Volume Title: A Retrospective on the Classical Gold Standard, 1821-1931

Volume Author/Editor: Michael D. Bordo and Anna J. Schwartz, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-06590-1

Volume URL: http://www.nber.org/books/bord84-1

Publication Date: 1984

Chapter Title: The Bank of England and the Rules of the Game under the International Gold Standard: New Evidence

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Chapter URL: http://www.nber.org/chapters/c11128

Chapter pages in book: (p. 173 - 202)

3 The Bank of England and the Rules of the Game under the International Gold Standard: New Evidence

John Dutton

3.1 Introduction

This paper is an investigation of the Bank of England's actions under the gold standard in the decades immediately preceding World War I. In particular, I use monthly data on Bank reserves, domestic activity, price changes, and gold inflows from the late 1880s to mid-1914 to determine which variables the Bank reacted to.

The years from 1870 or 1880 until 1914 are frequently regarded as a halcyon period in international monetary relations. Several financial crises occurred (in 1890—the Baring crisis—and in 1893 and 1907), but throughout the period the major central banks were able to maintain gold convertibility of their currencies. Had war not intervened in 1914, the system might have operated reasonably well for decades longer.

At the center of the system was London (Lindert 1969 describes its importance), and at the center of the London financial community was the Bank of England. Actually, in 1914 the Bank was still a private profit-making institution; however, it had for a century and more increasingly taken on quasi-official functions. After Walter Bagehot's publication of *Lombard Street* in 1873, the Bank's position as central bank had become widely recognized and accepted. Because of London's key position in the international financial community, the Bank at that time was clearly the foremost central bank of the world—a role that has special interest for anyone studying the international financial system.

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The author wishes to thank Michael David Bordo, Paul McGouldrick, John Pippenger, Anna Schwartz, Richard Sylla, and the numbers of a North Carolina State University International Trade Workshop for helpful comments and David Dickey for econometrics advice. They are absolved of all responsibility for the final result.

A salient feature of that international financial system is its apparent stability. Bloomfield (1959) points out that exchange rates among countries on gold were essentially unchanging; devaluations were a rarity. Implicitly, balance-of-payments problems were not the disrupting influence they came to be under the Bretton Woods system. Admittedly some economies may have experienced greater instability with respect to certain measures of prices and output than after World War II (see Bordo 1981 for statistics for the United States and the United Kingdom); nonetheless, the international aspects of the system were stable.

Analysts of the pre-1914 era have stressed two explanations of international stability. In the short run, if trade imbalances developed (caused perhaps by exogenous shocks), capital would flow in the opposite direction. This capital counterflow would take place because of the effects of gold flows on money supplies and interest rates. In the United Kingdom, according to the descriptive literature (e.g., Clapham 1970; Sayers 1976), such interest-rate effects were produced by central-bank authorities. Of course, changed flows of capital in response to interest-rate changes were primarily stock-adjustment processes and therefore inherently temporary. For this reason capital flows are not a satisfactory explanation of long-term flow adjustment. Once any capital stock adjustment had taken place and capital stopped moving, the outward gold flows caused by the original trade imbalance would reappear.

A second explanation of long-term adjustment was the Hume price-specie-flow mechanism. According to that explanation, international-payments imbalances resulted in money-supply changes in the countries involved. These in turn caused prices to change (upward in the country receiving gold, downward in the country losing gold), and these price changes altered the international flow of goods in such a way as to eliminate the initial trade imbalance.

Although it does not appear in analyses of international adjustment before World War I, after the war the phrase "rules of the gold standard game" was applied to a prescription for a specific central-bank role in the adjustment process. According to the "rules," central banks had the important role of facilitating international-payments adjustment, either by reinforcing the effects of payments imbalances on the domestic economy so as to speed the adjustment process, or at least by not hindering those effects. According to one definition of the rules articulated by Bloomfield (1959 pp. 47–48):

> A discount rate and credit policy . . . was supposed . . . to have the effect of increasing central bank holdings of domestic income-earning assets when holdings of external reserves rose, and of reducing domestic assets when reserves fell. In this way, the effect of changes in central bank reserve holdings on the domestic credit base would be *magnified* by central bank action.

Bloomfield mentions that Nurkse (1944) applied this definition to the period between the world wars and found that during that period central banks in general did not follow this form of the rules. Bloomfield himself applied the definition to annual data in the 1880–1914 period. He computed the number of times international and domestic interest-earning assets of each central bank moved together, indicating rules compliance, and moved in opposite directions, indicating rules violation. He found for all the observations covered a compliance rate of 34 percent and a violation rate of 60 percent, with the remainder being cases of no change. The comparable figures for the Bank of England in Bloomfield's study were 47 percent and 50 percent.

Pippenger's (1974) study uses a definition of the rules somewhat like Bloomfield's. He regresses Bank of England monetary liabilities on the Bank's stock of gold during the 1890–1908 period and finds a positive and significant relationship when data for periods of a quarter and longer are used, though not when the data are monthly. Pippenger's conclusion is that the Bank responded to gold flows by changing the money supply in the medium to long run but not in the short run. Such long-run behavior, if the response were sufficient, would be in keeping with the rules. Pippenger's coefficient for annual data indicates a bit less than a one-for-one transmission.

Bloomfield notes in his description of the rules that the definition quoted above is by no means the only one. Another possible definition, which he does not explicitly mention, is that central banks refrain from countercyclical domestic policy. Under the rules, central banks were obligated to maintain the convertibility of their currencies. Given the limited nature of their policy tools, that obligation would have left them little capacity to pursue domestic stabilization. In addition, pursuit of the stabilization goal might well have interrupted the process of long-term adjustment to eliminate payments imbalances.

Qualitative discussions provide mixed answers to the question of the incidence of domestic countercyclical policy. Bloomfield (1959, p. 24) himself says: "the view . . . of central banking policy as a means of facilitating the achievement and maintenance of reasonable stability in the level of economic activity and of prices was scarcely thought about before 1914, and certainly not accepted, as a formal objective of policy," but then he goes on to note increasing awareness and sensitivity on the part of central banks to the domestic effects of their actions. Sayers (1976) also notes some sensitivity of the Bank of England to the effects of its policy on business conditions. Apparently, critics of the effects of Bank policy on the domestic economy made their views known (see Dornbusch and Frenkel, this volume). Mints (1945, pp. 188–89) cites several writers of the pre-1914 period who decried those effects. Palgrave, writing in 1903, complains: "Great instability in the rate of discount is a very prejudicial thing to the interests of commerce," and favors minimizing the transmission of disturbances from abroad to the domestic economy ([1903] 1968, p. viii). Whether the Bank actually pursued countercyclical policies or not, certainly the possibility of doing so must have been evident to its directors.

One problem in testing for Bank countercyclical policy is a possible strong negative relationship between reserves and domestic activity. Ford (1962, p. 21) points out that at cyclical peaks high import demand might have coincided with high capital exports, with consequent demands on central-bank reserves. If low reserves led to high Bank discount rates, then the Bank might appear to be following a countercyclical policy without actually doing so. Ford apparently believes the Bank-rate–domestic-activity relationship to be such an indirect one, for he states, "the Bank did not pursue a conscious contra-cyclical policy in its use of Bank Rate" (1962, p. 34). Goodhart (1972, p. 199) presents evidence to support the negative reserve-activity relationship. A regression he reports of the balance-of-trade surplus on an activity variable for the 1890s and early 1900s yielded a significant negative coefficient.

A possible test for separate effects of reserves, domestic activity, and inflation on Bank policy is to include all three in the equations estimated. Dutton (1978) reports such a regression on Bank rate using annual data for 1862–1913. Despite the presence of reserves as a control in the equation, domestic activity, as measured by the rate of unemployment, had a significant positive effect on Bank rate.

Another problem in the interpretation of the effects of domestic activity involves the Bank's profits. If high activity led to high market interest rates, the Bank might have raised its own discount rate as a way of enhancing its profits. Such profit-motivated behavior might appear to be countercyclical policy. It would be hard to discriminate between profit-motivated and purely countercyclical Bank-rate policy. Most of the descriptive literature takes for granted that profit was secondary to other Bank policies. In this paper I assume that it was. Actually, if Bank policy was countercyclical, whether for profitability reasons or otherwise, the Bank would have broken the rules. The need to discriminate between profitability and stabilization as motives may not be important in testing for violations of the rules.

In the present study, I use monthly data available for several series from the late 1880s to 1914 to find out how well Bank actions fit the rules of the game. In doing so, I test for both countercyclical policy on the part of the Bank (ignoring profit motives) and for relationships between Bank holdings of non-interest-bearing reserves and interest-bearing domestic assets. I expect to find, if the Bank followed the rules, that it did not react to domestic activity and inflation in its conduct of policy. I also expect to find, if the Bank followed the rules, that reserve changes and Bank interest-bearing assets moved together, indicating that the Bank did not sterilize the effects of reserve changes on the money supply.

3.2 Specific Variables Considered

3.2.1 Policy Tools

The Bank of England's chief instrument of monetary control was its discount rate, known as "Bank rate." According to Sayers (1976, p. 23), "the accepted doctrine both inside and outside the Bank was that its most important action was the fixing of Bank Rate." Of course, for Bank rate to have an effect, it had to influence market rates of interest. Accordingly, the Bank had to ensure that capital markets in London were dependent on it for at least part of their funds. In fact, many commercial concerns borrowed regularly from the Bank at Bank rate, or at rates closely related to Bank rate. Consequently, during much of the period, that rate constituted the opportunity cost of funds at the margin for market participants. A great deal of the energies of those governing the Bank was expended in making sure at certain key times that Bank rate did constitute that opportunity cost. "Making Bank rate effective" generally involved the use of other more limited tools of the Bank to back up Bank rate.

Altering the Bank's holdings of interest-earning assets—the tool used frequently to "make Bank rate effective"—can be thought of as an early form of open-market operations. To force market participants to borrow at Bank rate, the Bank would in one way or another gain command of additional funds in the market. It did so at times by selling securities, at other times by borrowing against its securities holdings, and at still other times by selling consols spot and buying them forward. All of these procedures removed funds from the market and eventually forced customers to borrow from the Bank. How common these operations were is difficult to say. Clapham notes their use as far back as the midnineteenth century and earlier; he goes on to say that "in the seventeen years from 1873 to 1890 there are only four in which no market borrowing is done, and in several the borrowings are repeated and complex" ([1944] 1970, pp. 295–98). Sayers (1976, pp. 37–43), on the other hand, stresses the relative infrequency of these operations before 1890, though he describes them as used with increasing frequency after that time (see also Morgan 1965 for a description of the practices involved).

A third instrument, in addition to Bank rate and altering the Bank's portfolio, was use of the so-called gold devices. The Bank was required by law to purchase gold with notes and to redeem notes with gold sovereigns on certain set terms of exchange. However, the Bank was free to alter those terms somewhat in favor of persons bringing gold for exchange. It was also free to force its customers to follow the law's conditions more or less exactly in presenting or seeking gold. Thus the Bank could draw more gold by making it more advantageous for customers to bring gold and more costly for them to remove it from the Bank. These practices—lumped together under the name "gold devices"—had the effect of increasing the spread between the gold points, the rates of exchange at which gold could profitably be imported or exported. Sayers (1953, 1976) describes these gold devices in some detail. Their use was in a sense a violation of the rules, since the devices interfered with the free convertibility of gold at clearly specified rates of exchange. They were usually used to retain or attract gold without resorting to extreme Bank-rate changes that would otherwise be necessary. In this paper I ignore the gold devices largely because I have no data series on their use. The descriptive literature portrays them as a relatively minor part of Bank policy.

The policy tool I focus on in the empirical work is Bank rate, since all descriptions feature it as the principal embodiment of policy. Bank-rate information is available in weekly form from several sources, including, for the period 1888 to 1909, a very useful U.S. National Monetary Commission statistical volume (1910). Following Goodhart (1972), I use for each month the Bank rate in effect at the beginning of the month.

I also use a form of the second policy tool, the Bank's prototype form of open-market operations. The U.S. National Monetary Commission volume contains information on Bank holdings of government securities and other domestic interest-bearing assets. As a securities-holdings variable, I use the reported holdings of all such assets at the beginning of each month.

3.2.2 Target Variables

By all accounts, the Bank of England devoted a large share of its attention to ensuring the adequacy of the liquid reserves in its Banking Department. Those reserves formed the base of the credit structure in the United Kingdom. As a result of its lending, the Banking Department's liabilities were generally two or three times its reserves. Some of those liabilities were deposits of the government or of customers of the sort a commercial bank might have. Others, however, were "bankers' balances," and as such constituted a large part of the reserves of the commercial-banking system. Thus any unusual demand for money anywhere in the U.K. economy or from abroad was likely to end up quickly as a demand on the Bank. Only the Banking Department's reserves were available in normal times to meet that demand. Generally the gold reserves in the other half of the Bank, the Issue Department, were considerably larger than Banking Department reserves; however, that gold was by law (the Bank Charter Act of 1844) only to be given up in return for Bank of England notes. Gold held for backing notes not in the hands of the Bank was unavailable for meeting a money demand. Of course that gold was physically within the country and therefore available for emergency use in meeting a demand from abroad. In fact, the 1844 law governing Bank behavior with respect to gold was suspended by a special letter from the cabinet on rare crises occasions. (See Dornbusch and Frenkel, this volume, on the 1847 crises in which domestic liquidity demands supervened on foreign gold demands.) The Bank and government, however, were highly reluctant to suspend the law; for essentially all purposes, then, the Bank's available reserve was that of the Banking Department. For the purposes of this paper, therefore, I use Banking Department reserves as a variable indicating the Bank's ability to meet its liabilities, including its obligation to provide gold in return for its bank notes. I also use another widely watched indicator of reserve position, the "proportion." The proportion was the ratio of reserves to liabilities of the Banking Department. It was of course closely related to the level of reserves. Either of these variables, if they act as expected, should demonstrate a significant inverse relationship to Bank rate in the empirical work. As reserves and/or the proportion dropped, Bank rate should have risen. In some equations a reserve-change variable will be used with Bank securities-holdings changes. In that case, if the Bank adapted its interest-bearing asset-holdings to reinforce the effects of changes in reserve holdings, in accordance with the rules, then the measured relationship should be positive.

In the description of the rules above, I mentioned the rules interpretation that would prohibit a countercyclical reaction of the Bank to domestic activity and prices. The empirical work described below tests for such reactions. On an annual basis, estimates of gross domestic product are available for years quite a bit earlier than those covered in this study. However, on a monthly basis they do not exist. I therefore employ proxies for domestic activity. Goodhart (1972) collected and used railway freight receipts, which were available by month back to the early 1890s. I have borrowed that series for this work. As an alternative I also use an unemployment-rate series originally collected from trade unions. Neither series is a perfect proxy for domestic activity. The railway-receipt series, of course, is unduly representative of certain sectors of the economy. Since it is a revenue series, it reflects not only quantity movements but price movements. The unemployment series applies only to a subset of workers, those in trade unions. In addition that subset altered as the number of trade unions reporting increased. Despite these limitations I employ the two series to test for Bank reactions. If the Bank followed the rules, then Bank rate should not respond to them.

The rate of inflation, like domestic activity, should not have affected

Bank rate if the Bank followed the rules. I have computed a monthly rate of inflation based on a crude wholesale price index collected by Augustus Sauerbeck.

Another variable I use, gold inflows, will serve as an indicator of internationally induced money movements. In some ways a gold inflow is like a positive movement in reserves. Therefore, I enter it in some versions of the securities-holdings equation to see if the Bank responded to gold flows rather than to changes in its own reserves. Unfortunately the data on gold flows are poor. Goodhart (1972) presents two monthly series, one collected by the Bank and the other by the English Board of Trade, both purportedly measuring the same thing. The two series are quite different, indicating that one or the other or both are defective. I have chosen to include gold flows, despite the limitations of the data. I use the Bank of England series; presumably the Bank would use that series, if it used any, to govern its behavior.

3.3 Modeling and Estimation

The question posed is: What variables did the Bank of England react to? To answer it I treat the Bank's policy tools as dependent variables and regress them on several variables to which the Bank might have responded. Of course, any response is founded on a belief by the Bank that its tools in turn would affect these variables. The process of feedback of target variables to the actions of a policy authority is discussed by Sargent (1979, chap. 15). As he notes, proponents of the recently developed rational-expectations hypothesis tend to discount the effectiveness of systematically applied policy tools in influencing economic events. The argument is that individuals and firms, if they come fully to anticipate policy reactions, will take compensatory actions that will obviate the effects of policy. If these analysts are right, then feedback processes, being very regular and predictable, will be ineffectual in altering economic events. As Sargent points out, however, a sufficient condition for feedback policy responses to work is greater and more timely information availability to the policy authority. If such a condition holds, then individual agents will be unable fully to anticipate and compensate for policy actions; those policy actions as a result will have real effects on the economy. In this paper, I assume that the Bank of England at least believed its policy actions, including those determined by feedback rules, to be effective. The appearance of any significant coefficients in the feedback equation would bear out that assumption.

For purposes of testing, the Bank is assumed to react each month to the values of target variables for that month, or more strictly speaking, to forecasts of target variables for that month. The feedback process is modeled in linear form, i.e., the policy-tool variable is treated as a linear function of forecasts of the target variables.

The forecasts, rather than the actual variables themselves, are used for two reasons. First, it is unlikely that the Bank would have full information about the most recent values of its targets at the time of undertaking policy action. Second, the forecasts serve to eliminate problems of simultaneous-equation bias. Two-way causality is implicit in the formulation of the model; policy actions influence targets, and targets, through the feedback mechanism, influence policy actions. The second avenue of causality is the one I test for. One way to reduce the chances of detecting the first direction of causality and mistaking it for the second is to use regressors that are predetermined at the time policy action is taken. In this case, I use forecasts of the target values based on information from previous months.

The ideal forecast series, of course, would be those actually used by Bank officials. However, such series were likely never made completely explicit, much less written down. Proxies for the forecast series must be sought. One approach to forecasting used a great deal of late is that of Box and Jenkins (1976). To predict a variable, they use the past history of the variable, including both past values of the variable itself and past differences between the variable and its predicted value. The equations fitted for forecasting are of the form:

$$Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \ldots + \phi_p Z_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q},$$

where Z_t is the variable at time t (or in some cases changes in the variable), Z_{t-i} is the variable at time $t - i$, a_t is the prediction error at time t, a_{t-i} is the prediction error at time $t - i$, and ϕ_i and θ_i are parameters. The Z_{t-i} terms form the autoregressive part of the process and the a_{t-i} terms are denominated the moving average part. Usually p and q are low numbers ranging from zero to two. If differencing is used, the process is said to be integrated. The acronym ARIMA, for "autoregressive integrated moving average" is commonly used with these models. In much of the empirical work that follows, I use ARIMA models to obtain forecasts for the target variables.

Several objections to this method of generating forecasts may be raised. First, the Bank likely used information other than a variable's past history in generating forecasts for that variable. It probably used other variables, for example. Second, even if the Bank used only a variable's past history in generating its forecast, it might have used a different forecasting process than the equation estimated here. The forecasting equation estimated for a variable in this paper is based on data covering the whole period under consideration. At any given time, of course, the

Bank could have used only data preceding that time. If the pattern a variable followed were stable over the whole period covered, as well as over a suitably long preceding period, then the Bank in principle could have used the forecasting equation used here. If, on the other hand, that pattern were changing, then the equation I estimate here based on data up to 1914 could not, even in principle, have been available to the Bank before 1914. These considerations all imply that the forecast series are at best quite imperfect proxies for the Bank of England's forecasts. The problem can be viewed as one of errors in the variables. In such a case, the observed coefficients will be biased toward zero, making detection of any existing feedback less likely.

Earlier I mentioned the use of predetermined forecasts as a way of eliminating simultaneous-equation bias. Unfortunately, use of those forecasts does not eliminate another "back-door" route by which causality running in the "wrong" direction could be picked up by the equations. If the policy-tool variable is autocorrelated, i.e., if its value at time t is correlated with its value at time $t - i$, then the possibility exists that any results from regressing the policy tool at time t directly on the forecasts could simply reflect relationships of both with the policy tool at time $t - i$. This problem, however, would not exist if the dependent variable at time t were not correlated with its own previous values. One way to meet this condition is to subtract from the dependent variable the part of it that can be predicted from its own past. For this purpose, I use an ARIMA model fitted to each dependent variable to generate predicted values, which are then subtracted from the actual values. The residuals can be thought of as the innovations that occurred each period in the policy variable. The innovations are uncorrelated with each other and therefore will not evidence any spurious back-door relationships with the predetermined target forecasts. This method should yield results reflecting causality going only in the direction from target variables to Bank policy.

The equations fitted with this techinque are of the form $a_t = \hat{X}_t'\beta + \epsilon_t$, where a_t is the time t residual in the ARIMA equation for the policy tool, $\hat{X}_t$ is a vector of forecasts of the target variables, β is a vector of coefficients, and ϵ_t is the error at time t. Despite alterations of the Z and X series, the errors in this equation may still exhibit autocorrelation. If they do, the standard errors of the coefficients may be biased. To remove that autocorrelation and resulting bias, a generalized least-squares procedure may be used (see Theil 1971, p. 253, for a general description of the procedure).

The monthly data for the empirical work come from several sources, all detailed in a data appendix. Most of the series cover the period from the late 1880s to mid-1914; the specific period for each series is listed in table 3.1. Most of the series exhibited marked seasonality. Some also exhibited distinctive time trends. To remove those influences the data were regres-

Table 3.1 **Monthly Means and Trends**

	Bank Rate (percent per annum)	Bank of England Reserves (million £)	U.K. Railway Receipts (thousand £)	Unem-ployment Rate (percent)	Bank of England Proportion (percent)	Bank of England Securities (thousand £)	Gold Flows[1] (million £)
Period	JAN. 1888–JUNE 1914	JAN. 1888–JUNE 1914	JAN. 1893–JUNE 1914	JAN. 1887–JUNE 1914	JAN. 1888–JUNE 1914	JAN. 1888–DEC. 1909	JULY 1891–JUNE 1914
January	4.15	9.65	442.5	4.96	37.3	52,721	0.11
February	3.54	13.98	509.3	4.54	50.0	44,399	0.46
March	3.31	15.22	520.3	4.48	48.3	47,779	0.93
April	3.22	13.11	471.1	4.01	44.3	48,560	0.83
May	3.07	12.83	492.9	3.99	47.0	45,905	1.36
June	3.06	13.82	442.1	3.94	48.6	45,080	1.46
July	2.81	14.07	445.7	4.07	44.5	49,441	0.70
August	2.92	12.99	442.4	4.40	48.0	45,212	1.02
September	3.13	14.92	523.8	4.51	51.9	43,671	−1.28
October	3.58	12.13	565.8	4.57	45.6	46,775	−2.27
November	4.12	10.82	558.4	4.39	45.9	44,848	0.08
December	4.12	11.77	468.9	4.90	48.1	43,961	−0.03
Trend	—	.039/mo.	1.73/mo.	—	—	60.4/mo.	—

Sources: See Appendix.

[1] + = in; − = out.

sed on monthly dummy variables and trend terms. The residuals from those equations were used in subsequent steps. These residuals should be trendless and free of seasonal effects. Table 3.1 also presents the monthly means and estimated-trend coefficients. These statistics, though a secondary feature of this paper, are of interest in themselves. Note the unusually low average reserves and high average interest-earning assets of the Bank during January—the most usual month for issuing financial reports. Those averages apparently reflect the "window-dressing" in which English banks of the period engaged. The practice involved boosting gold and Bank of England note holdings just before public statements of financial condition were to be issued. The higher reserve holdings made the financial conditions of the banks appear more favorable to depositors and others.

Table 3.2 presents the ARIMA equations used to generate the forecasts used as independent variables and the innovations used as dependent variables in the final equations. The Z's represent the detrended series with monthly means removed. L is a lag operator; i.e., $.80L\ Z_t = .80Z_{t-1}$ and $.16L^5\ Z_t = .16Z_{t-5}$. The a's are residuals that are assumed to be "white noise." A variable is a white-noise series if the value of the variable at time t is independent of its value in any other period. If an equation in table 3.2 has "captured" all the explanatory power of the variable's history in explaining its value in the present, then the residual series in that equation will be white noise. The Q-statistic probabilities on the right-hand side of the table are meant to answer the question: What is the probability of obtaining these residuals if they are from a white noise series? The Q-statistics are computed using autocorrelation coefficients of the residual series up through lags 6, 12, 18, and 24. The probabilities reported are all well above .1, indicating that we cannot reject the hypothesis that they are white noise. This fact demonstrates that the equations of the table are good fits and do capture most of the explanatory power present in each variable's history.

One is led to ask why the particular lag structures of table 3.2 show up in the data. The low-order lags are what one might expect, and they show up fairly uniformly. The twelfth-order lags are also to be expected; they represent a bit of seasonality left in the data despite removal of monthly means. The other scattered lag terms of the Bank-rate and -reserves equations are harder to explain. I have been unable to divine any economic explanation of their presence but have simply accepted them.

Before proceeding to report the results of the outlined procedures, I note an additional, similar mode of estimating the feedback equations described above. The use of the forecasting equations of table 3.2 effectively makes the policy variables into functions of lags of the target variables, with specific lag structures imposed from prior information. It seems reasonable also to estimate those equations without imposing lag

Table 3.2 Forecasting Equations and Filters

	Fitted Equation[a]	Q = Statistic[b] Probabilities for Lags: 6	12	18	24
Bank rate (1888)	$Z_t(1 - .80L - .16L^5 + .16L^6 - .09L^9) = a_t$ (21.76) (2.74) (2.64) (2.28)	.424	.512	.727	.732
Reserves (1888)	$Z_t(1 - .85L - .19L^5 + .11L^7 + .14L^{11} - .16L^{12}) = a_t$ (25.19) (4.06) (2.32) (2.39) (2.83)	.956	.991	.945	.989
Proportion (1888)	$Z_t(1 - 1.21L + .24L^2) = a_t\,(1 - .64L)$ (8.78) (1.94) (5.46)	.132	.214	.142	.330
Railway receipts (1893)	$Z_t(1 - .91L)(1 - .24L^{12}) = a_t(1 - .69L)$ (18.52) (8.34) (3.64)	.232	.671	.343	.165
Unemployment (1887)	$Z_t(1 - .72L - .17L^2 - .07L^3) = a_t$ (13.08) (2.51) (1.30)	.628	.436	.675	.849
Inflation rate (1885)	$Z_t(1 - .24L) = a_t$ (4.70)	.503	.154	.243	.234
Securities holdings (1888–1909)	$Z_t(1 - L)(1 - .20L^{12}) = a_t(1 - .57L)$ (11.01) (3.28)	.292	.487	.233	.394
Gold inflow (1891)	$Z_t = a_t(1 + .21L - .30L^2)$ (3.60) (5.18)	.642	.416	.465	.584

[a] Z indicates the variables before filtering; a indicates the variables after filtering and ideally is white noise. L is a lag operator; for example, $.16L^6 Z_t = .16Z_{t-6}$. Beginning year of data indicated; end was June 1914 except where indicated. Asymptotic t-statistics are in parentheses.

[b] The probabilities of obtaining the estimated a's if they are from a white-noise series.

structures, i.e., to enter the lagged target variables themselves (with trend and monthly means removed) rather than the functions of those variables reported in table 3.2. Results of such an estimate procedure are reported below. It follows in some respects a procedure outlined in Nerlove, Grether, and Carvalho (1979, chap. 11).

3.4 Empirical Results

Table 3.3 reports coefficients for forecast variables regressed on the transformed Bank-rate variable. As expected from the descriptive literature on Bank policy, both the reserve level and the proportion showed up as strong influences on Bank rate. The relationship in each case was consistently negative, indicating that Bank rate was raised in response to low values of those variables and vice versa. Apparently the reserve level and the proportion are highly correlated; as a result, when both appear together in an equation, the effect of neither can be measured with precision. When they appear separately, however, each evidences statistically significant coefficients.

Domestic economic activity was entered in some equations in the form of railway freight receipts and in others in the form of the unemployment rate. The former had consistently positive coefficients and the latter consistently negative ones. Both types indicate that Bank rate rose when activity was high and dropped when it was low. The level of statistical significance of the coefficients varied somewhat. The coefficient of unemployment was always high relative to its standard error, but the coefficient of railway receipts dropped when reserves or the proportion were included in the equation. Possibly railway receipts were more closely related to imports than was unemployment; if that were the case, it would be easier to estimate precisely a separate effect of unemployment than it would to estimate an effect for activity as represented by railway receipts.

The rate of inflation also had significant coefficients in several of the equations. Its positive sign apparently indicates that Bank rate rose in response to high predicted rates of inflation and vice versa.

Table 3.4 reports results when the change in Bank holdings of domestic interest-bearing assets is the dependent variable. The relationship between that variable and changes in reserves is of particular interest because of the emphasis Bloomfield (1959) and Nurkse (1944) placed on it. The negative sign on reserve changes (measured here as predicted reserves less actual reserves in the previous month, both adjusted for trend and seasonality) indicates that Bank securities holdings generally increased when reserves were predicted to fall, and vice versa. An increase in those security holdings, other things equal, would lead to an increase in Bank of England notes and gold held by commercial banks and the public, and to an increase in the domestic money supply. The increase would tend to counteract any decrease caused by the withdrawal of reserves to the foreign sector. Thus the Bank at least in part seems to have sterilized the effects of international money flows on the domestic supply of money. As an alternative approach to the Bank's reactions, I estimate similar equations using gold inflows rather than reserve changes. The results, reported in equations 6 through 9, are similar to those described above, though the significance level of the coefficients is substantially lower. Gold inflows, which would normally suggest money-supply increases, led the Bank to respond by selling off securities, thus countering some or all of the change in the supply of money.

In none of the equations of table 3.4 was either of the activity variables significant. The rate of price change, however, appears to be nearly significant. Its positive coefficient indicates that expected increases in prices led to higher Bank holdings of interest-earning assets. The response, if correctly measured, is a procyclical one; that is, higher inflation appears to cause the Bank to expand the British supply of money. This procyclical response contrasts with the apparently countercyclical response reported in table 3.3.

The reserve level was also included in several equations. It had no significant effect in the reserve-change equations, though its coefficients were always positive. When gold inflows were substituted for reserve changes, the reserve level almost assumed statistical significance. Its positive coefficient indicates that the higher the reserves, the greater the inflow of interest-bearing securities into the Bank's portfolio, other things equal.

Table 3.5 contains results of stepwise regressions paralleling the equations of table 3.3. These regressions are estimated by allowing independent variables to enter the equations in order of statistical significance. Only variables significant at the 0.15 level were included in the equations of table 3.5. The independent variables in these equations are lagged values of the detrended, deseasonalized series. Entering lagged values directly avoids imposing a lag structure of the sort imposed in using the ARIMA forecasting equations. The dependent variables are the same "innovations" in Bank rate used for table 3.3.

Because of the loose specification of the equations, table 3.5 is harder to interpret than table 3.3. However, it appears that reserves and/or the proportion had the most significant overall effects on Bank rate. In each case, the sum of the effects is negative. The fact that much of the effect comes from lags of low order lends credibility to the results. The other variable that seems significant is inflation. Its overall effect is positive, as it was also in the table 3.3 equations. Neither of the activity variables appears to be important, though lags 2 and 12 of the railway-receipts variable enter equation 3. Possibly the specification of the equation is too loose for domestic activity to appear significant in the presence of re-

Table 3.3 Bank-rate Equations, 1888–1914

Equation[a]	N^{b}	Reserves $\times 10^{-2}$	Proportion $\times 10^{-2}$	Rlwy Rcpts $\times 10^{-3}$	Unemp $\times 10^{-2}$	Inflation	Autoregressive Terms[c]
1. (1893)	258	−2.07 (2.74)		1.62 (0.95)			Lag 3, −.11(1.76)
2. (1893)	258	−1.72 (2.49)		2.05 (1.28)		1.14 (1.16)	None
3. (1889)	306	−1.54 (2.82)			−3.35 (2.79)		Lag 2, .10(1.76) Lag 12, .13(2.29)
4. (1889)	306	−1.47 (2.76)			−3.19 (2.70)	1.72 (1.92)	Lag 2, .12(2.16) Lag 12, .13(2.32)
5. (1893)	258		−1.80 (3.20)	0.52 (0.30)			None
6. (1893)	258		−1.57 (2.98)	1.01 (0.62)		1.27 (1.31)	Lag 2, .11(1.72)
7. (1888)	318		−1.15 (2.29)		−3.07 (1.98)		Lag 3, −.10(1.87) Lag 12, .10(1.74)1.74)
8. (1888)	318		−0.99 (2.16)		−2.97 (2.12)	1.99 (2.34)	Lag 2, .10(1.80), Lag 3, −.10(1.84) Lag 12, .10(1.80)
9. (1889)	306	−0.75 (0.64)	−1.18 (1.38)				Lag 3, −.10(1.76) Lag 12, .12(2.11)

10. (1893)	258	−0.02 (0.02)	−1.55 (1.80)	1.02 (0.61)		1.27 (1.30)	Lag 2, .11(1.71)
11. (1889)	306	−1.02 (0.97)	−0.42 (0.51)		−2.87 (2.15)	1.70 (1.89)	Lag 2, .12(2.16) Lag 12, .12(2.19)
12. (1889)	306	−2.12 (3.28)					Lag 3, −.11(1.99) Lag 12, .13(2.25)
13. (1888)	318		−1.60 (3.08)				Lag 3, −.11(2.07)
14. (1893)	258			2.99 (1.92)			None
15. (1888)	318				−4.15 (2.84)		Lag 3, −.10(1.72) Lag 12, .10(1.87)
16. (1888)	318					1.92 (2.19)	Lag 3, −.11(2.07) Lag 12, .11(1.93)
17. (1893)	258			3.33 (2.31)		1.71 (1.76)	Lag 2, .11(1.82)
18. (1888)	318				−3.90 (2.98)	2.14 (2.52)	Lag 2, .11(1.98), Lag 3, −.09(1.69) Lag 12, .11(1.94)

Note: *t*-statistics are in parentheses.

[a]Date is beginning year of data; all data extend through June 1914.

[b]N = number of observations.

[c]Indicated are lag number of autoregressive error term, estimated autocorrelation coefficient used in data transformation, and *t*-statistic of parameter.

Table 3.4 Securities-Holdings Equations, 1888–1909

Equation[a]	N^b	Reserve Forecast − Reserves $(-1)\times 10^2$	Reserve $FC \times 10$	Gold Inflow $FC \times 10^2$	Rlwy Rcpts FC	Unemp $\times 10$	Inflation $\times 10^3$	Autoregressive Terms[c]
1. (1889)	252	−6.61						Lag 7, .11(1.78)
		(2.53)						
2. (1889)	252	−5.53	2.20					Lag 7, .11(1.82)
		(1.76)	(0.61)					
3. (1893)	204	−8.96	0.79		−3.21		10.08	None
		(2.31)	(0.17)		(0.33)		(1.70)	
4. (1889)	252	−6.81	1.86			−3.11	9.67	None
		(2.08)	(0.48)			(0.40)	(1.91)	
5. (1889)	252	−6.70	1.80				9.84	None
		(2.06)	(0.47)				(1.96)	
6. (1891)	222			−4.93				Lag 7, .12(1.73)
				(1.49)				
7. (1891)	222		6.35	−3.83				Lag 7, .13(1.96)
			(1.95)	(1.15)				
8. (1893)	204		5.30	−4.94	−6.03		9.70	None
			(1.33)	(1.42)	(0.61)		(1.62)	
9. (1891)	222		6.48	−4.52		1.22	9.65	None
			(1.80)	(1.36)		(0.14)	(1.73)	

Note: t-statistics are in parentheses. FC = forecast.

[a]Beginning year in parentheses; final year is 1909.

[b]N = number of observations.

[c]Figures are lag number of autoregressive term, parameter estimate, and t-statistic (in parentheses).

Table 3.5 Stepwise Regressions on Bank Rate

EQUATION	1	2	3
Explan-			Reserves Lags 1–12
atory	Reserves, Lags 1–5	Proportion Lags 1–12	Proportion Lags 1–12
Variables	Rlwy Rcpts, Lags 1–12	Rlwy Rcpts, Lags 1–12	Rlwy Rcpts, Lags 1–12
Entered	Inflation, Lags 1–12	Inflation, Lags 1–12	Inflation, Lags 1–12
	Reserves		Reserves
Variables[a]	Lag 1 −.0865 (6.08)		Lag 1 −.0989 (7.04)
	2 .0578 (3.56)		2 .0609 (3.83)
Significant	4 .0411 (2.57)		4 .0289 (2.38)
	5 −.0210 (1.50)		7 .0391 (2.49)
at 0.15			8 −.0482 (3.28)
Level		Proportion	Proportion
		Lag 1 −.0218 (3.75)	Lag 6 −.0234 (3.90)
		4 .0127 (1.89)	10 .0134 (1.87)
		6 −.0163 (2.35)	11 .0125 (1.82)
		11 −.0157 (2.92)	
	Railway Receipts	Railway Receipts	Railway Receipts
	None Significant	None Significant	Lag 2 .0012 (1.57)
			12 −.0014 (1.93)
	Inflation	Inflation	Inflation
	Lag 1 .448 (2.19)	Lag 1 .372 (1.75)	Lag 1 .356 (1.76)
	7 .591 (2.91)	5 −.471 (2.17)	5 −.507 (2.40)
	11 .543 (2.64)	7 .417 (1.91)	6 .431 (2.01)
		11 .468 (2.17)	11 .344 (1.69)
R^2	0.24	0.19	0.32

[a] *t*-statistics in parentheses following coefficients. Intercept included but not shown.

serves and/or the proportion. Of course, if either appeared significant despite the loose structure, then the hypothesis that the Bank engaged in countercyclical policy would have been strengthened.

3.5 Interpretation

The question addressed in the paper is: Did the Bank of England follow the rules of the gold standard game? The answer, insofar as it can be given, is a soft-spoken no. The rules, at least in spirit, required that the Bank not react countercyclically to domestic activity or price changes. The results of the equations of table 3.3 indicate that the Bank did react countercyclically. The reaction is present even controlling for the effects of reserves on Bank policy, suggesting that the domestic-activity and price-change variables are not simply acting as proxies for reserves in the equations. Those variables appear to have had direct effects on Bank policy independent of their indirect effects via reserves. This finding conflicts with the beliefs of several previous analysts (e.g., Ford 1962; Bloomfield 1959) that the Bank did not engage in countercyclical policy of any sort. On the other hand, the finding is supported by much descriptive literature, which frequently mentions the Bank's sensitivity to the effects of its policies on the domestic economy.

Table 3.3 suggests that the effects of reserves and the proportion were strongest. They showed up consistently and generally had the highest levels of statistical significance. This suggests that whatever domestic cyclical variables affected Bank behavior, they were outweighed by the need to maintain convertibility of the currency. The conclusion is also supported by the less constrained equations of table 3.5; there reserves and the proportion show up as the most significant variables and with low-order lag structures of the type that seem most reasonable. Thus it is necessary to speak softly of Bank rule-breaking; the results of the Bank-rate equations indicate a strong preoccupation with convertibility.

Table 3.4 also supports a negative answer to the question: Did the Bank follow the rules? 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. The sterilization may or may not have been intentional. Bloomfield (1959) described Bank policy with respect to its securities holdings as somewhat passive; demands for additional liquidity were met by passively acceding to requests for additional discounting. Whether passive or active in the process, the Bank apparently acted as a buffer between reserve movements and money-supply changes. The rules would demand that it be an amplifier.

The Bank at least to some extent seems to have violated the rules, yet the international monetary system was stable. Were the Bank's violations too minor to be important? Or were the rules themselves unimportant for the adjustment process? Must we rely on the unsatisfying attribution of stability to blind luck, the confluence of fortuitous circumstances?

Appendix *Data Sources*

Sources for the monthly data used are Goodhart (1972, appendixes VA and VB), the U.S. National Monetary Commission statistics volume on the United Kingdom, Germany, and France (1910), and some National Bureau of Economic Research data sheets kindly supplied me by Anna Schwartz. The latter include price data based on a 1928 *Journal of the Royal Statistical Society* article ("Wholesale Prices of Commodities") attributed to "the Editor of the 'Statist'," and unemployment data taken from the British *Abstract of Labour Statistics*. The unemployment data are based on returns collected by the Board of Trade and the Ministry of Labour from trade unions paying unemployment benefits. The price data are based on price indexes for forty-five commodities computed by Augustus Sauerbeck; the overall index is a simple arithmetic average of the individual ones. As such, it suffers from obvious weaknesses. However, I have been unable to locate an alternative monthly index.

The sources of the data used are listed below.

Bank rate, Banking Department reserves, and the proportion: January 1888–June 1891, U.S. National Monetary Commission 1910; July 1891–June 1914, Goodhart 1972.

Railway receipts ("average weekly gross goods receipts of major British Rlys"): January 1893–June 1914, Goodhart 1972. The March and April 1912 figures were substantially lowered by a coal strike; because the effect on domestic activity was likely much less drastic, I have substituted higher numbers (1182 and 1161) for those two months.

Unemployment rates: January 1887–June 1914, NBER data sheets.

Price index: January 1885–June 1914, "Wholesale Prices" 1928.

Securities holdings: January 1888–December 1909, U.S. National Monetary Commission 1910. This series consists of the sum of government securities in both Bank departments, plus "other securities" in the Banking Department.

Gold inflows: July 1891–June 1914, Goodhart 1972. The series used is that attributed to the Bank of England.

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Comment Donald E. Moggridge

The phrase "rules of the game" only came into the economist's vocabulary as the interwar gold standard neared its end. So far as I can ascertain, the term was first used by Sir Robert Kindersley, a director of the Bank of England, on February 1930 in the course of his evidence to the Committee on Finance and Industry (United Kingdom 1931b, question 1595). The phrase attracted Keynes's attention and found its way into his "private evidence" to the committee two weeks later (Keynes 1981, p. 42) and subsequently into the committee's report (United Kingdom, Committee on Finance and Industry 1931a, pars. 46–47).

Between Kindersley's coining of the phrase and the present the exact meaning of the "rules" has varied. For Keynes, they meant that "you so conduct your affairs that you tend neither to gain nor to lose large quantities of gold" (Keynes 1981, p. 42). The Macmillan committee was even more general when it argued:

> It is difficult to define in precise terms what is implied by the "rules of the game". The management of an international standard is an art and not a science, and no one would suggest that it is possible to draw up a formal code of action, admitting of no exceptions and qualifications, adherence to which is obligatory on peril of wrecking the whole structure. Much must necessarily be left to time and circumstance. (United Kingdom, Committee on Finance and Industry 1931a, par. 47)

Nevertheless, when economists have come to assess the possible reasons for the success or failure of fixed-exchange-rate regimes, and occasionally even more "flexible" ones (Chisholm 1979), they have often specified a set of rules conducive to the stability of the regime and tested for the relevant authorities' adherence or nonadherence thereto. The most famous of these exercises are those of Nurkse (1944) and Bloomfield (1959) for the interwar and pre-1914 gold standard periods. Both men tested a relatively activist rule that internationally equilibrating behavior would move central banks' foreign and domestic assets in the same direction as they reinforced the impact of reserve movements on financial

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markets. In both cases, using annual data, they found adherence to such a rule was the exception rather than the norm. Alternative suggestions for rules have been provided by Bloomfield (1959, 1968) and Michaely (1968). The former suggested that behavior would be equilibrating if central banks did not offset the effects of reserve changes or if their discount rate moved inversely with their reserve holdings or reserve ratios. The latter suggested that suitable behavior would see the money supply varying directly and the central-bank discount rate moving inversely with reserve changes. Bloomfield only chose to test his discount-rate rule during the pre-1914 period while Michaely's rule was applied to the Bretton Woods period. Doubtless one could also present another rule involving relative rates of change of a suitable monetary aggregate and apply it to the pre-1914 period, but as yet I know of no such exercise.

John Dutton's paper brings to the discussion of the observance or nonobservance of the rules of the game by the pre-war Bank of England a new twist to the rules and a new test of observance of the Nurkse-Bloomfield reinforcement rule—and incidentally a check on the more passive no-offsetting and discount-rate rules. Dutton's new twist states that given equilibrating central-bank behavior under classical gold standard conditions, one would not observe central banks pursuing countercyclical policies. One can see the sense of such a rule in the abstract, for it would mean that the banks involved would avoid meeting potentially destabilizing dilemma cases and it would incidentally economize on the need for international reserves. However, I wonder whether it is an appropriate rule for the pre-1914 international economy given that Bloomfield (1959, p. 38), Morgenstern (1959, chap. 2) and Triffin (1964, chap. 1) have all noted the strong parallelism in movements of economic activity during the period. In such circumstances, nonadherence to the rule might still be consistent with the successful operation of the standard.

As well as providing a possible new rule, Dutton's paper tests the Bank of England's observance of various rules in a new form. Rather than simply comparing the authorities' actual behavior to the rules, he proposes a more complex model in which the Bank reacts to forecasts of its possible target variables (the Banking Department reserve, the proportion, domestic activity, prices and gold movements) by altering the level of its discount rate and its domestic assets. The rationale for this more involved procedure is twofold. First the Bank might not have full information as to the most recent values of its target variables at the time of making policy adjustments, and second, the procedure eliminates some problems of simultaneous-equation bias.

Leaving the second reason to one side, I cannot fully see the strength of Dutton's first procedural rationalization. It is true, given Dutton's—and Charles Goodhart's (1972)—problem of finding a good monthly index of activity, that the Bank was unlikely to have had full information on that score. The same would almost certainly be the case as regards the price level. But why Dutton should think that the Bank did not have full information about its own reserve, its proportion, and gold movements strikes me as odd, given the information the governors received each working day at the daily "books" meeting (Sayers 1976, 1: p. 31). Thus it would seem to me that the justification for Dutton's technique must depend more on the usefulness of the new rule he wishes to test and on its statistical characteristics than on its being representative of the details of Bank behavior. This is particularly the case when the forecasting model assumes that the Bank had information on each variable's behavior over the entire period and used the same processes consistently. Both of these assumptions seem to me suspect, for the seasonal variability of certain matters such as internal drains changed over the period (Sayers 1976, 1: p. 32) and it is clear from the narrative material available that the Bank's procedures and techniques, as well as the balance among the latter, were changing markedly over the twenty-five years before 1914. Thus it would seem to me that one cannot really be certain exactly what Dutton's procedures are capturing at the end of the day.

What appears to be going on is that the Bank reacted most markedly to the traditional stimuli, changes in the level of its reserves and the proportion, and in the expected direction. One would expect these reactions; they would be consistent with one Bloomfield rule and part of the Michaely rule of the game. There is as well the confirmation of the inverse relationship between changes in the Bank's reserves and its holding of securities that one might expect given Bloomfield's evidence on annual data that the Bank followed the reinforcing rule of the game just less than half the time between 1880 and 1914 (Bloomfield 1959, p. 50). What we do not know is whether this offsetting was partial as Bloomfield suggested (1959, p. 50) or complete—whether the Bank was merely inclined to lean against the wind or stand resolutely against it. The former might be within the spirit of a possible rule, given its Bank-rate reaction, while the latter would represent a violation of the rules in almost any common formulation. Nor do we know, although the Bank did, how much offsetting was an automatic reflection of the discount market being forced into the Bank and how much reflected deliberate policy. Perhaps some day the Bank or some private scholars will extract the necessary information from the "books" and thus help remove another puzzle. Finally we have the suggestion that the Bank responded countercyclically to the activity and price variables, something that Bloomfield (1959, p. 33) regarded as incidental and Ford (1962, p. 34) believed was not a conscious policy at all, although narrative accounts of the Bank's behavior have understood it as a subsidiary but growing preoccupation. Whether this behavior reflected a continuing but changing Bank concern or the long-standing suggestion that given the power of Bank rate the money-supply process in Britain was to some extent endogenous (Ford 1962, p. 36; Goodhart 1972, chap. 15) is not pursued in this paper, concerned as it is with the rules of the game.

Thus the paper leaves us in the position of confirming the Bank's adherence to some rules and suggesting violations of others. Perhaps further work by Dutton will clarify the extent of these violations, especially of the no-offsetting rule, and indicate whether the Bank became more inclined to violate some rules over time—perhaps because it did become more concerned about levels of economic activity. For the present we can thank Dutton for the questions he has raised and hope that discussion and more work will help us come to find answers.

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Reply John Dutton

I would like to respond to two points in Professor Moggridge's "Comment."

First, he indicates concern that the behavior of the Bank of England varied substantially over the twenty-seven years studied. He is also bothered by the possibility of changes in seasonal and other patterns in the target variables over the period and by the effects those changes might have on the forecasting equations. I share those concerns and so have attempted to allay them. Tables C3.1 and C3.2 contain linear feedback equations, similar to those of tables 3.3 and 3.4, but for two shorter periods. Some changes in the coefficients appear. However, the earlier findings for the whole period remain intact in the results for the two subperiods. Bank rate in each subperiod reacted negatively to reserves, positively to economic activity, and positively to inflation. The reserve variable is clearly significant in each case (although its coefficient is much greater for the second period). The activity variables give much the same results as those for the whole period. Unemployment has a significant, or nearly significant, negative effect; railway receipts show a weak but consistently positive effect. Inflation has statistically significant positive coefficients for the first period but not the second.

Likewise, in both periods, securities holdings of the Bank tend to change in the opposite direction from predicted reserve changes. Securities appear to have decreased about one-half to two-thirds as much as the change in reserves. This decrease is consistent with results for the whole period, indicating that the processes governing the Bank probably did not change dramatically between the two periods.

Moggridge mentions concern that seasonal patterns of the variables changed over the twenty-seven years of the study. Figures C3.1 and C3.2 contain plots of monthly means of several variables for periods ending in 1900 and beginning in 1901. The patterns for the two periods seem remarkably similar. Gold inflows evidence the largest change (as well as large standard deviations for the means). Unemployment patterns during the first quarter of the two subperiods differ somewhat. The overall impression, however, is of substantial likeness between the overall seasonal patterns.

Professor Moggridge rightly worries about stability of the forecasting

Table C3.1 Bank-rate Equations

Equation[a]	N^b	Reserves $\times 10^{-2}$	Rlwy Rcpts $\times 10^{-3}$	Unemp $\times 10^{-2}$	Inflation	Autoregressive Terms[c]
First Period (through 1900)						
1. (1893)	96	−1.34 (1.82)	4.01 (1.01)			none
2. (1893)	96	−1.10 (1.47)	4.87 (1.23)		2.40 (1.59)	none
3. (1888)	156	−1.45 (1.95)		−3.49 (1.83)		lag 7, .14(1.73) lag 10, −.14(1.80)
4. (1888)	156	−1.28 (1.75)		−3.12 (1.65)	2.18 (2.03)	lag 7, .15(1.87) lag 10, −.14(1.80)
5. (1888)	156	−1.81 (2.23)				lag 10, −.16(2.08)
Second Period (through 1914)						
6. (1901)	162	−18.42 (6.19)	1.70 (1.05)			lag 1, .13(1.68)
7. (1901)	162	−18.46 (6.18)	1.73 (1.07)		0.25 (0.39)	lag 1, .13(1.70)
8. (1901)	162	−18.37 (6.37)		−3.79 (2.53)		lag 1, .15(1.99)
9. (1901)	162	−18.43 (6.39)		−3.84 (2.56)	0.34 (0.55)	lag 1, .18(2.02)
10. (1901)	162	−18.50 (5.92)				none

Note: *t*-statistics are in parentheses.

[a]Date in parentheses is beginning year.

[b]N = number of observations.

[c]Indicated are lag number of autoregressive error term, estimated autocorrelation coefficient used in data transformation, and *t*-statistic of parameter.

Table C3.2 Securities-Holdings Equations[a]

Period	N	Reserve Forecast − Reserves (−1) $\times 10^2$
1888–1900	155	−7.39 (1.40)
1901–1909	108	−5.25 (1.84)

Note: *t*-statistics are in parentheses.

[a]The errors in this equation showed no statistically significant autocorrelation.

Securities changes measured in thousand-pound units, reserves in million-pound units. Coefficient $\times 10^{-1}$ indicates portion of reserves changes offset.

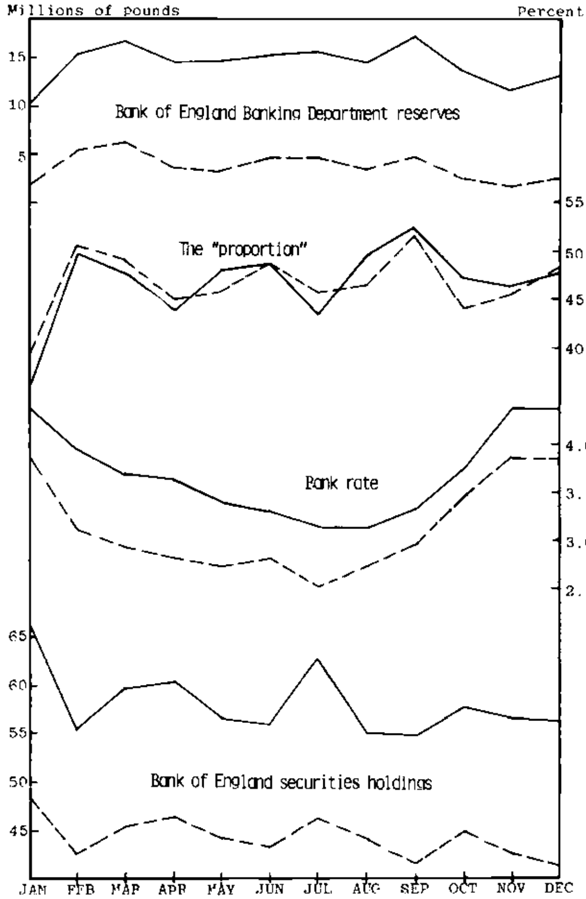

Fig. C3.1 Bank of England financial variables, means, by months, 1888–1900 and 1901–14. Earlier and later period values are indicated by broken and solid lines, respectively. *Source*: See section 3.6.

process over the whole period in question. The ARIMA forecasting equations are at best only rough proxies for the Bank's forecasts. One would expect the coefficients on these rough proxies to be biased toward zero. That significant coefficients are obtained for the period as a whole and for the two subperiods seems to indicate that the ARIMA forecasts are doing their proxying job reasonably well.

The second of Moggridge's concerns to which I should like to respond is the validity of the no-countercyclical-activity rule of the game used in the paper. The rule seems reasonable to me because the Bank, with limited policy tools, would have needed to concentrate its efforts on the single major goal of maintaining convertibility. Efforts at countercyclical policy would likely have interfered with pursuit of that goal. They might

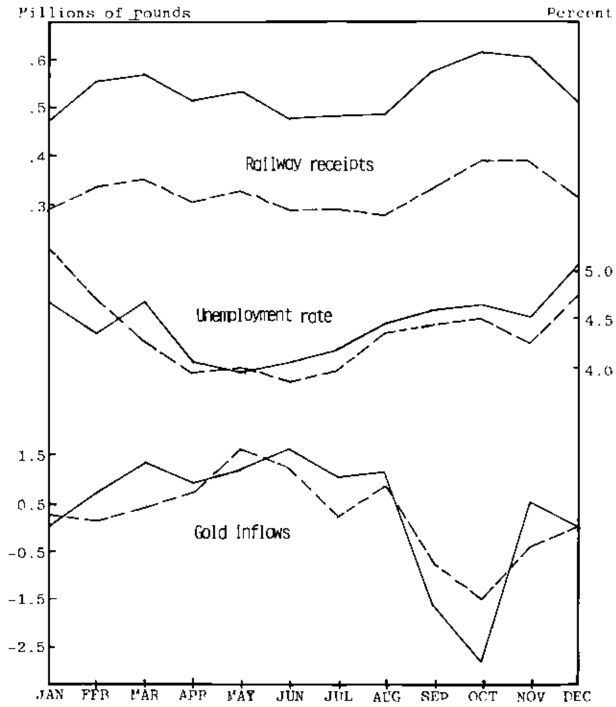

Fig. C3.2 U.K. railway receipts, unemployment rate, and gold flows, means, by months, 1888–1900 and 1901–14. *Source*: See fig. C3.1.

also have had destabilizing effects. There is some reason to believe that gold inflows, Banking Department reserves, and domestic activity moved together (see Pippenger, this volume). If they did, then countercyclical Bank-rate policy would have tended to reinforce those cyclical movements of gold and reserves, rather than tempering them.

Moggridge also suggests in his comment that the apparent countercyclical policy evidenced in my equations might have reflected a common response of Bank rate and economic activity to some third variable. Such a possibility cannot be completely dismissed. Possible candidate variables are reserves and the money supply. However, if reserves and the money supply were positively related to domestic activity, as seems likely, and Bank rate negatively related to those two, then any indirect effect of activity via reserves on Bank rate would be negative. The coefficients in the paper consistently indicate a positive relationship. Other scenarios for explaining the empirical results are of course possible. It is plausible, however, that the results could signify countercyclical actions on the part of the Bank. In any case, Professor Moggridge is certainly correct in calling for more work to reduce the extent of uncertainty about the Bank's policies.