS	200.3 (2.44)	-206.7 (-2.58)	6.4 (0.09)	0.0
IP	290.6 (2.25)	-727.9 (-5.78)	437.3 (3.83)	0.0
R^2	.9853	.9968	.9726	
D.W.	1.82	1.82	2.00	
S.E.E.	149.2	145.8	132.2	
S.E.E./$\overline{A}$	0.190	0.038	0.030	

Note: $\overline{A}$ = mean of dependent variable.

TABLE 6

THE LONG-RUN RESPONSE OF ASSET HOLDINGS TO A UNIT CHANGE IN AN EXPLANATORY VARIABLE

Variable	Asset E	Asset I	Asset L	Sum
W	-0.433	0.207	1.226	1.0
R	-700.	-1012.	1682.	0.0
FS	1932.	280.	-2212.	0.0
IP	8640.	-1916.	-6724.	0.0

TABLE 7

SHARE OF VARIATION IN ACTUAL EXCESS RESERVES EXPLAINED BY SIMULATED SERIES

Movement in Simulated Series Due to Movement in	Sample Period 31:2-41:4	Sample Period 31:2-35:4	Sample Period 36:1-41:4
ALL variables	0.96	0.70	0.96
FS only	-0.78	-0.09	-1.78
R only	0.63	0.08	0.55

NOTE: Each series is set equal to zero for the initial period in each sample. Entries are calculated as

$$1 - \left(\left(\sum_{t=t_0}^{t_1} (\hat{E}_t^2) \right) \Big/ \left(\sum_{t=t_0}^{t_1} (E_t^2) \right) \right) ,$$

where t_0 and t_1 are the beginning and ending dates of the sample, $\hat{E}_t$ is the simulated series, and E is the actual excess reserve series.

FIGURE 1

SHIFTING AND FLATTENING EXCESS RESERVE DEMAND CURVES

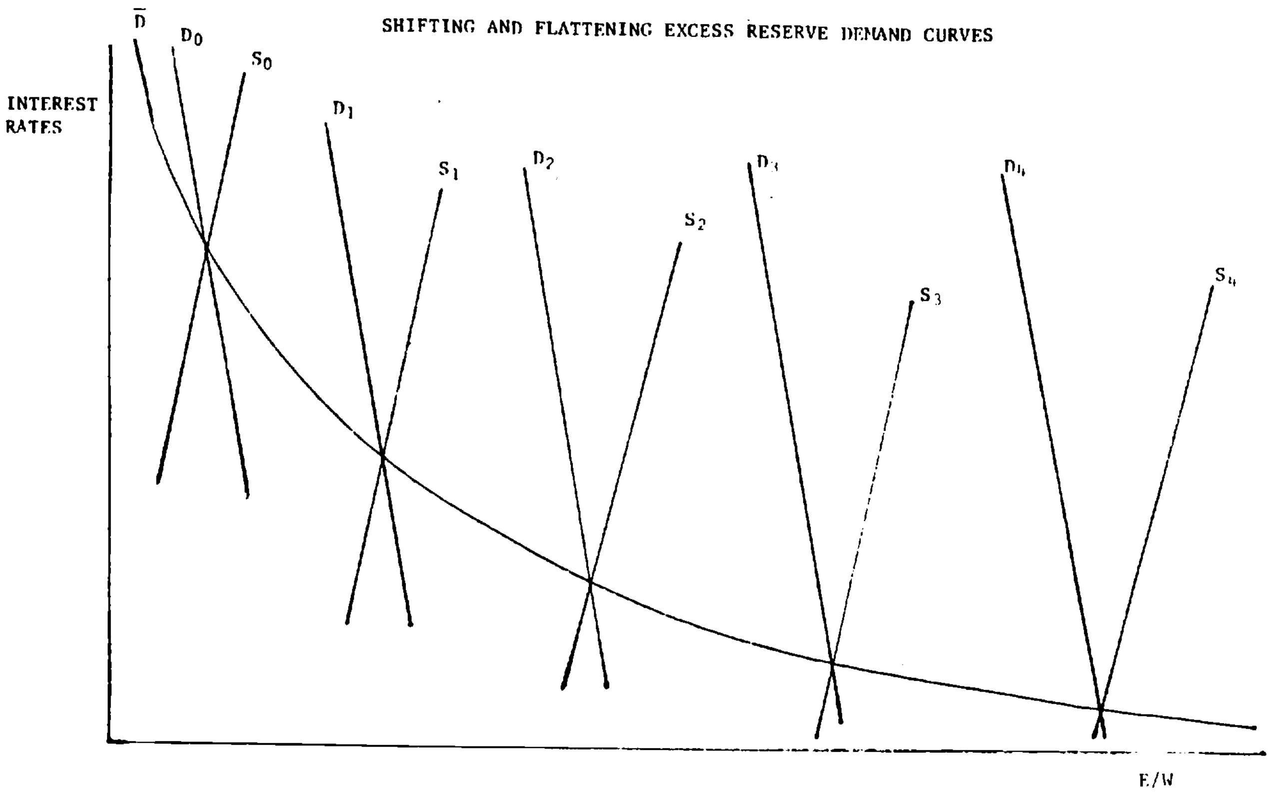
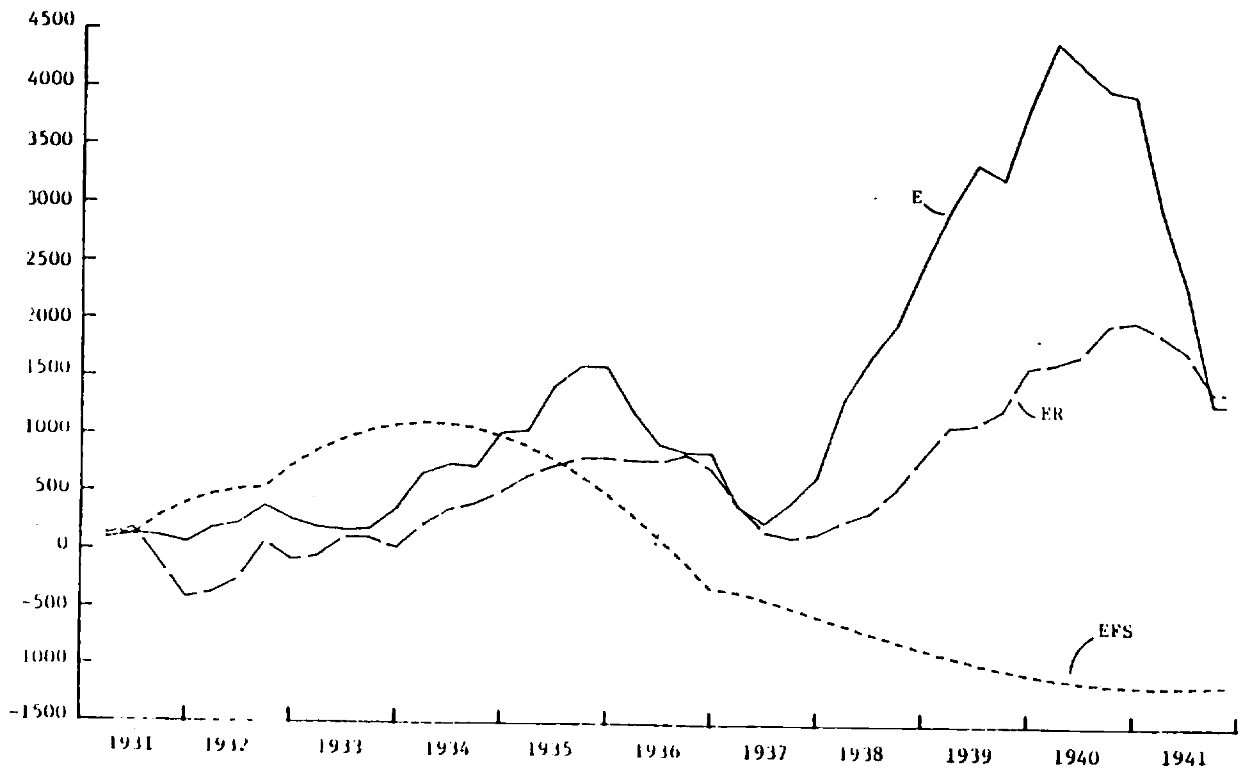


FIGURE 2

ACTUAL (E) AND SIMULATED EXCESS RESERVE MOVEMENTS DUE TO CHANGES IN INTEREST RATES (ER) AND TO SHOCKS (EFS)
MILLIONS OF 1929 DOLLARS, QUARTERLY, 1931:2-1941:4



Data Definition and Sources

All data are quarterly, 1921-1941, unless otherwise noted. Flows are in millions of dollars at annual rates. Real variables have been obtained by deflating by the CPI (1929 = 1.00).

CPI -- Consumer Price Index

Seasonally adjusted, 1929 = 1.00.

Source: U.S. Department of Labor, Bureau of Labor Statistics

E -- Effective Excess Reserves

Real, seasonally adjusted. Calculated as $E = ER + VC$.

ER -- Legal Excess Reserves

Real, seasonally adjusted. Calculated as $ER = R - RR$.

FS -- "Liquidity Crisis" aggregate variable

$FS = FS1^{0.4} + FS2^{0.4} + FS3^{0.4}$.

FS1, FS2, FS3 -- "Liquidity Crisis" variables

The FS (Friedman and Schwartz) individual liquidity crisis or shock variables are each calculated as the reciprocal of the number of quarters since the last "crisis." FS1, FS2, and FS3 take on a value of zero for the quarters up to and including October 1931; January 1933; and March 1937, respectively.

GSP -- Federal Government Expenditures.

Real, seasonally adjusted.

Source: Firestone (1960).

H — High-Powered-Money

Real, seasonally adjusted.

Source: Banking and Monetary Statistics, pp. 802-805.

HHS -- Index of Standardized Households

Source: Hickman (1973).

Hickman provides data from 1922 on. The 1921 values have been assumed equal to the 1922 value less the 1922-1923 increment. To generate quarterly stocks from the annual stocks, the value for the third quarter of each year is set equal to the annual stock value that was dated July 1. Remaining quarterly values were obtained by linear interpolation between the third-quarter values.

I -- Investments

Real, seasonally adjusted. Includes private and public sector securities.

Source: Banking and Monetary Statistics, pp. 166-193.

IP — Industrial Production

Real, seasonally adjusted.

IP, designed to capture business cycle movements, is the difference between the log of the seasonally adjusted index of industrial production and its own logarithmic trend. That trend is calculated by regressing the log of industrial production on a constant and a linear trend variable, TIME. The sample is monthly, 1921:1-1941:12. The industrial production index is from Industrial Production, 1971 Edition, p. S-143. The results are given below.

$$\log(IP) = \underset{(188.0)}{4.94} + \underset{(10.3)}{0.001855}\ TIME + e$$

$$R^2 = 0.30$$

$$D.W. = 0.03$$

$$S.E.E. = 0.21$$

mean of dependent variable = 5.18.

The monthly growth rate of trend industrial production of 0.19 percent corresponds to an annual trend growth rate of about 2.25 percent.

KEXP -- Capital Expenditures for Manufacturing Plant and Equipment Real, seasonally adjusted.

Source: Chawner (1941).

Since Chawner provides data only through 1940, we have generated the quarterly observations for 1941 as follows. Chawner's estimate for 1940 is multiplied by the ratio of nominal net private domestic investment in 1941 to that in 1940 as reported in U.S. Department of Commerce (1976), page 345, Table 5.2, line 3. This annual estimate is then converted into quarterly flows by apportioning the annual flow according to Gilbert's (1947) estimate of the quarterly flows of the sum of new construction and producers' durable equipment. These four nominal, not seasonally adjusted, flows are appended to the Chawner series that ends in 1940. The entire series is then converted to real terms and then seasonally adjusted.

L — Loans

Real, seasonally adjusted.

Source: Banking and Monetary Statistics, pp. 166-193.

NETDD -- Net Demand Deposits

Real, seasonally adjusted. From January 1921 until August 1934, net demand deposits are taken from Banking and Monetary Statistics, pp. 166-193. From September 1934 on, published net demand deposit data are not available. Estimates of nominal net demand deposits are calculated as follows. For the period September 1934 through July 1935, we follow the instructions on pages 65 and 66 in Banking and Monetary Statistics, subtracting U.S. government demand deposits, deposits with other banks, and cash items in process of collection from total demand deposits (pp. 180-183). From August 1935, until the end of the sample in December 1941, nominal net demand deposits are estimated by subtracting deposits with other banks and cash items in process of collection from total demand deposits. These data come from Banking and Monetary Statistics, pp. 182-195.

Though Banking and Monetary Statistics, pp. 65-66, hints that our approximation is likely to be good, we have sought other evidence that our estimates provide an accurate representation of actual net demand deposits. To check on the closeness of our approximation, we have constructed our nominal approximation, $\widehat{NETDD}$, for New York City member banks for the 56 call dates between January 1919 and June 1934. We compare $\widehat{NETDD}$ with the reported nominal net demand deposit, NETDD, for those same dates. Regressing NETDD on $\widehat{NETDD}$ yields:

$$NETDD = 363.5 + 0.94\ \widehat{NETDD} + e$$

$$R^2 = 0.99$$

$$D.W. = 1.21$$

$$S.E.E. = 79.8$$

$$\text{mean of } NETDD = 5238$$

NYSE -- Index of Common Stock Prices

Seasonally adjusted.

Source: Banking and Monetary Statistics, pp. 480-481.

RCP -- Interest Rate on 4- to 6-Month Prime Commercial Paper Seasonally adjusted. Banking and Monetary Statistics, pp. 450-451.

RD -- New York Federal Reserve Bank Discount Rate on Eligible Paper Not seasonally adjusted. Monthly data are weighted averages of daily data, the weights being the proportion of the month each rate was in effect. Banking and Monetary Statistics, pp. 439-443.

RG -- Interest Rate on Government Bonds

Seasonally adjusted. Banking and Monetary Statistics, pp. 468-471.

RL -- Interest Rate on Customers Loans

Seasonally adjusted, 1921-1929, Banking and Monetary Statistics, p. 463.

RR -- Required Reserves

Real, seasonally adjusted. Calculated as RR = (RRDD×NETDD) + (RRTD×TD) since NETDD, and not gross demand deposits, was used in calculating legally required reserves.

RRDD -- Required Reserve Ratio for Demand Deposits

Source: Banking and Monetary Statistics, p. 400.

RRTD -- Required Reserve Ratio for Time Deposits

Source: Banking and Monetary Statistics, p. 400.

RS -- Interest Rate on Short-Term Government Securities

From 1921 through 1930, the rate on 3- to 6-month Treasury notes and certificates is used. From 1931 through 1933, the rate on newly issued Treasury bills is used. From 1934 through 1941, the rate on Treasury bills as measured by dealers' quotations is used. These yields are tax-free until March 1941. From March 1941 until the end of the sample in December 1941, rates are multiplied by one minus the marginal tax rate of 0.31 in order to create a completely tax-free yield series. The tax rate is taken from Frost (1971). Rates are from Banking and Monetary Statistics, p. 460.

TAX -- Federal Government Receipts

Real, seasonally adjusted.

Source: Firestone (1960).

TD -- Time Deposits

Real, seasonally adjusted.

Source: Banking and Monetary Statistics, pp. 166-193.

TOBIN -- "Convertible" Excess Reserves

Real, seasonally adjusted.

TOBIN is the difference between actual reserves, given deposits and current required reserve ratios, and the amount of reserves that would be required, given those same deposits, if the Fed raised required reserve ratios to their congressionally determined legal maxima: $TOBIN_t = (NETDD_t)\times(RRDDMAX_t - RRDD_t) + (TD_t)\times(RRTDMAX_t - RRTD_t)$ where $RRDDMAX_t$ and $RRTDMAX_t$ are the highest level to which the Fed had the authority to raise demand and time deposit requirements as of time t. Actual and legal-maxima reserve requirements are from Banking and Monetary Statistics, pages 365 and 400.

TR -- Total Reserves

Real, seasonally adjusted. Since only reserves held at Federal

Reserve banks counted toward legal reserves during this period, vault cash (VC) is not included.

Source: Banking and Monetary Statistics, pp. 166-193.

VC — Vault Cash

Real, seasonally adjusted.

Source: Banking and Monetary Statistics, pp. 166-193.

W -- Wealth or "Allocable Assets"

Real, seasonally adjusted. Defined as the sum of assets allocated between effective excess reserves, investments, and loans: $W = E + I + L$.