OPEN MARKET OPERATIONS, GOLD FLOWS, AND THE SCISSORS EFFECT: A REINTERPRETATION OF MONETARY POLICY IN THE 1920s

By

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ABSTRACT

Many commentators have attributed the success of Federal Reserve monetary policy during the 1920s to the active use of open market operations to sterilize gold flows and to stabilize aggregate demand. We find, however, that the discount window was "open" during this period, thereby enabling banks to offset Federal Reserve open market operations. Monetary conditions during the 1920s were determined by changes in the Reserve Banks' discount rates. While open market operations were ineffective in altering the level of reserves held by member banks, we document that they produced significant capital gains for the Fed on its bond portfolio.
I. INTRODUCTION

Economists who have examined monetary policy during the 1920s have emphasized the use of "central bank powers to promote internal economic stability as well as to preserve balance in international payments and to prevent and moderate strictly financial crises" (Friedman & Schwartz, 1963, p. 240). In its search for instruments to accomplish these goals, the Federal Reserve began to experiment in the early 1920s with a new technique for implementing monetary policy—open market operations. Many commentators on the 1920s (Hardy, 1932, p. 228; Chandler, 1958, p. 205; Trescott, 1982 p. 212-5) emphasized the ability of the Federal Reserve to affect total bank reserves by buying or selling government securities. But at the same time some commentators (Burgess, 1927, pp. 213; Turner, 1938, pp. 28-32; Friedman & Schwartz, pp. 272, 296; Huynh, 1985, pp. 119-133) recognized an offsetting effect. When the Federal Reserve bought (sold) government securities, member banks reacted by borrowing fewer (more) reserves from the Federal Reserve system. Labelled the "scissors action" by Reed (1930, p. 28), it was carefully analyzed by Friedman & Schwartz (p. 272) and renamed the "scissors effect." The existence of this phenomenon raises serious questions concerning the standard interpretation of open market operations in the 1920s. If member banks can effectively offset the monetary effects of open market operations by adjusting their rediscounting at Federal Reserve Banks, the importance of open market operations as an instrument of monetary policy is called into question.
Our aim in this paper is to examine the magnitude of the scissors effect and to determine the role played by open market operations during the 1920s. In Section II we provide a brief history of the scissors effect and document the important recognition given it during the 1920s. In Section III we estimate a model of borrowed reserves which allows us to test the degree to which the discount window was "open" during this period, thereby allowing the scissors effect to operate. Section IV examines the use of open market operations as a policy tool and attempts to explain why the Federal Reserve usually preceded discount rate changes with open market operations. Section V examines the sterilization of gold flows during this period and concludes that while gold flows were effectively sterilized, the usual description of the sterilization process is highly flawed. We conclude that sterilization was simply another manifestation of the scissors effect. Finally, Section VI summarizes our findings on the operation of the scissors effect and shows how they modify conventional interpretations of Fed monetary policy in the 1920s.

II. A BRIEF INTRODUCTION TO THE SCISSORS EFFECT

The decade of the 1920s was a unique period in Federal Reserve history. Freed from pressures to finance wartime deficits or to maintain gold reserve ratios (as had been the case in 1919 and 1920), the Federal Reserve was at last able to pay more attention to the goal of economic stabilization.\footnote{Concurrently, the System began to experiment with a new tool of monetary policy—open market operations.}
operations. Until 1922, Federal Reserve Banks had purchased
government securities principally for the purpose of securing a
stream of earnings to provide for their expenses and to pay
dividends to member banks (Reed, pp. 25-6, Friedman & Schwartz, p.
251). But with the formation in May, 1922 of the Committee of
Governors on Centralized Execution of Purchases and Sales of
Government Securities by Federal Reserve Banks, the Federal Reserve
formally recognized open market operations as an important tool of
monetary policy.\(^2\) Under the leadership of Governor Benjamin Strong
of the Federal Reserve Bank of New York, this Committee of
Governors (which was reorganized in 1923 as the Open Market
Investment Committee) became the focus of Federal Reserve
policymaking.

The Committee soon recognized that control of bank reserves
through open market operations was not a simple matter. Lester
Chandler (p. 237) states that as early as the spring of 1923,\(^3\)
Federal Reserve officials began to understand that open market
operations produced an offsetting movement in bills discounted.
Benjamin Strong described the relationship to a congressional
committee in 1926 in the following terms:\(^4\)

"Referring to this compensating effect of discounts versus
the sale and purchase of Government securities, let me give
you the changes that took place. Between January, 1922, and
May, 1922, our holdings of Government securities increased
$400,000,000. All of our other earning assets decreased
$430,000,000; in other words, there was a net change of only
$30,000,000, and that was a decrease.

Between June, 1922, and December, 1922, the next period, we
reduced our holdings of Government securities by $330,000,000
and all our other earning assets increased exactly
$330,000,000. One offset the other. In the period March,
1923, to July, 1923, we further reduced our Government
securities holdings $260,000,000, and in that period all other
earning assets went up $160,000,000. That is in the period of the year when there is always liquidation of assets.
Between December, 1923, and September, 1924, we increased our
Government security holdings by $510,000,000. In that period
our discounts went off $750,000,000, and roughly, the
difference, that is, the reduction of earning assets which
exceeded the amount of increase of Government securities
(nearly $200,000,000), was almost wholly caused by imports of
gold.

Between November, 1924 and March, 1925, we had a reduction of
our Government securities of $260,000,000 and an increase of
other earning assets of exactly $260,000,000."

The scissors effect was also of special interest to students
of banking behavior because it served as an explanation for the
seemingly paradoxical relationship between borrowed reserves and
the discount rate. Increases in discount rates should, if other
factors are held constant, reduce the volume of discounting by
members. As is evident from the following regression, the
correlation between borrowed reserves (RESBR) and the New York
Federal Reserve Bank discount rate (NY) is positive over our sample
period (May 1922-Sept. 1929).

(1) RESBR = $-178.93 BIL + 280.38 NY
       (41.20)

\[ R^2 = .948 \quad D-W = 1.30 \]

Friedman and Schwartz (p. 272) explicitly use the concept of the
scissors effect to explain this correlation:

Other things being the same, a rise in discount rates tends
to reduce the volume of discounting by member banks, hence to
reduce Federal Reserve credit outstanding and to tighten
credit conditions, and conversely. But again, other things
are seldom the same. In the first place, the Federal Reserve
System may itself be undertaking other operations that offset
this effect. For example, when the System has wanted to tighten credit conditions it has generally both sold securities and bills and raised discount rates. The sale of securities and bills has reduced reserves of member banks, thereby increasing their desire to discount at any given rate, and conversely. In general this effect has been stronger than the direct effect of the rise in the rate, so that the level of discounts has generally moved in the same direction as the discount rate rather than in the opposite direction--this is the 'scissors effect' of open market operations and discount rates...

The scissors effect is thus as an argument within a model of member banks demand for borrowed reserves. We estimate such a model in the next section.

III. MEMBER BANK DEMAND FOR RESERVES

Throughout the 1920s, discount rates were set at levels sufficiently low that member banks were continuously in debt to Federal Reserve Banks. As a result, the discount rate remained the most important determinant of monetary conditions. Following Laurent (1982) and Hetzel (1982), we will assume that member banks intermediate between the supply of funds from the discount window of Federal Reserve Banks and the demand for bank loans. Profit maximizing banks are assumed to acquire earning assets (i.e., to extend loans and purchase securities) until the marginal return on these earning assets (net of risk and intermediation costs) is equal to the marginal effective cost of borrowing funds at the discount window. (See Figure 1.) Since increases in member bank earning assets simultaneously create deposits elsewhere in the banking system, and thus generate a demand for reserves, the demand
EFFECT OF A REDUCTION IN NON-BORROWED RESERVES

Figure 1.

Figure 2.
for bank credit schedule can be transformed into a demand for bank reserves. (See Figure 2.)

It is commonly assumed in studies of member bank borrowing behavior during the post-World War II era that the Federal Reserve partially rationed funds available through the discount window with devices other than price. (Otherwise, why would profit maximizing banks consistently borrow a much larger quantity of reserves on the federal funds market at interest rates which are often over a percentage point higher than the discount rate?) Monetary historians have made similar claims about discounting in the twenties. Chandler (1958, p. 238) is representative:

When the Federal Reserve sold securities and extracted money from bank reserves, more banks were forced to borrow from the Reserve Banks, and those already borrowing were forced more deeply into debt. Since banks had to pay interest on their borrowings and did not like to remain continuously in debt, they tended to lend less liberally, which raised interest rates in the market.6

In effect these arguments assume that the marginal effective cost of borrowing from Federal Reserve Banks is the discount rate plus a marginal non-pecuniary cost which reflects some undefined rationing cost inflicted on borrowers. It is additionally assumed that these marginal non-pecuniary costs are positively related to the aggregate indebtedness of the banking system to the Federal Reserve Banks. As a result, the marginal non-pecuniary cost of borrowing from the Federal Reserve, MC, is

\[(2) \, MC = NY + \text{RESBR}\]
where NY is the discount rate and RESBR is the quantity of reserves borrowed from the Federal Reserve Banks. This implies an aggregate supply schedule of bank reserves represented in Figure 2. If the marginal return on bank assets is less than the discount rate, member banks would have no incentive to borrow from the Federal Reserve. Total reserves would consist only of non-borrowed reserves. But with higher returns on assets, banks would borrow reserves from the Federal Reserve banks and the marginal cost of these funds would be equal to the discount rate plus marginal non-pecuniary costs, making the slope of the supply schedule equal to a.

Suppose the Federal Reserve sells government securities, and thus reduces non-borrowed reserves. Member banks must now borrow more from the discount window to meet reserve requirements on their current deposit liabilities. But the increased indebtedness would increase the marginal non-pecuniary costs of borrowing from the Federal Reserve and thus induce banks to liquidate some of their earning assets, destroying deposits, and thus reducing the demand for total reserves from R' to R''. As a result, the reduction in non-borrowed reserves is only partially offset by an increase in borrowed reserves, as the rest of the adjustment occurs through a reduction in deposit liabilities.

Thus the degree to which the "scissors effect" operates depends on the value of a. If the discount windows of Federal Reserve banks are open (defined as the situation where a=0), then rationing costs are not imposed on member banks. In this case the
supply of reserves would be completely elastic (as shown by supply schedule \( S_o \) in Figure 2), and full operation of the scissors effect would occur. So long as the discount rate remains constant, the demand for reserves by member banks from the Fed would simply be equal to \( R_o \). Any disturbance, such as the purchase or sale of government securities, would be completely offset by changes in borrowed reserves.

We specify a model of member banks' demand for total reserves which has the marginal cost of borrowed funds and a vector of exogenous variables as arguments. Since the marginal cost of borrowed reserves is \( N + a \) RESBR, the demand for total reserves is specified as the right hand side of relationship (3). The left hand side of (3) represents total reserves, borrowed reserves (RESBR) plus non-borrowed reserves (RESNB).

\[
(3) \quad \text{RESBR} + \text{RESNB} = C_o - b (N + a \text{RESBR}) + c X
\]

Since we are attempting to measure the endogenous response of member banks to exogenous changes in the supply and demand for reserves, we estimate a rearranged version of this equation:

\[
(4) \quad \text{RESBR} = C_o/(1+ab) - b/(1+ab)N - 1/(1+ab)\text{RESNB} + c/(1+ab)X
\]

Using monthly data, we choose May, 1922 as the start of the estimation period, as this month marks the beginning of centralized execution of open market operations by a committee of Reserve bank governors. The estimation period terminates in September, 1929 before monetary policy or the reaction function of banks could have
changed in response to the October, 1929 stock market crash. In order to capture the secular trend in the demand for total reserves we include a linear time trend (T). To account for cyclical fluctuations in the demand for reserves, we include the log of industrial production (LIP) and the log of the wholesale price index (LWPI). The results are reported as regression 1 in Table 1. The regression has a close statistical fit and the coefficients are significant and (with the exception of LIP) have the correct signs. The important finding from the standpoint of analyzing the scissors effect is that the coefficient on RESNB is close to -1. A t-test reveals that it is not significantly different from -1 at the 10% level. The regression coefficients imply an estimated "a" of only .0007. Since some economists (Field, 1984, Friedman, 1988) have found that stock market prices may affect money demand, we have included the Standard & Poors New York stock exchange index in regression 2; the addition of the index does not measurably affect results reported in regression 1. When we use Cochrane-Orcutt estimation to correct the low Durban-Watson statistic, virtually identical results are obtained (see Table 1, regressions 3 and 4).

Since the time series of borrowed reserves and of non-borrowed reserves cannot be easily identified as stationary or nonstationary (on the basis of Dickey-Fuller tests), we correct for trend by estimating the model again in first differences. The results are displayed in Table 2. First differencing does reduce the amount of autocorrelation in the residuals, but the results remain
# TABLE 1
BORROWED RESERVE LEVELS REGRESSIONS, 1922-1929

<table>
<thead>
<tr>
<th>ESTIMATION TECHNIQUE</th>
<th>OLS</th>
<th>OLS</th>
<th>AUTO</th>
<th>AUTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPENDENT VARIABLE</td>
<td>RESBR</td>
<td>RESBR</td>
<td>RESBR</td>
<td>RESBR</td>
</tr>
<tr>
<td>INDEPENDENT VARIABLES</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>-2967.20</td>
<td>-2940.30</td>
<td>-1383.6</td>
<td>-595.16</td>
</tr>
<tr>
<td></td>
<td>(493.13)</td>
<td>(493.35)</td>
<td>(752.71)</td>
<td>(798.92)</td>
</tr>
<tr>
<td>RESNB</td>
<td>-.97</td>
<td>-.97</td>
<td>-.96</td>
<td>-.95</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.03)</td>
</tr>
<tr>
<td>NY</td>
<td>-42.96</td>
<td>-38.30</td>
<td>-24.68</td>
<td>-26.78</td>
</tr>
<tr>
<td></td>
<td>(12.44)</td>
<td>(13.13)</td>
<td>(11.81)</td>
<td>(11.60)</td>
</tr>
<tr>
<td>T</td>
<td>9.20</td>
<td>9.60</td>
<td>6.96</td>
<td>3.06</td>
</tr>
<tr>
<td></td>
<td>(.26)</td>
<td>(.50)</td>
<td>(.76)</td>
<td>(1.71)</td>
</tr>
<tr>
<td>LWPI</td>
<td>1378.40</td>
<td>1367.90</td>
<td>733.62</td>
<td>504.36</td>
</tr>
<tr>
<td></td>
<td>(123.26)</td>
<td>(123.54)</td>
<td>(166.44)</td>
<td>(173.77)</td>
</tr>
<tr>
<td>LIP</td>
<td>-386.11</td>
<td>-384.83</td>
<td>-72.44</td>
<td>6.16</td>
</tr>
<tr>
<td></td>
<td>(54.34)</td>
<td>(54.30)</td>
<td>(94.09)</td>
<td>(96.22)</td>
</tr>
<tr>
<td>STOCK</td>
<td>-.35</td>
<td></td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.33)</td>
<td></td>
<td>(.73)</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>.0007</td>
<td>.0008</td>
<td>.0016</td>
<td>.0019</td>
</tr>
<tr>
<td>b</td>
<td>44.29</td>
<td>39.48</td>
<td>27.42</td>
<td>28.19</td>
</tr>
<tr>
<td>R²</td>
<td>.9937</td>
<td>.9937</td>
<td>.9973</td>
<td>.9974</td>
</tr>
<tr>
<td>D-W</td>
<td>.59</td>
<td>.60</td>
<td>1.46</td>
<td>1.64</td>
</tr>
<tr>
<td>Rho</td>
<td>.88</td>
<td></td>
<td></td>
<td>.96</td>
</tr>
</tbody>
</table>

Data are from Board of Governors of the Federal Reserve System, *Banking and Monetary Statistics, 1943*. Standard errors are in parentheses.
TABLE 2
BORROWED RESERVE FIRST DIFFERENCE REGRESSIONS, 1922-1929

<table>
<thead>
<tr>
<th>ESTIMATION TECHNIQUE</th>
<th>OLS FRESBR</th>
<th>OLS FRESBR</th>
<th>AUTO FRESBR</th>
<th>AUTO FRESBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPENDENT VARIABLE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDEPENDENT VARIABLES</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>4.34 (.249)</td>
<td>1.67 (.264)</td>
<td>3.29 (3.33)</td>
<td>1.60 (3.20)</td>
</tr>
<tr>
<td>FRESNB</td>
<td>-.94 (.03)</td>
<td>-.95 (.02)</td>
<td>-.91 (.03)</td>
<td>-.92 (.03)</td>
</tr>
<tr>
<td>FNY</td>
<td>-25.22 (11.80)</td>
<td>-26.93 (11.49)</td>
<td>-17.99 (11.04)</td>
<td>-20.06 (11.07)</td>
</tr>
<tr>
<td>FLWPI</td>
<td>429.56 (87.59)</td>
<td>393.60 (86.31)</td>
<td>388.67 (87.91)</td>
<td>368.20 (88.11)</td>
</tr>
<tr>
<td>FLIP</td>
<td>-8.61 (96.09)</td>
<td>8.14 (93.65)</td>
<td>34.63 (96.31)</td>
<td>38.61 (95.37)</td>
</tr>
<tr>
<td>FSTOCK</td>
<td>1.84 (.72)</td>
<td></td>
<td></td>
<td>1.37 (.72)</td>
</tr>
<tr>
<td>a</td>
<td>.0024</td>
<td>.0019</td>
<td>.0050</td>
<td>.0040</td>
</tr>
<tr>
<td>b</td>
<td>26.83</td>
<td>28.35</td>
<td>19.77</td>
<td>21.80</td>
</tr>
<tr>
<td>R²</td>
<td>.9935</td>
<td>.9938</td>
<td>.9939</td>
<td>.9941</td>
</tr>
<tr>
<td>D-W</td>
<td>1.52</td>
<td>1.65</td>
<td>1.94</td>
<td>1.97</td>
</tr>
<tr>
<td>Rho</td>
<td></td>
<td></td>
<td>.30</td>
<td>.24</td>
</tr>
</tbody>
</table>

Data are taken from Board of Governors of the Federal Reserve System, Banking and Monetary Statistics, 1943. Standard errors are in parentheses.
substantially the same. The regression coefficient of RESNB is still close to -1, but since the estimate of the regression coefficient of NY is smaller in absolute value than its estimates in level regressions, the estimate of "a" rises to .0024.\(^7\) Correction for autocorrelation (see Table 2, regressions 3 and 4) does not alter the results substantially.\(^8\)

While rhetoric concerning "overborrowing" by member banks was evident throughout the 1920s (see Friedman & Schwartz, pp. 254-66), our estimates of "a" indicate that the discount window was substantially "open" to the banks without substantive restrictions throughout the period. Using the estimates from Table 1, regression 1, it would take a $1429 million reduction in non-borrowed reserves to increase the marginal cost of borrowed funds by 1 percentage point. Since the Federal Reserve's holdings of government securities averaged only $334 million during the period, it would seem that open market operations could not have had an appreciable effect on monetary conditions.

An open discount window has important implications for any analysis of Fed monetary policy. Unless there is a penalty discount rate, which would normally restrict rediscounting to a negligible level, open-market purchases could not be an effective tool of Federal Reserve monetary policy. Our regression results indicate that, in the absence of any change in the discount rate, open market operations would be almost completely offset by changes in member bank discounting behavior.\(^9\)
IV. A RATIONALE FOR OPEN MARKET OPERATIONS

The empirical estimates of the "scissors effect" in the previous section indicate that open market operations were effectively offset by member bank rediscounting, leaving Federal Reserve credit unchanged. In view of the negligible effects of open market operations on monetary conditions (due to the scissors effect described in the previous sections), how can we account for the importance given this instrument within the Federal Reserve System? The start of an explanation may be found in the regular patterns observed in the time series of open market operations. During the 1920s major changes in policy were almost always initiated with open market operations. Moves by the Federal Reserve to restrict credit began with open market sales of government securities followed months later by discount rate increases. Similarly, moves to ease credit and lower discount rates were usually preceded by open market purchases.

This pattern is apparent in Tables 3 and 4. Table 3 displays all discount rate changes at the Federal Reserve Bank of New York during the sample period as well as the System's holdings of government securities during the month in which the change occurred and during the preceding five months. Table 4 splits the sample into rate increases and decreases and shows the monthly changes in the Federal Reserve's holdings of government securities during the previous five months, or the interval since the last discount rate change. In all six instances in which the Fed decreased discount rates, the System purchased government securities during the
### TABLE 3

DISCOUNT RATE CHANGES AND OPEN MARKET OPERATIONS

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISCOUNT RATE</th>
<th>GS</th>
<th>GS1</th>
<th>GS2</th>
<th>GS3</th>
<th>GS4</th>
<th>GS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1922</td>
<td>4.5--4.0</td>
<td>591</td>
<td>603</td>
<td>520</td>
<td>459</td>
<td>357</td>
<td>238</td>
</tr>
<tr>
<td>Feb. 1923</td>
<td>4.0--4.5</td>
<td>356</td>
<td>421</td>
<td>380</td>
<td>325</td>
<td>448</td>
<td>486</td>
</tr>
<tr>
<td>May 1924</td>
<td>4.5--4.0</td>
<td>324</td>
<td>274</td>
<td>244</td>
<td>135</td>
<td>118</td>
<td>106</td>
</tr>
<tr>
<td>June 1924</td>
<td>4.0--3.5</td>
<td>416</td>
<td>324</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 1924</td>
<td>3.5--3.0</td>
<td>539</td>
<td>467</td>
<td>416</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb. 1925</td>
<td>3.0--3.5</td>
<td>384</td>
<td>464</td>
<td>554</td>
<td>588</td>
<td>585</td>
<td>575</td>
</tr>
<tr>
<td>Jan. 1926</td>
<td>3.5--4.0</td>
<td>368</td>
<td>359</td>
<td>332</td>
<td>328</td>
<td>335</td>
<td>329</td>
</tr>
<tr>
<td>April 1926</td>
<td>4.0--3.5</td>
<td>371</td>
<td>336</td>
<td>335</td>
<td>368</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 1926</td>
<td>3.5--4.0</td>
<td>353</td>
<td>380</td>
<td>408</td>
<td>398</td>
<td>371</td>
<td></td>
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<tr>
<td>Aug. 1927</td>
<td>4.0--3.5</td>
<td>439</td>
<td>381</td>
<td>398</td>
<td>291</td>
<td>341</td>
<td>345</td>
</tr>
<tr>
<td>Feb. 1928</td>
<td>3.5--4.0</td>
<td>406</td>
<td>512</td>
<td>606</td>
<td>579</td>
<td>506</td>
<td>501</td>
</tr>
<tr>
<td>May 1928</td>
<td>4.0--4.5</td>
<td>257</td>
<td>351</td>
<td>415</td>
<td>406</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 1928</td>
<td>4.5--5.0</td>
<td>213</td>
<td>232</td>
<td>257</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 1929</td>
<td>5.0--6.0</td>
<td>155</td>
<td>147</td>
<td>179</td>
<td>153</td>
<td>165</td>
<td>197</td>
</tr>
</tbody>
</table>

GS is the Federal Reserve System's stock of government securities in the month of discount rate change. GS1 is the stock one month prior to the discount rate change, etc. The data are from Board of Governors of the Federal Reserve System, *Banking and Monetary Statistics, 1943.*
## TABLE 4

### DISCOUNT RATE CHANGES AND CHANGES IN GOVERNMENT SECURITY HOLDINGS

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISCOUNT RATE DECREASES</th>
<th>GS1</th>
<th>GS2</th>
<th>GS3</th>
<th>GS4</th>
<th>GS5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1922</td>
<td>4.5--4.0</td>
<td>-12</td>
<td>83</td>
<td>61</td>
<td>102</td>
<td>119</td>
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<tr>
<td>May 1924</td>
<td>4.5--4.0</td>
<td>50</td>
<td>30</td>
<td>109</td>
<td>17</td>
<td>12</td>
<td>218</td>
</tr>
<tr>
<td>June 1924</td>
<td>4.0--3.5</td>
<td>92</td>
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<td>92</td>
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<td>3.5--3.0</td>
<td>72</td>
<td>51</td>
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<tr>
<td>April 1926</td>
<td>4.0--3.5</td>
<td>35</td>
<td>1</td>
<td>-33</td>
<td></td>
<td></td>
<td>3</td>
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<tr>
<td>Aug. 1927</td>
<td>4.0--3.5</td>
<td>58</td>
<td>-17</td>
<td>107</td>
<td>-50</td>
<td>-4</td>
<td>94</td>
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<tr>
<td></td>
<td>TOTAL</td>
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<td>148</td>
<td>244</td>
<td>69</td>
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<tr>
<td></td>
<td>AVERAGE</td>
<td>49.1</td>
<td>29.6</td>
<td>61</td>
<td>23</td>
<td>42.3</td>
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</table>

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DISCOUNT RATE INCREASES</th>
<th>GS1</th>
<th>GS2</th>
<th>GS3</th>
<th>GS4</th>
<th>GS5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb. 1923</td>
<td>4.0--4.5</td>
<td>-65</td>
<td>41</td>
<td>55</td>
<td>-123</td>
<td>-38</td>
<td>-130</td>
</tr>
<tr>
<td>Feb. 1925</td>
<td>3.0--3.5</td>
<td>-80</td>
<td>-90</td>
<td>-34</td>
<td>3</td>
<td>10</td>
<td>-191</td>
</tr>
<tr>
<td>Jan. 1926</td>
<td>3.5--4.0</td>
<td>9</td>
<td>27</td>
<td>4</td>
<td>-7</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>Aug. 1926</td>
<td>3.5--4.0</td>
<td>-27</td>
<td>-28</td>
<td>10</td>
<td>27</td>
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<td>-18</td>
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<td>-94</td>
<td>27</td>
<td>73</td>
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<td>4.0--4.5</td>
<td>-95</td>
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</tr>
<tr>
<td>July 1928</td>
<td>4.5--5.0</td>
<td>-19</td>
<td>-25</td>
<td></td>
<td></td>
<td></td>
<td>-44</td>
</tr>
<tr>
<td>Aug. 1929</td>
<td>5.0--6.0</td>
<td>8</td>
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<td>TOTAL</td>
<td>-375</td>
<td>-265</td>
<td>97</td>
<td>-39</td>
<td>-49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AVERAGE</td>
<td>-46.9</td>
<td>-33.1</td>
<td>13.9</td>
<td>-6.5</td>
<td>-9.8</td>
<td></td>
</tr>
</tbody>
</table>

GS is the Federal Reserve System's stock of government securities in the month of the discount rate change. GS-GS1 is the change in holdings between the time of the discount rate change and one month prior to the discount rate change, etc.
relevant interval prior to and including the month of the discount rate change. The average changes in security holdings during each of the five months prior to and including the discount rate change were all positive, as were sixteen of the twenty-one portfolio changes. In seven of the eight episodes in which the Fed increased discount rates, the System sold government securities during the relevant interval prior to and including the month of the discount rate change. In five of the six months prior to and including the discount rate change, the average changes in the Fed's government security portfolio were negative, as were eighteen of the thirty-four monthly portfolio changes.

Early discussions of monetary policy during the 1920s offered several explanations for this coordination of open market operations and discount rate changes. Burgess (1927) and Reed (1931) argued that open market operations made the discount rate "effective". This is a compelling argument only for the case of monetary restraint. Once member banks stop rediscOUNTing at Federal Reserve banks, the discount rate no longer reflects the marginal cost of funds. In order to make the discount rate "effective", the Federal Reserve would have to use open market security sales to induce member banks to borrow from the discount window. With an essentially "open" discount window during the 1920s (as indicated by our estimates in Section III), this explanation is less convincing for the case of discount rate reductions. Moreover, during the sample period bills discounted averaged $738.14 million and never fell below $228 million. At no
time during the 1922-1929 period were member banks out of debt to Federal Reserve banks. If increases in the discount rate ever did lead to a cessation of rediscOUNTing by member banks, the Federal Reserve could engage in open market sales at that time. Given the pattern of borrowing by member banks in the 1920s, there was no compelling reason why open market sales should precede increases in the discount rate.

Benjamin Strong offers an alternative reason for open market operations: 12

Unfortunately, it has always seemed to me that the country has given exaggerated importance to change of the discount rate sentimentally [sic]. The danger is that an advance of rate will operate as a sort of sledge-hammer blow to the feeling of confidence and security of the country as to credit, and that reaction has been somewhat modified by these open market operations ... The effect is less dramatic and less alarming to the country.

It is difficult to understand how the financial effects of an increase in the discount rate can be mollified by significantly increasing the indebtedness of the member banks prior to the announcement of the change. A gradualist policy on the part of the Federal Reserve would call for open market purchases at the time of the discount rate increase to minimize the shock on the marginal cost of borrowed funds. This was not typical of the period, as open market purchases were made in the month of a discount rate increase in only two of eight episodes, and these purchases were extremely small.

The announcement effect could, of course, be reduced by "signalling". If the sale of government securities acts as a
signal of future increases in the discount rate, the financial
effects of the discount rate increase may begin before the
announcement is made, and to the degree that the discount rate
increase is perfectly anticipated, its announcement may have no
effect on financial markets. But if Strong is really referring to
the signalling effects of open market operations, his explanation
raises interesting questions regarding the distribution of rents
resulting from the use of this inside information.

Perhaps part of the answer to the question of the rationale
behind open market operations is contained in the insights offered
by Henry Simons in his 1944 article, "On Debt Policy":

It is generally agreed that the Treasury, perhaps acting in
disguise, should sell bonds to banks in boom times and buy
them during severe deflation. This obviously means, in
general, seeking to maximize capital losses over time,
concentrating purchases at bond-price peaks and concentrating
sales at the lows. (Why such inherently lossful
responsibilities were ever delegated to private corporations,
I have never understood.)

Simons observes that the exclusive use of open market operations
in long-term government securities to stabilize economic activity
poses a dilemma for the Fed. Such a policy of economic
stabilization would lead to capital losses over time, an outcome
which would be incompatible with an institution like the Federal
Reserve during the 1920s. Unlike most other quasi-independent
government agencies, the Fed did not receive an annual
appropriation from the Treasury during this period. It paid its
expenses from earnings on its security portfolio and discounted
paper. Earnings were important to the Fed for another reason.
Regular dividend payments to member banks by the Reserve banks could encourage more banks to become member banks and thereby enhance the position of the System in Congress and among the banking community. Several authors have recently emphasized the importance of earnings in determining Federal Reserve behavior. Toma (1982) and Shughart & Tollison (1983), for example, have constructed models of Federal Reserve behavior based on the utility maximizing behavior of Fed officials. In both models, earnings considerations play an important role in the choice of monetary policy. To our knowledge, however, the capital gains and losses from open market operations have not been explicitly considered.

Once capital gains and losses are explicitly included in the earnings of the Federal Reserve banks, open market operations take on a new importance in the conduct of monetary policy. Let us assume that Fed officials can use two policy instruments (open market operations and the discount rate) to maximize a utility function which has both System earnings (including capital gains and losses when accrued) and economic stabilization as arguments. With two policy instruments, the Federal Reserve is no longer faced with the dilemma of a trade-off between stabilization and capital gains on its portfolio of assets. If the Fed's discount window is "open", the discount rate can be used to control the level of reserves in the banking system. Open market operations allow the System to adjust its portfolio of assets so as to maximize capital gains (or minimize losses) when it alters its monetary policy. If changes in the discount rate are unanticipated, for example, the
System could buy (sell) government bonds prior to discount rate reductions (increases), and thus capitalize on its "inside" information.

Of course, the potential for substantial capital gains or losses only exists for the Fed's portfolio of long-term bonds. From 1923-29 the value of the Federal Reserve banks' long-term government securities amounted to $66,767,000 or 19.57% of the total value ($341,200,000) of its average portfolio of government securities. Weekly figures on the Reserve banks' holdings of government bonds are available from the beginning of 1923.\textsuperscript{13} Table 5 uses this data to construct some crude estimates of the capital gains (or losses) resulting from open market operations in government bonds undertaken prior to changes in the discount rate. For each change in the discount rate, data is presented on the stock of government bonds held at the beginning of the interval, the monthly change in the System's holdings of government bonds, and an index of long-term government bond prices for the relevant periods. In order to establish a benchmark from which to evaluate the effects of open market operations, we first calculate the capital gains (losses) which would result if the Fed left its portfolio of government bonds unchanged during the period and then liquidated the portfolio at a price prevailing during the month following the rate change.\textsuperscript{14} This measure is presented as variable \(C\) in Table 5.\textsuperscript{15} Variable \(D\) measures the gains (losses) resulting from the open market transactions which actually occurred during the interval prior to the discount rate change.\textsuperscript{16} Bond purchases
<table>
<thead>
<tr>
<th>Date</th>
<th>Rate (yield)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 1929</td>
<td>6.5%</td>
</tr>
<tr>
<td>July 1928</td>
<td>6.5%</td>
</tr>
<tr>
<td>May 1923</td>
<td>6%</td>
</tr>
<tr>
<td>January 1926</td>
<td>6%</td>
</tr>
<tr>
<td>February 1924</td>
<td>6%</td>
</tr>
<tr>
<td>August 1927</td>
<td>6%</td>
</tr>
<tr>
<td>April 1926</td>
<td>6%</td>
</tr>
<tr>
<td>August 1924</td>
<td>6%</td>
</tr>
<tr>
<td>June 1924</td>
<td>6%</td>
</tr>
</tbody>
</table>

**TABLE 5**

Discount Rate Changes and Changes in Government Bond Holdings
at prices less than that existing during the month following the rate change create gains while sales at prices below the level existing one month following the rate increase create losses.

During four of the five rate reduction episodes, open market operations added to the hypothetical capital gains on the original portfolio of bonds because the Fed made open market purchases of bonds at prices below those prevailing after the rate reduction. Only during the May 1924 episode did open market operations lead to losses. They were the result of bond sales at prices below those prevailing after the rate reduction. Rate increases present less of a clear-cut picture. In four of the eight episodes, the Fed experienced losses in its open market transactions in bonds. In two of these episodes, bond prices were higher in the month following the discount rate increase than during the previous interval, leading to capital losses on the sales of bonds undertaken prior to both rate increases.

One difficulty with this analysis is that the Fed's opportunity to use "inside information" in bond transactions is defined too narrowly. The choice of time periods used in calculating the gains from open market transactions is predicated on the assumption that discount rate changes are the "surprises" of which only the Federal Reserve has foreknowledge. There are two problems associated with this restrictive assumption. The first is that discount rate changes may be anticipated and therefore may have no "announcement effects". In fact, if discount rate increases are less than expected, or reduce the necessity for
higher rates in the future, bond prices could rise with the announcement of the rate increase. The second is that the Federal Reserve may announce shifts in monetary policy by other means than discount rate changes. As a result, it seems more appropriate to define the "inside information" possessed by the Federal Reserve more broadly as knowledge of the current intent of monetary policy. The time periods chosen to evaluate the gains or losses from bond transactions should then correspond to the broad swings in monetary policy between "ease" and "restraint". In Table 6 we divide our sample period into five episodes: two episodes of "easy money" usually associated with a series of discount rate reductions, two periods of "tight money" usually associated with a series of discount rate increases, and one ambiguous period with a discount rate reduction quickly followed by an increase. With this change in perspective, it becomes apparent that open market transactions in government bonds produced gains in each episode, and the gains were especially large during the last two episodes. During the October 1926--December 1927 "easy money" episode, the rise in bond prices produced hypothetical capital gains on the portfolio of bonds held in October 1926 of $2,963,700. By increasing its bond portfolio by 617% during this episode, the Fed's bond transactions produced additional capital gains of $4,372,800. During the "tight money" episode of December 1927--September 1929, the drop in bond prices produced a huge hypothetical capital loss of $17,723,500 on the portfolio of bonds existing in December 1929. However, by liquidating 87% of its bond portfolio, the System saved
### TABLE 6
CAPITAL GAINS (LOSSES) ON GOVERNMENT BOND PORTFOLIO
BY SELECTED PERIODS

<table>
<thead>
<tr>
<th>Monetary Policy</th>
<th>Period</th>
<th>Discount Rate Changes</th>
<th>Bond Holdings</th>
<th>Bond Prices</th>
<th>Var C</th>
<th>Var D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>Nov. 1923</td>
<td>1924 May 4.5-4.0</td>
<td>18509</td>
<td>95.8</td>
<td>1043.3</td>
<td>101.3</td>
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<tr>
<td></td>
<td>Nov. 1924</td>
<td>1924 June 4.0-3.5</td>
<td>44320</td>
<td>101.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>1924 Aug. 3.5-3.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tight</td>
<td>Nov. 1924</td>
<td>1925 Feb. 3.0-3.5</td>
<td>44320</td>
<td>101.2</td>
<td>1007.3</td>
<td>850.9</td>
</tr>
<tr>
<td></td>
<td>Feb. 1926</td>
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<td>60213</td>
<td>103.5</td>
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<td></td>
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<tr>
<td>???</td>
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<td>1926 Apr. 4.0-3.5</td>
<td>60213</td>
<td>103.5</td>
<td>174.0</td>
<td>60.1</td>
</tr>
<tr>
<td></td>
<td>Oct. 1926</td>
<td>1926 Aug. 3.5-4.0</td>
<td>46611</td>
<td>103.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy</td>
<td>Oct. 1926</td>
<td>1927 Aug. 4.0-3.5</td>
<td>46611</td>
<td>103.8</td>
<td>2963.7</td>
<td>4372.8</td>
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<tr>
<td></td>
<td>Dec. 1927</td>
<td>1928 Feb. 3.5-4.0</td>
<td>287746</td>
<td>110.4</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>May 4.0-4.5</td>
<td>287746</td>
<td>110.4</td>
<td>(17723.5)</td>
<td>14441.9</td>
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<tr>
<td></td>
<td></td>
<td>Jul. 4.5-5.0</td>
<td>37660</td>
<td>103.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aug. 5.0-6.0</td>
<td>37660</td>
<td>103.6</td>
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<td></td>
</tr>
</tbody>
</table>

Federal Reserve bank holdings of government bonds are averages for the last week in each month (in thousands of dollars) and are taken from Resources and Liabilities, Federal Reserve Bulletin, various issues, 1923-1929. Bond prices are an index of government bond prices taken from Banking and Monetary Statistics (1943).
$14,441,900, thereby substantially eliminating the losses that would have been incurred.

V. STERILIZATION AND THE "SCISSORS EFFECT"

The "scissors effect" also provides new insights into the sterilization of gold flows during the 1920s. For example, Friedman & Schwartz (p. 297) maintain that the Federal Reserve consciously sterilized gold flows.

Gold movements were not permitted to affect the total of high-powered money. They were—in the antiseptic term that came into use—sterilized, inflows being offset by open market sales, outflows by open market purchases. As a result, short-term movements in Federal Reserve credit outstanding after 1923 showed a nice inverse relation to corresponding movements in the gold stock.

More recently, Schwartz (1986, pp. 61-2) states:

In the post-World War I period, intervention was indeed exercised by the monetary authorities. For example, from 1923 to 1929 the Federal Reserve System offset inflows of gold by open market sales of government securities and outflows by open market purchases. Federal Reserve credit moved inversely with movements in the gold stock... Similarly, gold standard requirements were ignored by the Federal Reserve System in 1929-31, when gold inflows were not matched by an expansion of the U.S. money stock and the quantity of money was even permitted to decline...

To test this hypothesis, we regressed Federal Reserve credit (FRC) on the gold stock (GOLD):

\[
(5) \quad FRC = 6323.5\text{mil} - 1.285 \text{GOLD} \\
\quad \quad (.18) \\
\quad R^2 = .9655 \quad D-W = 1.73
\]

Our regression results show clearly that "sterilization" was significant during the 1920s in the sense that Federal Reserve
credit is negatively correlated with gold holdings. But this relationship does not carry over to the correlation between gold holdings (GOLD) and government security holdings (USGV) which turns out to be positive:

(6) \[ \text{USGV} = 63.51 \text{ mil} + 0.07 \text{ GOLD} \]

\[
\begin{align*}
R^2 &= 0.0379 \\
D-W &= 1.321
\end{align*}
\]

Since the negative correlation between the Fed's gold holdings and Federal Reserve Credit is not due to open market operations by the Fed, we examine the hypothesis that the gold flows were sterilized by member banks through borrowings at the discount windows:

(7) \[ \text{RESBR} = 6524.2 \text{ mil} - 1.41 \text{ GOLD} \]

\[
\begin{align*}
R^2 &= 0.969 \\
D-W &= 1.53
\end{align*}
\]

In fact the observed "sterilization" could simply be another manifestation of the "scissors effect". Gold inflows add directly to non-borrowed reserves. If the discount rate remains unchanged, member banks will simply adjust by reducing borrowed reserves. As a result, "sterilization" of gold flows is done automatically through the operation of member bank initiatives, not through the conscious use of open market operations by the Federal Reserve System.

However, these correlations do not preclude an active attempt by the Federal Reserve to use open market operations to "sterilize" at a higher level of abstraction. The regressions provided above only examine the hypothesis that the Federal Reserve offset gold flows with open market operations. They do not take into account other \textit{ceteris paribus} factors that may have affected Fed behavior.
Suppose the Federal Reserve takes many other variables into consideration in addition to gold flows when it is determining its open market operations. Specifically, let us assume that the Federal Reserve uses open market operations to offset any disturbance which would affect total reserves (adjusted for trend) and, in addition, to reinforce any change in the discount rate. In fact this is the reaction function tested by Trescott (1982):

\[
(8) \quad \text{USGV} = 1.065\text{bil.} - 1.063 \ \text{RESBR} - 1.176 \ \text{GOLD} + 1.079 \ C \\
\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad (0.054) (0.058) (0.053) \\
\quad - 0.087 \ \text{NY} + 0.009 \ T \\
\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad (0.014) (0.0004)
\]

where \( C \) is currency in circulation.\(^{17}\) Trescott's partial correlation between gold flows and open market operations is highly negative, implying perfect sterilization after taking into consideration all other factors affecting total reserves, the discount rate, and a time trend. But this result could simply be due to the fact that the arguments in Trescott's reaction function are identical with the arguments in our model of member banks' demand for borrowed reserves. One could argue that his results are due to the close fit (indicated by the exceptionally high \( R^2 \) in our equation) between total reserves and a demand schedule for reserves as specified by the discount rate and a trend term. Regardless of the direction of causation, the regression coefficient of the other components of total reserves are constrained to be close to -1 if we hold the demand for reserves constant by including the time trend and the discount rate as explanatory variables. Trescott's reaction function may be just a misspecification of the "scissors
effect". Our regression results do not enable us to "reject" Trescott's results. They do, however, provide another interpretation of the data which is inconsistent with his interpretation. Given the possibility in both equations for feedback between the LHS variable and several of the RHS variables, it is unlikely that this controversy will be resolved within the context of a single equation estimation. A model of the Federal Reserve and the banking system which simultaneously determines discount rates, open market operations, and member bank borrowing is needed if the hypotheses are to be resolved. Whether such a model can be adequately identified remains an open question.

VI. SUMMARY AND CONCLUSIONS

Our analysis has called into question some of the major stylized facts of the monetary history of the 1920s. First, our empirical result indicate that the Federal Reserve did not impose significant nonpecuniary costs on member banks that were in debt to the Reserve banks. "Open" discount rate windows imply that member banks rediscounting could substantially neutralize the monetary effects of open market operations. Our estimate of "a" (from regression 1) of .0007 implies that it would take a $1429 million change in non-borrowed reserves to cause a one percentage point change in the marginal cost of funds to member banks. Since the Fed's average holdings of government securities during the period were only $333.5 million, and its maximum holdings were $606 million, open market operations do not appear to have been an
important tool which the System could use to alter the stock of Federal Reserve credit outstanding or the money supply.

Second, the System regularly engaged in open market operations despite their lack of power to alter federal reserve credit outstanding. Increases in the discount rate were preceded by sales of government securities, while reductions in the discount rate were preceded by purchases. We conclude that Fed officials used its two primary policy instruments (open market operations and the discount rate) to maximize a utility function which has both System earnings (including capital gains and losses when accrued) and economic stabilization as arguments. With two policy instruments, the Federal Reserve did not face the dilemma of a trade-off between stabilization and capital gains on its portfolio of assets. The "open" discount window enabled the Fed to control the level of reserves in the banking system by altering the discount rate. Open market operations allowed the System to adjust its portfolio of assets so as to earn capital gains (or reduce losses) when it alters monetary policy. While this hypothesis offers, at best, only a partial explanation for the observed pattern of open market operations and discount rate changes, our estimates of the capital gains realized in these transactions indicate that the Fed did act on its inside information about future monetary policy to generate capital gains on its portfolio of bonds.

Finally, the conventional wisdom is that the Federal Reserve System sterilized gold flows by engaging in open market operations. However, government security holdings are positively correlated
with the gold stock. Thus it was not the Federal Reserve System that sterilized gold flows; instead sterilization was accomplished by member banks changing their rediscounting at reserve banks. With an open discount rate window, gold flows were automatically sterilized by member banks adjusting their reserves to desired levels. Consequently gold sterilization may be nothing more than another manifestation of the scissors effect.
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Harris, S.E. Twenty Years of Federal Reserve Policy (Cambridge: Harvard University Press, 1933).


Turner, Robert C. _Member-Bank Borrowing_ (Columbus: Ohio State University Press, 1938).


1. See Stabilization Hearings before the House Committee on Banking and Currency, 69 Cong. 1 Sess., Pt 1 (1927), pp. 331-32 and Friedman & Schwartz, p. 240. Turner's discussion (pp. 4-5) emphasizes "that the Treasury Department was mainly responsible for our war-finance policies and that the requirements of Treasury finance continued to demand first attention for many months after the signing of the armistice." If the inflation of 1919 and the deflation and recession of 1920-1921 are seen as consequences of the war and the postwar inflation, then the period in which the Fed could begin to develop its own policies began with the recovery in May 1922. As Turner emphasizes, although many observers regard the 1920s as normal years, they were characterized by "[h]uge gold movements, political attacks growing out of the so-called 'deflation,' disorganized foreign exchanges," and the major economic policy changes implemented by European countries (such as Great Britain) in order to return to the gold standard.

2. See, for example, the discussion in Friedman & Schwartz, pp. 251-4, particularly footnote 15.

3. We are including both acceptances bought and bills discounted in the category of bills discounted. The presumption is that the Reserve banks purchased all acceptances presented by member banks. Since acceptance rate and discount rate changes were highly
correlated during the 1920s (except in 1929 when acceptance rates were reduced and discount rates were increased), acceptance sales and presentation of bills for discounting both represented similarly profitable sources of funds to member banks.

The Tenth Annual Report of the System for 1923 emphasizes the relation between open market operations and discount rate changes and stresses the need for the Fed to coordinate its use of these two tools.

4. Chandler, p. 238. Harris, pp. 175-80, criticizes Strong's choice of periods; he argues that the offsetting movements are not observed for every open market operation. Strong has merely picked out several periods in which the offsetting effect is present. His critique centers on whether the offsetting movements will always be observed in reduced form. He argues, correctly, that gold flows and changes in currency demand will affect the relationship in some periods. In our analysis (see Section III) we account for gold and currency movements, as they are included in non-borrowed reserves.

5. See Hardy, p. 229 for a graph which visually confirms the correlation. Standard errors are in parentheses. The regression uses monthly data from May 1922 to September 1929. Regression analysis is conducted with the SHAZAM regression package.

6. Friedman & Schwartz (pp. 254-66) extensively discuss the
ongoing dispute between the Board of Governors and the New York Reserve Bank on the use of "direct pressure" on member banks who borrow funds from the Reserve Banks to lend for "speculative" purposes. However, rhetoric is not always translated into policy and it appears that the New York Federal Reserve Bank was able to resist the Board's pressures until February, 1929. Even when direct pressure was implemented by (some) Reserve Banks, it was not perceived as a success by some Governors. Friedman & Schwartz (p. 265) state that "[a]fter June [1929], Governor Young came to believe that direct pressure was a total failure; but Miller and especially Hamlin persisted in a favorable view of the policy."

Other economists have emphasized the disinclination of member banks to respond to open market purchases by extending additional credit when they are heavily in debt to the reserve banks. See Reed, pp. 27-8 and Friedman & Schwartz's discussion (p. 267) of Federal Reserve staff attitudes. For contrary views, see Burgess, pp. 210-1 and Willis, 1936, p. 200.

7. This is unsurprising since in first difference form the discount rate variable is an occasional monthly 'blip' followed by a long series of zeros. Since the full adjustment to the discount rate change may not occur during the month of the change, especially when it occurs late in the month, the regression coefficient may not be a good measure of the full adjustment by member banks.
8. All regressions were also estimated with monthly dummy variables to adjust for seasonal demands for credit. The regression results are unaffected by the addition of the seasonal variables.

9. These results are supported by two recent studies of Federal Reserve monetary policy during the 1920s, Toma (1988) and Wheelock (1988). Toma concludes (p. 15) that "the private banking system reacted to open market operations in a way that eliminated any lasting effect these operations might have had on Federal Reserve credit." Wheelock also finds (p. 15) that "open-market operations did not produce systematic changes in bank reserves or in the supply of money."

10. Since some discount rate changes occurred at intervals of less than five months' duration, the interval was shortened to prevent double counting of security portfolio changes.

11. Data from the month of the discount rate change should be interpreted with caution, as we do not know whether the Fed's sales and purchases of government securities within a given month occurred before or after the discount rate change.

13. Before 1923, notes and bonds are consolidated into one category in the Fed's Resources and Liabilities balance sheet.

14. Since bond prices are monthly averages, the effects of a discount rate change occurring late in the month may not be reflected in that month's bond prices.

15. \[ C = \frac{B_{t-x}(P_{t+1} - P_{t-x})}{P_t} \] where \( B_{t-x} \) equals the Fed's bond holdings at the beginning of the interval and \( P_t \) is the relevant bond price.

16. \[ D = \frac{1}{x-4} \sum_{x=0}^{x-4} \Delta B_{t-x} (P_{t+1} - P_{t-x}), \] where \( P \) is the average price over the interval.

17. Total reserves are equal to gold + Federal Reserve credit + Treasury currency - money in circulation - Treasury cash - Treasury deposits - other Federal Reserve accounts. Thus our specification includes all of the elements in Trescott's specification.

18. Toma (1988) runs Granger causality tests to determine whether gold flows caused the Federal Reserve to engage in offsetting open market operations. He concludes (p. 14) that rather than engaging
in defensive open market operations, "the Fed seemed to follow a gold standard rule of increasing government security purchases with a gold inflow."