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4 Bank of England Operations, 1893–1913

John Pippenger

The Bank of England did not publish figures for bankers' deposits until 1967. The first economist to use that information was Goodhart (1972). This study builds on and reexamines the work of Goodhart, whose conclusions conflict with the conventional wisdom about the Bank and the gold standard.

Section 4.1 reviews some of Goodhart's results, section 4.2 examines the long-run operations of the Bank, section 4.3 analyzes short-run behavior, and the final section 4.4 presents the conclusions. An appendix provides spectral estimates of key variables examined in this study.

4.1 Goodhart's Results

Goodhart (1972) analyzed the operations of the Bank of England and British commercial banks and their roles in the functioning of the gold standard from 1891 to 1914. His conclusions about the role of the Bank in the operation of the gold standard challenge the conventional wisdom.

> The strongest link in the causal chain of the classical analysis of the working of the gold standard mechanism is generally considered to be that connecting changes in the reserve base of the commercial banks with fluctuations in the (gold) reserve, or liquidity, position of the central bank. Yet in this study of the working of the system in the UK this is the link which shatters.
>
> . . . there is no simple direct relationship between the variations in the levels of bankers' balances at the Bank and in the level of the reserve in the Bank. (Goodhart 1972, p. 209)

This conclusion rests primarily on two regressions. In the first, monthly data on bankers' balances at the head office of the Bank of England are

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regressed against time, reserves in the Banking Department, and seasonal factors. There is no link between bankers' balances and reserves.

$$\begin{aligned}\text{Bankers' balances} &= 7913.5 + 37.74 \text{ time} \\ &\quad (967.4) \quad (1.97) \\ &\quad - 1.29 \text{ reserves} + \text{seasonals}. \\ &\quad (34.53)\end{aligned}$$

With seasonals $\bar{R}^2 = 0.64$, D.W. $= 1.07$.

Without seasonals $\bar{R}^2 = 0.56$.

The numbers in parentheses are the standard errors.

The second equation is in logs and adds railway freight receipts as a proxy for nominal income.

$$\begin{aligned}\text{Log bankers' balances} &= 4.843 + 0.0006 \text{ time} \\ &\quad (1.142) \quad (0.0003) \\ &\quad + 0.707 \text{ log freight receipts} \\ &\quad (0.167) \\ &\quad + 0.092 \text{ log reserves}. \\ &\quad (0.40)\end{aligned}$$

With Seasonals $\bar{R}^2 = 0.679$, D.W. $= 0.96$.

Without seasonals $\bar{R}^2 = 0.579$.

Now a positive relation between bankers' balances and reserves emerges, but the estimated response to income is several times larger than the response to reserves.

Goodhart also estimates two other relationships that are relevant for the operations of the Bank of England. One attempts to explain the ratio of reserves in the Banking Department to total liabilities of that department—otherwise known as the proportion.

$$\begin{aligned}\text{Log proportion} &= 7.39 + 0.0006 \text{ time} \\ &\quad (0.78) \quad (0.0002) \\ &\quad - 0.79 \text{ log freight receipts} \\ &\quad (0.11) \\ &\quad + 0.53 \text{ log reserves} + \text{seasonals}. \\ &\quad (0.03)\end{aligned}$$

With seasonals $\bar{R}^2 = 0.765$, D.W. $= 0.90$.

Without seasonals $\bar{R}^2 = 0.584$.

The standard errors are in parentheses. Goodhart (1972, p. 206) interprets this result as follows: "It suggests that the Bank must have regularly accommodated, to some large extent, variations in the demand for cash

caused by changes in the level of domestic activity by varying its holdings of other assets, independently of the level of gold reserves."

The final relationship attempts to explain Bank rate in terms of trend and the liquidity position of the Bank of England, first using the proportion and then the reserves as a measure of liquidity.[1]

$$\begin{aligned}\text{Bank rate} &= 4.48 + 0.0012 \text{ time} \\ &\quad (0.89)\ (0.0004) \\ &\quad - 1.09 \log \text{proportion} \\ &\quad (0.22) \\ &\quad + 0.746 \text{ Bank rate } (t-1) + \text{seasonals}. \\ &\quad (0.037)\end{aligned}$$

$$\text{With seasonals } \bar{R}^2 = 0.795.$$

$$\text{Without seasonals } \bar{R}^2 = 0.736.$$

$$\begin{aligned}\text{Bank rate} &= 2.49 + 0.0021 \text{ time} \\ &\quad (0.55)\ (0.0005) \\ &\quad - 0.714 \log \text{reserves} \\ &\quad (0.165) \\ &\quad + 0.756 \text{ Bank rate } (t-1) + \text{seasonals}. \\ &\quad (0.038)\end{aligned}$$

$$\text{With seasonals } \bar{R}^2 = 0.791.$$

$$\text{Without seasonals } \bar{R}^2 = 0.749.$$

The numbers in parentheses are the standard errors. The results show the expected inverse relation between Bank rate and the liquidity position of the Banking Department.

The next two sections reexamine the operations of the Bank of England, employing as much as possible the data used by Goodhart.[2] The first section concentrates on the long-run and the second looks at the short-run behavior of the Bank.

4.2 Long-Run Operations

This section concentrates on long-run behavior by using annual averages of monthly data.[3] The next section, in order to emphasize short-run operations, uses monthly changes.

Sayers (1976, p. 8) points out that the governor of the Bank of England had three primary objectives.

> He had a statutory duty to maintain the convertibility of the note into gold coin; he had a political duty to look after the financial needs of government; and he had a commercial duty to maintain an income for

> the stockholders. Whenever possible, he was running all three horses at once, but if there was a conflict, he knew which he had to put first. He would think of his primary duty as the maintenance of the gold standard.

Although a variety of special situations probably influenced the short-run operations of the Bank, the duties cited by Sayers, particularly the statutory and commercial duties, appear to dominate long-run behavior of the Bank.

4.2.1 Bankers' Deposits and Reserves

Goodhart's most challenging discovery is the weak relationship between reserves in the Banking Department and bankers' deposits at the Bank of England. His results threaten a crucial link in the conventional interpretation of the gold standard.

Consider a very simple model of Bank-portfolio behavior in which desired reserves R depend on deposits and interest rates.

$$R = \alpha_1' i + \alpha_2' BD + \alpha_3' NBD + e, \tag{1}$$

where i is the market rate of interest (or vector of such rates), BD is bankers' deposits, and NBD is nonbankers' deposits at the Bank.[4] Rewriting equation (1) yields an expression describing bankers' deposits.

$$BD = \alpha_1 R - \alpha_2 NBD - \alpha_3 i - \alpha_4 e. \tag{1'}$$

It is hardly surprising that Goodhart finds no link between reserves and bankers' deposits. Equation (1) implies that reserves are correlated with the error term in his regression. In addition, the influence of interest rates and other deposits is ignored. The inclusion of time compounds the problem because time tends to exclude any positive relation between bankers' deposits and reserves generated by growth.

Goodhart's attempt to regress bankers' deposits against time, reserves, and a proxy for income has even less discriminatory power. Consider the following simple linear model for the determination of reserves. The demand for money depends on income and interest rates.

$$M = k_0 + k_1 Y - k_2 i. \tag{2}$$

The supply of money by the banking system depends on notes N plus bankers' deposits at the Bank and interest rates.

$$M = \gamma_0 + \gamma_1 N + \gamma_2 BD + \gamma_3 i. \tag{3}$$

Add a simplified balance sheet for the combined Banking and Issue departments of the Bank.

$$BD + N = R + S, \tag{4}$$

where S is securities held by the Bank.

Equations (2)–(4) imply the following solution for reserves.

$$R = \frac{k_0 - \gamma_0}{\gamma_1} + \frac{k_1}{\gamma_1} Y + \frac{k_2 + \gamma_3}{\gamma_1} i - S + \frac{\gamma_1 - \gamma_2}{\gamma_1} BD. \tag{5}$$

In this equation bankers' deposits are unrelated to reserves if γ_1 equals γ_2. This result however, ignores the fact that banks are free to choose how they hold liquid reserves. For simplicity, suppose they hold notes and deposits at the Bank in some fixed proportion.

$$N = \gamma_4 BD. \tag{6}$$

Equations (4) and (6) imply the following.

$$BD = [1/1 + \gamma_4)](R + S). \tag{7}$$

Substituting equation (7) into (5) yields a solution for reserves that is independent of bankers' deposits at the Bank of England.

$$R = K(k_0 - \gamma_0) + Kk_1 Y - K(k_2 + \gamma_3) i - K\left(\frac{1 + \gamma_4 + \gamma_2 - \gamma_1}{1 + \gamma_4}\right) S, \tag{8}$$

where K equals $1/[\gamma_1 + (\gamma_1 - \gamma_2)/(1 + \gamma_4)]$. Bankers' deposits are unrelated to reserves in equation (8) because those deposits are determined primarily by the public's demand for money and the portfolio decisions of commercial banks.

A more appropriate way to evaluate the link between reserves and bankers' deposits is to estimate an equation like (1). Equation (1) however ignores the Bank's statutory duties and treats the Bank as though it were only another commercial bank. In order to capture the influence of its role as a central bank, a proxy for income and a measure of foreign-relative-to-domestic interest rates are added to equation (1).

If Goodhart's argument that the Bank essentially accommodated the demand for money is correct, then the coefficient for both variables should be negative. Higher rates abroad should lead to a loss of reserves and higher income should increase the money stock leading to a rise in bankers' deposits and an outflow of notes from the Banking Department.

If the Bank operated only as a commercial bank, the coefficients for both these variables presumably would be zero. If however the Bank actively protected convertibility by responding to potential gold flows, then reserves in the Banking Department should increase as domestic income expands and foreign yields rise relative to domestic rates.

The results from estimating such an equation using annual averages of monthly data are as follows, where *t*-statistics are in parentheses.

$$R = -8847.75 + 0.52NBD + 0.57BD$$
$$\quad (1.90)\ (6.82)\qquad (2.29)$$
$$-2661.76i + 9040.07r + 9.35Y.$$
$$\quad (5.17)\qquad (2.96)\ \ (1.54)$$
$$\bar{R}^2 = 0.87,\ \text{D.W.} = 1.73.$$

The domestic interest rate i is the yield on fortnightly loans, r is the French market rate over i, and Y is railway freight receipts.

Including both bankers' deposits and a proxy for income is likely to underestimate the influence of bankers' deposits because those deposits are related to income through the demand for money. The proxy for income therefore is dropped and the equation reestimated. Since eliminating income substantially reduces the D.W. statistics, the equation is estimated using the Cochrane-Orcutt technique.

$$R = -8670.76 + 0.5NBD + 0.82BD$$
$$\quad (1.15)\ (6.21)\qquad (3.25)$$
$$-2113.38i + 8864.09r.$$
$$\quad (3.93)\qquad (2.78)$$
$$\bar{R}^2 = 0.82,\ \text{D.W.} = 1.77,\ \rho = 0.352.$$

The results do not support accommodation. The Bank held reserves against both bankers' deposits and other liabilities. Indeed the Bank seems to have been very conservative, holding up to eighty pounds in reserves for each one hundred pounds of deposits. The results also suggest that the Bank actively protected convertibility by increasing reserves as foreign rates increased relative to domestic rates. Although the coefficient on the proxy for income is not significant in the first regression, it is positive and therefore tends to refute accommodation. The Bank's concern for profit also emerges from these estimates. The coefficient on domestic rates is negative and significant, which is what we would expect from a bank concerned about paying dividends.

4.2.2 Proportion

The proportion P of reserves in the Banking Department to total liabilities was the most common measure of the Bank's liquidity. Goodhart's estimates based on monthly data reveal an inverse relation between the proportion and his proxy for income, which he interprets as support for an accommodative Bank. The analysis of the Bank's demand for reserves however suggests that the proportion should reflect the Bank's concern for dividends and the desire to protect convertibility. The proportion therefore should depend directly on foreign relative to domestic yields and be related inversely to domestic interest rates. In

order to test Goodhart's hypothesis, his proxy for income also is included.

Estimating such a relationship yields the following result.

$$P = 0.318 - 0.052i + 0.193r + 0.0002Y.$$
$$(3.98) \quad (5.29) \quad (3.51) \quad (3.38)$$

$$\bar{R}^2 = 0.73, \text{ D.W.} = 1.69.$$

The fit is good. All of the coefficients are significant at better than the 1 percent level and the Durbin-Watson statistic indicates that there is no serial correlation in the residuals. The evidence does not support accommodation. The Bank systematically reduced liquidity in order to earn income and protected convertibility by becoming increasingly conservative as domestic income increased or foreign rates rose relative to domestic rates.[5]

This result is particularly interesting because it provides insight into how the Bank handled the conflict between its statutory and commercial duties. For example, an upswing in business activity tended to make earning assets more attractive as interest rates rose, but the increased activity also posed a threat to convertibility. The Bank apparently responded to both influences, raising the proportion in response to increasing income and lowering it as interest rates rose. Such a policy of course would make it very difficult to identify a systematic pattern in Bank behavior over the business cycle and may help explain Bloomfield's inability to find evidence supporting the rules of the game in his seminal work (1959).

4.2.3 Bank Rate

The conventional story in which the Bank raises the discount rate in response to a loss of reserves is a disequilibrium process that is not relevant for this section because in the long run the actual and desired portfolio should be equal. Since the Bank of England was only one bank in the London money market and London was only part of the world capital market, in the long run Bank rate should follow rather then influence market rates. Bank rate therefore is assumed to depend primarily on market rates. A proxy for income and a measure of foreign relative to domestic rates were included to see if the Bank responded to potential threats to convertibility. Since the t-statistic for income is less than one, it has been dropped. The final result for Bank rate is as follows.

$$BR = -\ 0.443 + \ 0.882i + \ 1.000r.$$
$$(1.225) \ (18.73) \quad (3.09)$$

$$\bar{R}^2 = 0.95, \text{ D.W.} = 2.26.$$

The fit is very good. Both coefficients are significant at the 1 percent level and there is no evidence of serial correlation in the residuals.

The results indicate that the Bank actively protected convertibility by raising Bank rate basis point for basis point with the rise in French market rates relative to domestic yields. The evidence also suggests that Bank rate did not fully respond to domestic yields. This result however may reflect the fact that i is the yield on fortnightly loans while Bank rate tended to apply to longer maturities.

4.2.4 Summary

Although the results of this section indicate that the Bank was more concerned about profit than is often recognized in the conventional story about the gold standard, the evidence generally supports the conventional wisdom. In the long run the Bank was very conservative, maintaining up to eighty pounds sterling or more in liquid reserves for each hundred pounds in deposits. Such behavior implies that the Bank did play by the rules of the game and bought assets as reserves increased. Of course, if the monetary approach is correct, this behavior had no long-run effect except to alter the Bank's liquidity and earnings.

The evidence also suggests that the Bank responded to foreign financial conditions and followed a mixed monetary policy over the course of the business cycle. Reserves, the proportion, and Bank rate all rose as French market rates rose relative to domestic rates. This movement suggests that the Bank was sensitive to the threat to convertibility from international capital flows. Although the commercial duties of the Bank promoted a procyclical monetary policy, concern for convertibility apparently led the Bank to increase the proportion as nominal income expanded.

4.3 Short-Run Operations

Analysis of long-run behavior of the Bank is relatively straightforward because simultaneity is not a serious problem. In the short run, however, the Bank's portfolio decisions can affect bankers' deposits, interest rates, and other variables, and equations like those estimated in the last section may be biased in the short run.

Two-stage least squares can deal with simultaneity, but it does not appear to be applicable here. The technique requires the use of explanatory variables in the first stage that are independent from the error term in the second stage. No such variables appear to be available. One of course could use two-stage least squares anyway and pretend that the problem was solved. The choice here however is to use OLS and accept the bias due to simultaneity.

The variance of economic time series, including the ones used here,

tends to be dominated by long-run or low-frequency components. Since we want to concentrate on short-run behavior, and differencing tends to filter out long-run components of the variance in time series, the analysis of this section uses monthly changes.[6]

4.3.1 Reserves

The results of the last section indicate that in the long run, desired reserves R^D depend on bankers' balances BD, nonbankers' deposits NBD, market yields i, and foreign-relative-to-domestic interest rates r.

$$R^D = a_0 + a_1 BD + a_2 NBD - a_3 i + a_4 r + e_1, \tag{9}$$

where e_1 is an appropriate error term. Equation (9) describes the Bank's equilibrium or steady-state demand for reserves. This equation can be converted to a short-run model by using a simple stock-adjustment model.

$$\Delta R_t = \lambda_1 (R_t^D - R_{t-1}) + \lambda_2 \Delta G + e_2, \tag{10}$$

where ΔG is the gold flow into (+) and out of (−) the United Kingdom and e_2 reflects other shocks such as internal drains due to holidays.

The solution for reserves implied by equations (9) and (10) is given by equation (11).

$$\begin{aligned} R_t = {} & \lambda_1 a_0 + \lambda_1 a_1 BD + \lambda_1 a_2 NBD - \lambda_1 a_3 i \\ & + \lambda_1 a_4 r + \lambda_2 \Delta G + (\lambda_1 e_1 e_2). \end{aligned} \tag{11}$$

In estimating this equation in first differences, the seasonal components in e_2 are captured with seasonal dummies.[7]

There are two major potential sources for simultaneous-equations bias in this model. Consider a situation in which the Bank has excess reserves. In order to move toward portfolio equilibrium, the Bank buys securities. The purchase of securities raises bankers' deposits, reduces reserves, and tends to lower interest rates. As a result, unless the monetary approach holds even for monthly data, portfolio decisions by the Bank influence bankers' deposits and interest rates. The influence on interest rates however is probably not as important as for bankers' deposits. Purchases of securities almost certainly had an initial pound-for-pound impact on bankers' balances, but the Bank of England was only one of many banks in the London money market and for periods as long as a month there almost certainly was a strong link between the London and world capital markets.

When equation (11) is estimated in first differences, there is significant negative serial correlation in the residuals. The results reported in table 4.1 therefore are based on the Cochrane-Orcutt technique. The OLS results (table 4.2) however are almost identical, as they are for the other two regressions reported in table 4.1.

Table 4.1 **Short-Run Determinants of Reserves, Proportion, and Bank Rate (with first-order autocorrelation correction)**

Independent Variables	Dependent Variables		
	ΔR Estimate (t-statistic)	ΔP Estimate (t-statistic)	ΔBR Estimate (t-statistic)
Constant	−28.25	−0.001	−0.008
	(0.24)	(0.59)	(0.39)
Δi	−199.32	−0.007	0.609
	(0.94)	(1.68)	(14.84)
Δr	−124.33	−0.015	0.317
	(0.21)	(1.12)	(2.58)
ΔG	526.33	0.009	−0.026
	(10.32)	(7.82)	(2.56)
Mo1	−1366.81	−0.038	−0.081
	(2.57)	(3.10)	(0.72)
M02	3719.67	0.053	−0.036
	(6.49)	(4.05)	(0.30)
Mo3	−878.30	−0.010	0.083
	(1.44)	(0.81)	(0.68)
Mo4	−1981.79	−0.037	−0.058
	(3.46)	(2.96)	(0.50)
Mo5	1191.53	0.030	−0.081
	(2.07)	(2.35)	(0.70)
Mo6	1119.74	0.021	−0.008
	(2.17)	(1.82)	(0.07)
Mo7	−183.78	−0.001	−0.027
	(0.35)	(0.08)	(0.24)
Mo8	240.20	0.013	0.202
	(0.45)	(1.08)	(1.85)

Although equation (11) does a good job of explaining changes in reserves with an $\bar{R}^2$ of 0.60, there is no evidence of a stock-adjustment mechanism. The coefficients for i, r, BD and R_{t-1} are all insignificant. The explanatory power of the equation comes from the seasonal dummies together with gold flows and nonbankers' deposits. The insignificance of bankers' deposits probably results from a tendency for a purchase of securities to increase those deposits and reduce reserves.

4.3.2 Proportion

The long-run model for the proportion is also converted to the short run by using a simple stock-adjustment model. The equilibrium-desired proportion is described by equation (12) and stock adjustment by (13).

$$P^D = b_0 - b_1 i + b_2 r + b_3 Y + \epsilon_1 . \tag{12}$$

$$\Delta P_t = \gamma_1 [P_t^D - P_{t-1}] + \gamma_2 \Delta G + \epsilon_2 . \tag{13}$$

Table 4.1 (continued)

Independent Variables	Dependent Variables: ΔR Estimate (t-statistic)	ΔP Estimate (t-statistic)	ΔBR Estimate (t-statistic)
Mo9	1793.96	0.027	0.210
	(3.45)	(2.33)	(1.94)
Mo10	−1931.22	−0.016	0.056
	(3.42)	(1.21)	(0.46)
Mo11	109.68	0.011	−0.048
	(0.19)	(0.93)	(0.42)
ΔR_{t-1}	0.03		
	(0.66)		
ΔBD	0.07		
	(1.68)		
ΔNBD	0.25		
	(7.02)		
ΔP_{t-1}		−0.241	−1.65)
		(4.09)	(3.10)
ΔY		−0.000	0.000
		(1.11)	(1.25)
ρ	−0.275	−0.220	−0.314
$\bar{R}^2$	0.60	0.44	0.61
h	−0.61	−0.70	(D.W.) 2.06
SE	1602.51	0.037	0.331

Notes: Δ = first difference; R = Bank of England reserves; P = Bank of England proportion; BR = Bank rate; i = market yield on fortnightly loans; r = French market rate over market yield on fortnightly loans; G = gold flows into or out of the United Kingdom; Mo1–Mo11 = seasonal factors; BD = bankers' deposits; NBD = nonbankers' deposits; Y = railway freight receipts (proxy for income).

Equation (14) is the solution for the observed proportion

$$P_t = \gamma_1 b_0 - \gamma_1 b_1 i + \gamma_1 b_2 r + \gamma_1 b_3 Y + \gamma_2 \Delta G + (\gamma_1 \epsilon + \epsilon_2). \tag{14}$$

The error terms here have the same interpretation as in the model for reserves, and seasonal factors again are added.

The results from estimating equation (14) in first differences are reported in table 4.1. They reveal a pattern similar to that for reserves. None of the factors explaining the equilibrium behavior of the proportion are significant. The coefficient for the lagged proportion is significant but negative. Gold flows have the expected sign and are significant. Several seasonal factors also are important.

Although short-run models for reserves and the proportion explain a reasonable amount of the variance in those variables, the results do not show any evidence of a portfolio adjustment mechanism. Even after six

Table 4.2 **Short-Run Determinants of Reserves, Proportion, and Bank Rate (without first-order autocorrelation correction)**

Independent Variables	Dependent Variables: ΔR Estimate (t-statistic)	ΔP Estimate (t-statistic)	ΔBR Estimate (t-statistic)
Constant	−81.94	−0.002	−0.006
	(0.56)	(0.75)	(0.21)
Δi	−208.29	−0.008	0.557
	(0.97)	(1.91)	(13.14)
Δr	−128.78	−0.015	0.285
	(0.22)	(1.20)	(2.33)
ΔG	489.15	0.008	−0.033
	(9.77)	(7.77)	(3.15)
Mo1	−864.48	−0.032	−0.042
	(1.59)	(2.56)	(0.36)
Mo2	3537.34	0.047	−0.088
	(6.18)	(3.62)	(0.72)
Mo3	−146.97	−0.001	0.079
	(0.24)	(0.10)	(0.64)
Mo4	1758.14	−0.039	−0.054
	(3.09)	(3.10)	(0.46)
Mo5	922.25	0.029	−0.123
	(1.59)	(2.25)	(1.04)
Mo6	1200.92	0.026	−0.013
	(2.33)	(2.19)	(0.12)
Mo7	59.66	0.002	−0.035
	(0.11)	(0.17)	(0.32)
Mo8	214.27	0.012	0.180
	(0.40)	(1.06)	(1.62)
Mo9	1829.56	0.030	0.213
	(3.53)	(2.58)	(1.94)
Mo10	1867.23	−0.014	0.054
	(3.32)	(1.08)	(0.43)
Mo11	278.10	0.011	0.028
	(0.47)	(0.92)	(0.23)
ΔR_{t-1}	−0.09		
	(1.71)		
ΔBD	0.05		
	(1.45)		
ΔNBD	0.24		
	(7.00)		
ΔP_{t-1}		−0.366	−1.63
		(6.53)	(3.16)
ΔY		−0.00005	0.0004
		(1.10)	(1.08)
$\bar{R}^2$	0.59	0.43	0.57
h	−4.10	−3.63	(D.W.) 2.56
SE	1634.42	0.037	0.347

Notes: See table 4.1.

lags are added for the relevant explanatory variables such as interest rates and income, there is no evidence of stock adjustment.

The lack of any evidence of a stock-adjustment mechanism probably is due to three factors. The first is simultaneous-equations bais, which has already been discussed. The second is our inability to capture many of the short-run influences to which the Bank responded. For example, we can observe changes in reserves, but not the source of those changes. The Bank however had information about the source of reserve changes, whether they were internal or external and, if external, whether the gold came from France or South Africa.

The third, and perhaps most important, factor is the evolution of the Bank's short-run operating procedures. The long-run objectives of the Bank and its equilibrium portfolio probably did not change very much from 1893 to 1913. The short-run operating procedures by which the Bank attempted to reach its equilibrium portfolio however, were continually evolving (see Sayers 1976, pp. 28–60). In the 1890s the Bank had a great deal of trouble making Bank rate effective. It resorted to manipulating gold points, borrowing from private depositors, and engaging in transactions that were very close to open-market operations. After 1907 it relied primarily on Bank rate and rarely used these other techniques. As a result of the evolving short-run operating procedures, the adjustment mechanism changed over time, making it difficult to identify a significant distributed lag for the long-run determinants of the portfolio such as deposits and interest rates.

4.3.3 Bank Rate

Even though they have not been successful, stock-adjustment models for reserves and the proportion can be justified on the grounds that portfolio adjustments are costly. This argument however seems much weaker for Bank rate and so a different approach is used here. As implied by the long-run results, Bank rate depends on domestic interest rates and foreign-relative-to-domestic yields. For the short run, two other factors are added. It is assumed that the Bank raises Bank rate when the desired proportion exceeds the actual proportion and when the domestic gold stock declines.

$$BR_t = d_0 + d_1 i_t + d_2 r_t + d_3[P_t^D - P_{t-1}] - d_4 \Delta G_t + U_t. \tag{15}$$

Substituting equation (12) into (15) yields the solution for Bank rate.

$$BR_t = (d_0 + d_3 b_0) + (d_1 - d_3 b_1) i + (d_2 + d_3 b_2) r - d_3 P_{t-1} + d_3 b_3 Y - d_4 \Delta G_t + (d_3 \epsilon_1 + U_t). \tag{15'}$$

As in the earlier models, seasonal dummies are included and the equation is estimated in first differences.

If one accepts an integrated world capital market, this model probably is less prone to simultaneity bias than the previous short-run models because of the linkage between the London and world capital markets. If however one accepts the conventional story in which high Bank rates induced capital flows and reduced nominal income, simultaneous-equations bias could be very severe.

The results from estimating equation (15′) are reported in table 4.1. They strongly support the model. The 0.61 $\bar{R}^2$ is high for changes. All signs are correct and, except for income, all are significant. The high t-statistics for domestic yields may of course be due partly to a short-run influence from Bank rate to market rates. If the discount rate in France responded to Bank rate and the French discount rate influenced French market yields in the short run, then feedback also could run from Bank rate to r. It seems unlikely however that a rise in Bank rate would cause French market rates to rise by more than domestic rates, which is what is required for a positive coefficient for r. If Bank rate influenced the proportion and gold flow, then simultaneity presumably would work to reduce the coefficients for those variables, in which case their influence on Bank rate would be even stronger than indicated in table 4.1.

The results support the conventional view that the Bank systematically used Bank rate to defend convertibility. A low proportion, gold outflow, or increased tightness in foreign financial markets caused the Bank to raise Bank rate. What remains unclear is what short-run influence Bank rate had on market rates, the proportion, gold flows, or income. Since weekly data exist for all of these variables but income, an analysis of their interdependence based on "causality" tests would be a fruitful project for further research.

4.4 Conclusions

Month-to-month changes in reserves and the proportion appear to be dominated by seasonal factors and external gold flows. There is no evidence that in the short run they responded to bankers' deposits, domestic yields, or foreign-relative-to-domestic interest rates. The absence of any evidence for stock adjustment probably is due to several factors, including simultaneity, important unobserved variables, and changing short-run responses to portfolio disequilibrium. The evidence for Bank rate however is consistent with the conventional wisdom. Both a gold outflow and a high desired-relative-to-actual proportion tended to result in a higher Bank rate.

Analysis of long-run operations of the Bank strongly support the conventional wisdom about the gold standard. The Bank held fractional

reserves against deposits, which implies that it played by the rules of the game and bought securities as deposits and reserves increased. The Bank also actively protected convertibility by increasing both reserves and the proportion as French market rates rose relative to domestic yields. The evidence also indicates that the proportion rose as nominal income increased. In the long run Bank rate appeared to be dominated by domestic market yields. The evidence however, indicates that Bank rate rose as foreign rates increased relative to domestic yields.

The conventional wisdom tends to forget that the Bank was private and had to pay dividends. The results show that, like a normal commercial bank, the Bank of England reduced reserves and the proportion as interest rates increased. The tendency to reduce the proportion as interest rates rose and raise it as nominal income increased meant that the Bank followed conflicting policies over the business cycle. This behavior and the inverse relation between securities and reserves implied by the monetary approach helps explain why Bloomfield (1959) and others have concluded that the Bank did not play by the rules of the game.

Appendix *Spectral Patterns*

Figure 4.A.1 shows spectral estimates for monthly gold flows and changes in bankers' deposits. The variance in changes in bankers' deposits is dominated by cycles of one year or less with a dominant peak at three months and smaller peaks at four and six months.

The dominant elements for gold flows are a strong annual and three-month cycle. Unlike bankers' deposits, spectral estimates do not drop off sharply for cycles longer than one year. Instead estimates tend to drop off for cycles shorter than three months. The spectrum for differences in gold flows—which is used in the regressions—does fall off rapidly for cycles longer than one year.

Figure 4.A.2 shows spectral patterns for monthly changes in reserves and total-earning assets. The spectrum for securities tends to decline as cycle length increases with peaks at about 2.3 and 3.0 months and another at the one-year cycle. Estimates for reserves decline somewhat beyond one year, but reveal much stronger seasonal elements. There are significant peaks at about 2.3, 3.0, 6.0, 9.0, and 12.0 months.

Figure 4.A.3 shows the spectrum for monthly changes in sixty-day U.K.-Treasury-bill rates from 1897 to 1908 and, for comparison, the spectrum for monthly changes in the ninety-day Treasury-bill rate from 1959 to 1970. The pre–World War I period is restricted to the period 1897–1908 so that both periods have approximately the same number of observations. The spectrum for the post–World War II data is essentially

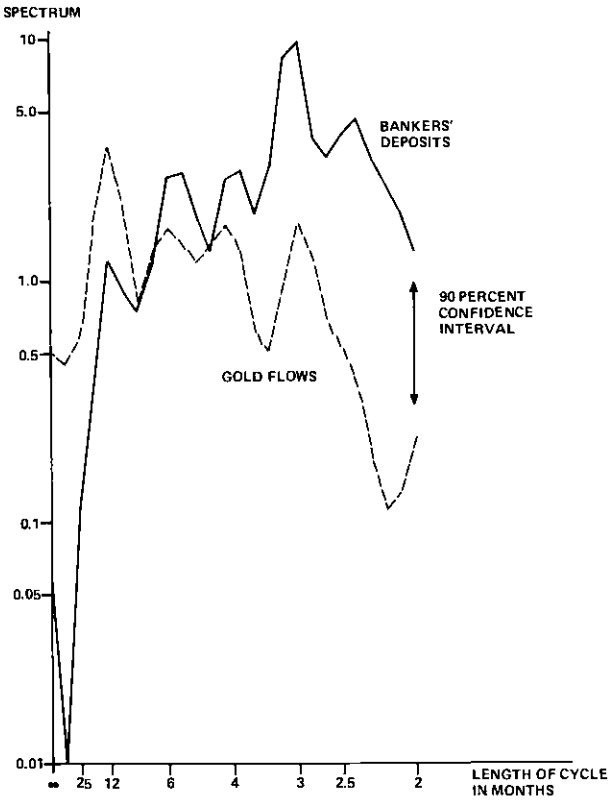

Fig. 4.A.1 Spectral estimates for monthly gold flows and changes in bankers' deposits.

flat. Although estimates seem to rise up to about the one-year cycle and then decline, the Treasury-bill rate behaved essentially like a random walk. Spectral estimates for the gold standard era also increase as cycle length increases, but then drop rapidly for cycles longer than one year. The pattern implies structure in changes in short-run rates under the gold standard. In addition, spectral estimates are much higher at every frequency for the gold standard era, indicating greater variability in interest rates in both the long and short run.

In order to combine the two series effectively, figure 4.A.4 shows the spectral-density estimates for changes in the proportion and changes in the log of the Bank rate. Once again the short run tends to dominate and estimates drop off rapidly beyond the one-year cycle. The proportion has a very strong peak at three months and Bank rate has a definite peak at one year. The decline in spectral estimates for the Bank rate for cycles shorter than about two-and-one-half months probably reflects the inertia

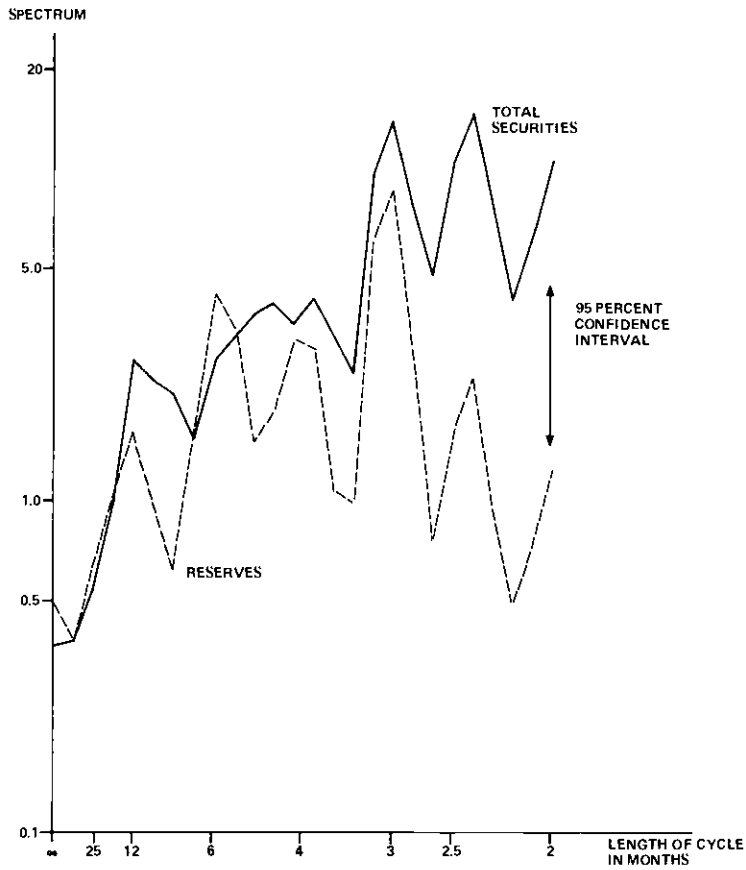

Fig. 4.A.2 Spectral estimates for monthly changes in total securities and reserves.

in the rate generated by the Bank's concern for domestic trade and its reluctance to make small changes (see, for example, Sayers [1936] 1970, pp. 50–54).

The spectra for monthly changes in most of the series tend to be dominated by high-frequency components. The spectral estimates also show that, except for short-term interest rates, most series have strong seasonal components.

Notes

1. No Durbin-Watson statistics are reported for these regressions.
2. Goodhart's series for bankers' balances is not for the same week in the month as his

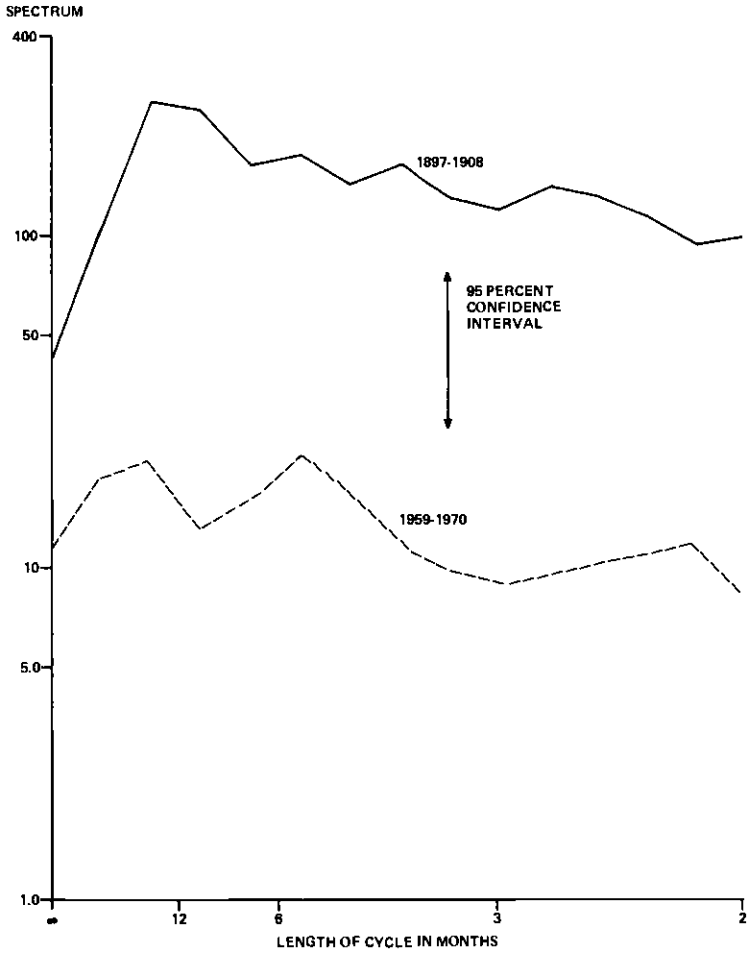

Fig. 4.A.3 Spectral estimates for changes in Treasury-bill rates, 1897–1908 and 1959–70.

other series for the Bank. I therefore used data from the U.S. National Monetary Commission (1910) and information supplied by Goodhart to construct series for the Bank that correspond to the same day of the month as his series on bankers' balances. Bank rate, but not the proportion, is taken from Goodhart's book.

3. The use of nonoverlapping annual averages of monthly observations smooths the data and eliminates most of the short-run noise. When monthly data at twelve-month intervals are used, the signal-to-noise ratio drops and most of the significance disappears.

4. Nonbankers' deposits also include the small item under liabilities called "seven day and other bills."

5. If the Bank held more reserves for bankers' deposits than other liabilities, the proportion would be positively related to those deposits. In that case, Y could be acting as a proxy for BD. That, however, does not appear to be the case because, when bankers' deposits replace the proxy for income, both the $\bar{R}^2$ and D.W. decline.

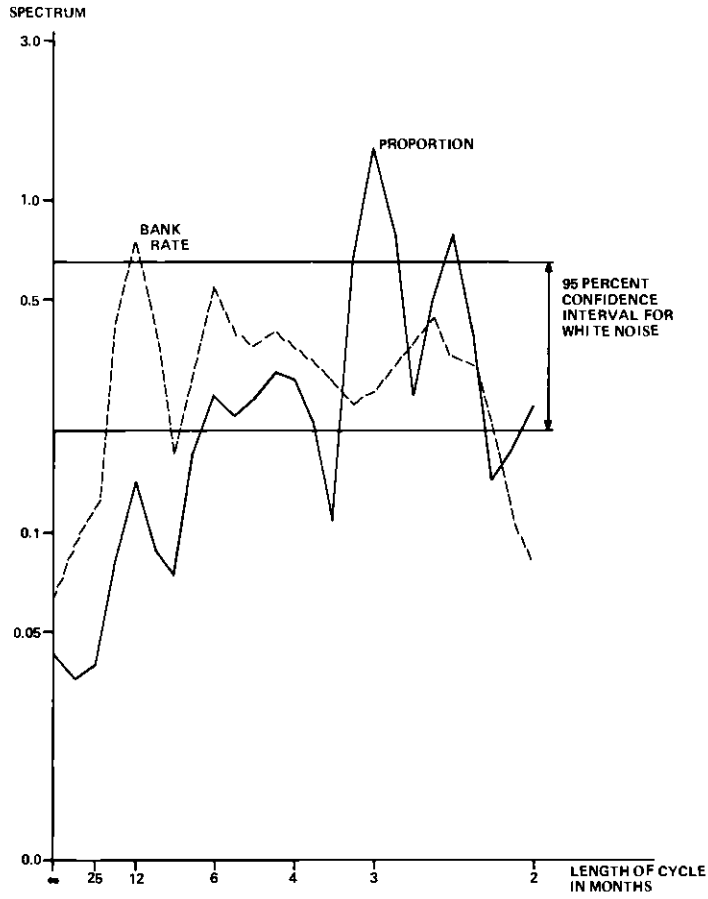

Fig. 4.A.4 Spectral-density estimates for monthly changes in bank rate and proportion, 1893–1913.

6. For those who are interested in the behavior of the variables, their spectral patterns are shown in the Appendix.

7. The Bank's balance sheet gives data for the second week of the month while gold flows are reported for the calendar month. As a result changes in reserves from the second week of June to the second week of July are regressed against the gold flow in June minus the gold flow in May. The same applies to regressions for the proportion and a similar situation also exists for Bank rate.

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———. 1976. *The Bank of England, 1891–1944*. Vol. 1. Cambridge: Cambridge University Press.
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Comment Charles A. E. Goodhart

John Pippenger quotes Richard Sayers on the three main duties of the governor of the Bank of England in the pre-1914 period: to maintain convertibility into gold, a political duty to look after the financial needs of government, and to maintain an income for the stockholders. Such stockholdings ceased in 1946 when the Bank was nationalized, and the fixed-exchange-rate system was abandoned in 1972. But the importance, and at times the difficulties, of the Bank's relationships with the politicians in Whitehall have increased over time. So it is something of a pleasure for me to turn back again to examine the history of a period when it could be said that the operations and objectives of the Bank were largely independently decided within the context of the Bank Act of 1844.

My reading of the papers by John Pippenger and John Dutton leads me to the view that there is a large measure of common agreement among us on the question of the actual way in which the Bank operated—its positive actions. There may be less certainty, or agreement, on what were the reasons, the normative motives, that led to such behavior.

I would characterize the Bank during this period as having a hierarchy of objectives, a lexicographical utility function in our jargon. Although it was only on rare occasions a matter of concern, the fundamental objective of the Bank was, I believe, the maintenance of the basic fabric and structure of the banking and financial system. It is worth remembering that the Bank Act was suspended at times of extreme crises and that the ultimate responsibility of the Bank was to the stability of the financial system itself, not to the gold standard.

Under normal circumstances, however—and, with the exception of the Baring crisis, the whole period up till the outbreak of war in August 1914 could be described as normal—the most important function of the Bank was to protect the convertibility of its notes into gold, i.e., to maintain the

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gold standard. The instrument(s) which it predominantly used for this purpose were short-term interest rates, administered changes in Bank rate and market operations to make Bank rate effective, i.e., to keep market rates in line with Bank rate. The gold devices were a rather lesser adjunct.

Most earlier writers have seen the Bank as adjusting its short-term interest rates solely in response to variations in its liquidity position (i.e., the interest-rate instrument was assigned to the protection of convertibility). Dutton mentions Ford and Bloomfield as taking this view, and in my own work (1972, p. 207) I also related changes in Bank rate only to the Bank's liquidity position. Dutton has now challenged this view since he finds that domestic cyclical variables, especially unemployment, had a perhaps minor but nonetheless significant effect on the decision to make Bank-rate changes. While I accept Dutton's carefully worked econometric findings, it is nevertheless possible to interpret them in more than one way. One interpretation is that there was a trade-off in objectives. For a given loss of reserves, the Bank would raise Bank rate by more (less) if domestic activity was higher (lower). But another possible interpretation was that the state of activity in the country was treated by the Bank as an indicator of the risk of future gold drains, either internal or external, from its reserves. Subject to the above qualification, it is, I hope, generally accepted that the Bank played the gold standard game faithfully in respect of varying short-term interest rates in response to changes in its liquidity position.

In my earlier work I noted that the elasticity of external gold flows in response to relative interest-rate changes was sufficient to provide some accommodation of monetary changes to domestic activity. More interesting, I felt, were my findings that bankers' balances at the Bank were not related to the reserves or the proportion in the Banking Department, but were related to the level of activity. This finding suggested to me that the Bank must have accommodated the demand for cash by buying more securities at times when the reserves and proportion were low and interest rates were high. These results are now supported by Dutton and Pippenger. "Bank-reserve decreases seem to have led to increases in Bank holdings of interest-earning assets. Instead of amplifying the effects of reserve changes on the money supply, the Bank seems to have sterilized them" (Dutton, p. 192). Pippenger also reports that the proportion (of gold reserves to liabilities in the Banking Department) fell when U.K. interest rates were higher. "The Bank systematically reduced liquidity in order to earn income" (Pippenger, p. 209). Having assigned to interest rates the task of protecting convertibility, the Bank's market operations provided a procyclical impulse to the monetary base in the United Kingdom. This conclusion about facts, reached from differing starting points by the three of us, is, I believe, an important finding.

Why did the Bank behave this way? Here there are a range of differing interpretations. The first, espoused by Dutton, is that the setting of interest rates by a central bank leaves it, during the period such rates are fixed, passively responding to demands for accommodation at that rate. Pippenger notes the inertia in Bank rate and the Bank's reluctance to make small changes. Milton Friedman has regularly complained that the preference of central banks for setting interest rates rather than the monetary base imparts a procyclical bias to monetary changes. It is interesting to find that this may have been the same in the United Kingdom under the gold standard, as subsequently.

The second hypothesis, strongly advanced by Pippenger, is that the Bank was concerned to maintain its profits for its stockholders, thus "the commercial duties of the Bank promoted a procyclical monetary policy" (Pippenger, p. 210). There is certainly evidence that the Bank was concerned to maintain (though *not* to seek to maximize) its profits during this period, and I do not doubt that Pippenger's preferred explanation has some weight (as also does Dutton's inertia hypothesis). My own reading of the literature, however, makes me doubt whether profitability concerns played quite such a major role as Pippenger suggests.

I would, however, tentatively offer a slightly different, but broadly similar, reason for the Bank's behavior. In the earlier part of the nineteenth century, the Bank had achieved a position of market dominance as much (or more) because of its size as from its strategic central position as holder of the main gold reserves and lender-of-last-resort. As the nineteenth century progressed, the relative size of the Bank fell progressively compared with the joint-stock banks around it, and, with the growth of the main London clearing banks, in part by a series of mergers, the Bank came to feel dwarfed and even threatened in power by them. So, in addition to profits, the Bank may have retained some concern with market share and size. As the size of the bill market increased, other things being equal (i.e., with interest rates raised high enough to maintain convertibility), the Bank, retaining a more than purely residual banker's instinct, would have wanted to keep its share.

If a short digression may be permitted, it was quite largely this fear of being left face-to-face in market operations with the overmighty subjects, in the form of the London Clearing Banks (LCB), that led the Bank in the nineteenth century to encourage and sustain the discount houses, to provide institutional buffers between itself and the LCB. If Americans try to imagine a world in which the Fed had to contend with, say, eight colossal banks throughout the United States dominating the banking system, they might also appreciate the need for buffers in such circumstances. It has been fascinating to me, as a monetary historian, to find that the provisions for revising monetary operations issued by the Bank in August 1981 restated the Bank's preference for dealing through the

discount houses and the bill markets, and for exactly the same reasons—a disinclination to deal face-to-face with the huge clearing banks—as had held in the nineteenth century. Plus ça change, plus c'est la même chose; perhaps a comforting maxim for central bankers!

There could be, I suppose, a third hypothesis to account for the Bank's behavior in this respect—that it was consciously following a procyclical policy, e.g., in order to support "the needs of trade." Although there was, as Dutton notes, some sensitivity in the Bank to the effects of its policy on business conditions, my own assessment is that this hypothesis is the least likely of the three to account for the procyclical variations in the Bank's security holdings. But I have not the evidence, either from contemporary accounts or econometric test (how could this be set up?) to discriminate between these hypotheses.

Since I interpret Pippenger's results, as well as Dutton's, as closely in accordance with my own, why then does Pippenger think he is challenging my findings? You must ask him. Perhaps he thought my claim that "the Bank must have regularly accommodated, to some large extent, variations in the demand for cash" (1972, p. 206), implied that the Bank's motive was *consciously* to do so. If so, he read too much into those words, for it remains entirely consistent with my position for such accommodation to have been the unconscious result of other sources of action, including Pippenger's profit motive.

Nonetheless there are some differences in approach between us. Subject to the gold devices, the maintenance of convertibility required the Bank to buy or sell gold at fixed, known prices. So in the short run, changes in the Bank's reserves were determined by others, not by the Bank. It was *not*, within this time frame, a choice variable that the Bank could determine. The Bank's choice variables were Bank rate and its market operations. Thus I would follow Dutton in setting up equations in which Bank rate or securities holdings are functions, inter alia, of the level of reserves or the proportion. It may be that this concentrates attention on the shorter run: indeed, my reason for including a time variable in my own equations was to try to eliminate the influence of long-run common trends.

I hope Pippenger would accept the above. I think he criticizes me for ignoring the possible effect of longer-term changes in the Bank's demand for reserves. But since any individual short-run observation will tend to be off the Bank's underlying demand function, he has to transform his data into annual averages of monthly data to try and capture his longer-term relationships, so both the time period and data base of our studies were rather diferent. In any case, I find no difficulty in accepting his findings of the relationships between U.K. and French interest rates and the Bank's reserves and proportion, though I would interpret the direction of causality somewhat differently. A problem with his longer-term

approach (see the equation on p. 208) is that both the dependent and (some of) the independent variables will have been growing over time, so that deflation by a scale variable (perhaps preferable to my use of a time dummy) would help to remove common trends. Even in the case of his equation for the proportion (see p. 209), there was a rise between 1893 and 1913 (from 45.7 to 48.5), so that when time is entered as an additional variable, the significant positive coefficient on Y (which appears to contrast so sharply with my own result), disappears.[1]

What Pippenger's reformulated equations have done, for me at least, is to raise the question of the determinants of deposits in the Banking Department that were *not* bankers' balances, *NBD* in his terminology, and also whether the Bank responded differently to changes in *BD* and *NBD*. For example, in the second part of his paper where he sought to examine short-run relationships, Pippenger found a significant positive relationship between monthly changes in the Bank's reserves and in *NBD*. One possible explanation may be that most of the main gold dealers in London had accounts at the Bank (though there could be some question in one or two cases whether the accounts would be classified as a banker's balance or not), so payments for gold purchases (sales) might in the first instance be met by crediting (debiting) an *NBD* account.[2]

In private correspondence with me, John Pippenger also raised the possibility that the Bank may have felt a stronger obligation to hold reserves against *NBD* than against *BD*, perhaps on the grounds that the Bank could rely on the banks' need to hold some minimum level of operational balances. Although the Bank did have an estimate of the latter,[3] I doubt that it is a likely possibility. First, it would suggest that the level of reserves was more under the *short-term* control of the Bank than, I believe, is justified. Second, it hardly squares with the relative sizes of the coefficients for *BD* and *NBD* in Pippenger's earlier equations (p. 208). Be that as it may, Pippenger's work suggests that the behavior of nonbankers' deposits (*NBD*) may also be worth studying. Whether we will also obtain more enlightenment from his spectral patterns, I find more difficult to tell; I did not get much from them.

Both Pippenger's and Dutton's papers applied econometric methods to examine the historical behavior of the Bank. Amidst the differences of econometric techniques and some academic disputations, I have—perhaps hopefully—perceived an emerging consensus of views about the positive facts of—if not the normative motives for—such behavior. That is an advance.

Notes

1. My thanks are due to John Pippenger for running these extra regressions for me.

2. I owe this information to A. F. A. Carlisle who found a record of these accounts in the Bank's archives.

3. See Goodhart 1972, pp. 109–17 and Presnell 1968, pp. 167–228.

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General Discussion of Dutton and Pippenger Papers

MUNDELL made several points drawn from the session as a whole. He noted that it was an historical occasion to hear a discussion by so many economists of an issue that had been close to his heart for some time. From his casual knowledge of economic history he believed that the gold standard has never received so much attention by so many economists in such a concentrated period of time. This testifies to the importance of the subject to the economics profession.

He was struck by two key issues. One was the way in which the international adjustment process worked under the gold standard; the other was the overall global approach to the nineteenth century gold standard. He thought that the transfer problem was swept under the rug at first, but it quickly won attention when empirical issues were discussed. It is important to realize that the transfer problem itself is crucial for an understanding of the gold standard. Thus periods in which international transfers were being made should be used to illustrate the economic events of those years.

Mundell stressed that the transfer problem exists even outside the context of capital movements, reparations payments, or other unilateral transfers. It exists by the very idea that money is transferred from one group to another, which is a shift of purchasing power from one country to another, and a gold flow accompanies the shift either as cause or effect. There is an accompanying transfer of real resources because the country that receives gold has to have income in excess of its expenditures, and the deficit country—the gold exporting country—to effect the transfer has to have expenditure in excess of its income. That is the heart of the earlier mechanism of Gervaise up through the absorption approach to the transfer problems in the balance of payments in the 1950s.

In the literature over the past fifty years there is a great controversy as to whether, in order to effect a transfer, relative prices must change, and whether that change comes about in the terms of trade or in the ratio of international-to-domestic prices. Even Viner at some point understood that there are cases in which relative changes are not crucial to the movement of transfers. Take as an example a small country in the world economy that has to lend or pay money to another small country. With perfect capital and goods mobility, there is no need for any changes in prices. There is simply a shift of expenditures, without any further effects. This shift is a crucial part of the mechanism quite apart from pure capital flows. Liquidity flows, then, are the starting point; secondly, there is the transfer problem; and thirdly, the issue of long-term lending flows or transfers that was involved in the discussion with Brinley Thomas and Moe Abramovitz. In that context of the long swings of economic activity, Britain lends to America, the lending is a result of an expansionary boom in the United States like the railway boom, capital flows to the United States, but the money or the trade transfer is *not* as large as the capital-movement transfer. The explanation comes in the correct solution of the transfer problem, which was discussed most exactly and very precisely in the literature of the 1930s—*not* in the literature of the Keynes-Ohlin controversy but rather in the literature following the review by Sir Dennis Robertson of Viner's *Studies in the Theory of International Trade* (1937). According to Viner, in the discussion of where the gold goes, the key issue is what happens to the demand for money. If the demand for money increases in the gold-receiving country, then the gold has to go to the receiving country. The crucial distinction is whether the demand for money is a function of domestic expenditure or a function of national income. Robertson took the position that the demand for money is a function of national income while Viner took the opposing position that the demand for money is a function of domestic expenditure, which he calls "final purchases" and which Keynes and Meade later on call domestic expenditure.

FRATIANNI pointed out that both the Humean price–specie flow and the monetary approach to the balance of payments suggest that following an expansion of the domestic component of the monetary base, there will be an outflow of gold. In this view, causation runs from domestic credit expansion to gold flows. The reaction-function framework used by Dutton and Pippenger suggests the opposite; according to that framework, the monetary authorities adjust through purchases and sales on the open market to changes in gold flows. The data clearly cannot discriminate between the two views. Thus, the crucial unanswered question is how to go about differentiating between these mechanisms.

Fratianni also raised the question of whether, in Dutton's paper, right-hand-side variables such as gold flows are truly exogenous in the

sense that changes in the independent variables occur before changes in domestic credit expansion. This question is crucial for differentiating between the two possible interpretations of the results.

McGouldrick also expressed the opinion that the correlation between Bank rate and gold flows results from the influence of the first variable over the second.

Dutton responded that econometrically the right-hand-side variables are completely predetermined. Whatever the Bank of England chooses to do at that point is a result rather than a cause.

Mundell stated that whether a positive correlation between gold flows and changes in the Bank's domestic assets was evidence of passive behavior of the Bank or evidence of deliberate policy was important and similar to the debate for the 1945–71 period.

Pippenger responded to Goodhart by arguing that the idea that the Bank of England controlled interest rates in London over any substantial period of time is almost inconceivable. Throughout the nineteenth century, London was the center of an international capital market of vast proportions; the Bank of England was only one relatively small bank in London, a city that was only one part of a large international capital market. Changes in Bank rate merely reflect the fact that the Bank of England sometimes found itself in portfolio disequilibrium. One of the ways the Bank restored portfolio equilibrium in periods when its actual proportion fell below desired levels was to raise Bank rate relative to discount rates in order to discourage discounting at the Bank of England. This maneuver would reduce the Bank's holdings of assets and raise its proportion. The idea that the Bank of England could use Bank rate to control interest rates in Great Britain would imply that over the longer run, if its choice of Bank rate was inappropriate, then its proportion would explode to plus or minus infinity.

Goodhart responded that there was not that much difference between Pippenger's and his own views. Pippenger concentrates on the long run, whereas Goodhart in his earlier work had concentrated on the short run.

In Goodhart's view, Pippenger's analysis of the long run is correct. Under a fixed-exchange-rate system, there is no way that in the long run the United Kingdom could have maintained interest rates out of line with those in the rest of the world without the Bank of England's proportion moving up or down endlessly. In the short run, on the other hand, the Bank of England actually did exert some control over interest rates.

Pippenger disagreed with Goodhart even for the short run. In his view, the Bank of England could no more control market interest rates in London in the 1800s than the Federal Reserve Board can control interest rates in New York today. But this statement is different from saying that the Bank of England cannot influence interest rates—control and influence are different matters. Pippenger agreed that the Bank of England

was capable of influencing interest rates. However, if the Bank of England had attempted to set an inappropriately low rate, it would have been inundated with borrowing and would have found its proportion going to zero. If it had set Bank rate at 20 percent, it would have found that no one borrowed from it, and furthermore that it was earning no income and might go bankrupt. Therefore, it could not act independently of market rates, even in the short run.

GOODHART responded by pointing out that the Bank of England actually operated in markets to try and make Bank rate effective. On many occasions in the nineteenth century, there are indications of concern within the Bank of England that it was not able to make Bank rate effective, at least until the Bank developed mechanisms by which it could affect the amount of cash available in the market. Of course, the range of freedom of any central bank—if not the Fed then certainly the central bank of a relatively small open economy—is severely limited. The Bank of England cannot go out tomorrow and set rates at 30 percent any more than it can go out and set them at 2 percent. But if Bank rate today is 13, then the Bank of England can surely change it up to 15 or change it down to 11. It could do that in the nineteenth century as well.

FREEDMAN returned to the distinction between the long run and the short run. He pointed out that Goodhart and Pippenger seemed to have agreed that in the long run the Bank of England was incapable of maintaining a Bank rate out-of-line with interest rates elsewhere. But that conclusion depends on assumptions about the response of other central banks. If the Bank of England lowered Bank rate and was inundated with discounts, it is important to know how the Bank of France and other central banks responded to the Bank of England's initiative. If they adjusted their discount rates in the same direction, then it was at least conceivable that the Bank of England could impose its rate on the rest of the world.

DORNBUSCH pointed out that the Bank of England never actually discounted at Bank rate. It posted Bank rate but intervened at rates very close to market rates. The actual rates at which transactions took place in any given week took the form of a distribution centered around the market rate. Although Bank rate was infrequently moved, the effective rate of interest charged by the Bank moved week-to-week.

MUNDELL suggested that it may be useful to divide the nineteenth century into two parts when addressing the question of speeds of adjustment. Conditions certainly changed with the invention of the telegraph. The ability of the telegraph to increase the speed with which information was diffused permitted a global market to become established.

Mundell commented also on another difference between the pre-1870 and post-1870 periods, namely, the introduction of flexible silver prices and the bimetallic system, which broke down after 1870. There were

really two worlds: one of silver standard countries and another of gold standard countries. That made a very large difference in the interpretation of the two periods.

EICHENGREEN addressed the seemingly paradoxical results concerning changes over time in the sensitivity of the Bank of England to internal economic conditions. According to Dutton's paper, the Bank of England became less sensitive to changes in internal conditions after 1890, which seems counterintuitive. Eichengreen reported some results by Richard Grossman of Harvard University, who attempted to estimate a similar function for the period 1925–31, finding that the Bank of England again became less sensitive to changes in internal conditions after the First World War. This result is clearly inconsistent with the vast majority of historical studies that indicate the Bank often hesitated to raise Bank rate in the interwar period for fear that its action might injure British industry or arouse Treasury officials. It is certainly conceivable that the vast majority of historical studies are simply wrong, but it is also possible that the reaction-function methodology, the specification, or the empirical techniques adopted by the authors is inappropriate. One way in which the specification may be deficient is that it fails to recognize the existence of nonlinearities in the relationship of Bank rate to internal economic conditions. Such nonlinearities were recognized at the time by the Bank of England: for example, Bank officials apparently believed that Bank rate had to exceed a certain crucial threshold—usually taken to be 4.5 percent—before it began to affect short-term interest rates, and that only when Bank rate remained above that threshold for extended periods were long-term market rates of interest affected. Although commercial-bank overdrafts were extended at rates 0.5 to 1 percent above Bank rate, and although exceptions were sometimes made for favored customers, these rates were normally subject to a floor of about 5 percent. Thus, so long as Bank rate remained at or below 4.5 percent, it could be argued that domestic-credit conditions were unaffected by measures designed to attract gold and short-term capital inflows. Such nonlinearities could be readily incorporated into the reaction-function framework, but the authors' failure to model such institutional detail may bias their results toward insignificance.

MCCLOSKEY argued that the Bank of England's actions only matter if one believes in the price-specie-flow mechanism. That theoretical construct is the intellectual origin of the question of whether the Bank played by the rules of the gold standard game. If one does not believe in the price-specie-flow mechanism, then the question of whether the Bank played by the rules of the game or sterilized gold flows and whether it raised or lowered Bank rate in response to changes in its financial position is irrelevant to the question of what determined the level of interest rates in England and the rest of the world.

GOODHART responded to other discussants by pointing out that Bank rate, at least from 1900 onwards, was varied with frequency. While the Bank of England was concerned to make Bank rate effective, it is also true that movements in Bank rate were regarded as signals and that most of the Bank's business, as Dornbusch noted, was done at rates related to existing market rates. However, when the Bank wished to signal a change of gear, to use Richard Sayers's phrase, it would raise or lower Bank rate and then try to enforce the change in market rates by operating to do so.

PIPPENGER concluded by summarizing his view that the way the Bank of England behaved in the long run is straightforward and fits the conventional view with only minor modifications. What is interesting, therefore, is how the gold standard worked and the Bank's role in its operation, particularly in the short run.

DUTTON concluded with a dissent from the view that the Bank of England's operations had no impact. Even if the Bank had no control over the money supply, Dutton argued, it still retained an influence over the proportion of the money suply that was backed by gold. In any case, it had some control over its gold stocks and had a desire to defend their level.

From reading descriptions of the period, Dutton suggested, it certainly appears that in the short run at least, the Bank of England believed Bank rate could be used to change London money-market rates relative to rates in the rest of world, and, by so doing, that it could induce capital to flow among financial centers. Bank rate did have some effect, despite being simultaneously determined with other interest rates. It could be and was used as a policy tool.