

NOTES, COMMENTS, REPLIES

International Gold Flows in Gold Standard Germany: A Test of the Monetary Approach to the Balance of Payments, 1880–1911

A Note by Andrea Sommariva and Giuseppe Tullio

Arthur Bloomfield (1959) defined the "rules of the game" of the classical gold standard on the basis of the observed correlation between changes in domestic and foreign assets of the central bank. He argued that if the correlation were positive, the central bank was following the "rules of the game" because it reinforced the adjustment process set in motion by gold and foreign exchange flows by moving the domestic assets in the same direction. It did not follow the "rules of the game" if the observed correlation were negative, implying sterilization of reserve flows and a weakening of the adjustment process. Implicitly in Bloomfield's model the direction of causation runs from exogenous changes in foreign assets to endogenous changes in domestic assets. He found for a sample of gold standard central banks that domestic and foreign assets moved in the opposite direction in 60 percent of the observations, while they moved in the same direction in 34 percent of the observations and concluded that central banks did not follow the "rules of the game" at all times. The observed negative correlation is also consistent, however, with the direction of causation running mainly from changes in domestic assets to endogenously determined changes in foreign assets, as suggested by the monetary approach to the balance of payments.¹

This paper presents in section 1 a stylized model of the German monetary system during the gold standard. An equation is derived explaining international gold flows in the spirit of the monetary approach. Section 2 contains the esti-

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¹See Johnson (1958, 1973). For empirical tests for industrial countries in the post-World War II period, see Frenkel and Johnson (1976) and Tullio (1979, 1981).

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mates of the equation. Section 3 contains the main conclusions of the paper. They are (i) that the monetary approach provides a good theoretical framework to explain German gold flows and the balance of payments; (ii) that there is evidence of a significant causation running from the Reichsbank's domestic assets to international gold flows; (iii) that gold flows were sensitive to the domestic and the foreign business cycle; (iv) that one should be very careful in judging whether a central bank followed the "rules of the game" by looking at the sign of the correlation between changes in foreign assets of the Reichsbank (or international gold flows) and changes in its domestic assets, as Bloomfield does. Rather, the judgment should be based on the degree to which the central bank stabilized by means of official discount rate changes the ratio of gold holdings to notes issued or the ratio of all metal holdings to the sum of note issues and sight deposits, as suggested by Goodhart (1972, 1984) and Sommariva and Tullio (1987a, b).

1. A STYLIZED MODEL OF THE GERMAN MONETARY SYSTEM DURING THE GOLD STANDARD

Capital letters indicate nominal variables, while small letters refer to real variables, prices, and interest rates. The symbol Δ stands for a first difference. Equation (1a) is a demand function for currency (BU) and sight deposits (SD) at the Reichsbank by the German private sector:

$$BU + SD = pL(y, r) \quad (1a)$$

The demand for currency and sight deposits is assumed to depend on the price level, real national product, and the private short-term interest rate in Berlin. Equation (1b) defines currency in circulation as the sum of coins other than gold coins (S^c), gold coins, (G^c), Reichsbank notes outstanding (N), and notes issued by private issuing banks and by the Treasury (NT).

$$BU = S^c + G^c + N + NT \quad (1b)$$

Substitution of equation (1b) into equation (1a) and differentiation with respect to time, yields equation (1c), the equilibrium condition in the market for currency and sight deposits at the Reichsbank.

$$L\Delta p + p \frac{\partial L}{\partial y} \Delta y + p \frac{\partial L}{\partial r} \Delta r = \Delta(S^c + G^c) + \Delta(N + SD) + \Delta NT \quad (1c)$$

Equations (2a) and (2b) represent the balance sheet of the Reichsbank expressed in level form and in first differences, respectively.

$$DA + G^R + S^R + F^R = N + SD \quad (2a)$$

$$\Delta DA + \Delta G^R + \Delta S^R + \Delta F^R = \Delta(N + SD) \quad (2b)$$

DA are domestic earning assets of the Reichsbank, G^R and S^R are gold and silver holdings of the Reichsbank and F stands for foreign exchange holdings. The sum of N and SD from equation (2b) can be substituted into equation (1c) to obtain another expression for the equilibrium condition in the market for banknotes and sight deposits issued by the Reichsbank:

$$L\Delta p + \frac{pL}{y} \eta_{L,y} \Delta y + \frac{pL}{r} \eta_{L,r} \Delta r = \Delta(G^c + S^c) + \Delta(G^R + S^R + F^R) + \Delta(DA) \quad (3a)$$

where the symbol η stands for an elasticity and ΔNT has been assumed to be equal to zero, because not doing so would have implied aggregating the balance sheets of the Reichsbank with that of private issuing banks and of the Treasury. This was not possible, however, because data on gold holdings and domestic assets of private issuing banks are not available.² Equation (4a) defines the balance of payments surplus, B , as the sum of additions of gold, silver, and other metals to private circulation and to the Reichsbank's holdings and of changes in the foreign currency reserves of the Reichsbank.

$$B = \Delta(G^c + S^c) + \Delta(G^R + S^R + F^R) \quad (4a)$$

B is the net inflow of gold, other metals (largely silver), and foreign exchange into Germany in a given year. This definition leaves above the line the current account, long-term and short-term capital flows. Leaving private short-term capital flows above the line is, on one hand, consistent with one of the objectives of this paper, which is to explain net international gold and silver flows, and, on the other hand, with the literature on the monetary approach to the balance of payments. While in the earlier part of the sample period reserves of foreign currencies were a minor item on the asset side of the Reichsbank, they grew rapidly towards the end of the last century and in the period preceding World War I.³ Therefore, changes in foreign exchange holdings of the Reichsbank were considered explicitly in equation (2b) and, as a result, are included in the balance of

²The stock of notes issued by private issuing banks was 27.7 percent of total notes outstanding in 1880 and 10.3 in 1913, as they changed little compared with notes issued by the Reichsbank. The standard deviation of notes issued by private issuing banks divided by the mean was 0.124 from 1882 to 1912, while it was 0.203 for notes issued by the Treasury and 0.319 for notes issued by the Reichsbank.

³As a proportion of total international reserves of the Reichsbank they were 5.4 percent in the 1880s, 2.9 percent in the 1890s, 11.9 percent from 1900 to 1909, and 18.4 percent on average from 1910 to 1913.

payments definition below the line. Equation (4b) is the balance of payments equation to be tested and is obtained by substituting (3a) into (4a).

$$B = L\Delta p + \frac{pL}{y} \eta_{L,y} \Delta y + \frac{pL}{r} \eta_{L,r} \Delta r - \Delta(DA) \quad (4b)$$

The assumptions of purchasing power parity and of perfect capital market integration under which equation (4b) was derived did not hold perfectly during the gold standard. However, this does not invalidate the major implications of the monetary approach to the balance of payments developed above, namely, that an increase in earning assets of the Reichsbank should lead to a gold and silver outflow from Germany, other things being equal and after equilibrium is reached in the currency market, and that international gold and silver flows are positively correlated with real national product and the price level. By applying the same theory to foreign countries, an increase in foreign real national product and in the foreign price level is expected to influence positively the demand for currency abroad and hence negatively German gold and silver holdings. Furthermore, the world production of gold or gold and silver should influence positively the German balance of payments. By adding the foreign variables to equation (4b) one obtains the equation that will be actually tested in the next section.

$$B = a_1 \Delta p + a_2 \Delta y - a_3 \Delta r - a_4 \Delta DA - a_5 \Delta p_f - a_6 \Delta y_f + a_7 \Delta r_f + a_8 \Delta DA_f + a_9 \Delta G_w \quad (4c)$$

where a subscript f indicates a foreign variable and G_w is an index of the world stock of monetary gold.

2. EMPIRICAL TESTS OF THE MONETARY APPROACH TO THE BALANCE OF PAYMENTS

The foreign price and output indices are a weighted average of British, U.S., and French indices, with weights equal to 0.43, 0.39, and 0.18, respectively. The weights are the shares of German 1890 imports from the above countries in total imports from the three countries. Gross national product and the price level for the United Kingdom, the United States and France are obtained from different sources.⁴ An index of the world stock of monetary gold has been obtained from Duprier (1966). The foreign interest rate is the short-term private discount rate in London, obtained from *Vergleichende Notenbankstatistik* (1925). German real net national product from Hoffmann (1965) was used instead of gross national

⁴See the Appendix for the definition of the variables and the sources of the data.

product because the latter is not available. The source of the other German series is Deutsche Bundesbank (1976).

Equation (4c) has been estimated by ordinary least squares and two-stage least squares from 1880 to 1912. The latter method allows the elimination of the influence of gold, silver, and foreign exchange flows on domestic earning assets and on the domestic private interest rate. No matter what method was used, the coefficients of changes in the domestic and the foreign interest rate and of ΔDA_t were never statistically significant.⁵ Only estimates obtained by the two-stage-least-squares method will be shown below. The results are reported in Table 1 for two alternative definitions of the balance of payments: B as defined in equation (4a) including gold, silver, and foreign exchange flows, and for gold and foreign exchange flows only ($B1 = B - \Delta S^c - \Delta S^R$). The results are slightly better if silver flows are included in the definition of the balance of payments.

The coefficients of changes in German prices and in real net national product were at first constrained to be equal. The same was done for the coefficients of changes in the foreign price level and in foreign real output. The data do not reject the hypothesis of equal coefficients for the components of foreign nominal income, but they reject it for the components of domestic nominal income. The coefficient of the changes in current real German net national product is never statistically significant while the coefficient of lagged German real net national product is statistically significantly different from zero at the 1 percent level (regressions 1 and 4). In regressions 2 and 5 current German real net national product is therefore removed from the set of explanatory variables. This improves the statistical significance of the coefficient of ΔDA . The fact that the coefficient of current changes in German real net national product was never statistically significant confirms in part McGouldrick's (1984) finding that German gold flows were not cyclical. In the early stages of cyclical upswings and downswings the Reichsbank's gold and silver holdings were probably accommodating fluctuations in private demand, while international gold and silver flows were reacting with a longer lag. The coefficient of changes in foreign current nominal income is statistically significant at the 1 percent level. In regressions 3 and 6 the coefficients of German and foreign nominal income are constrained to be equal. While still satisfactory in terms of explanatory power, this constraint leads to inferior regression results.

Returning to the more satisfactory regressions 2 and 5, the coefficient of changes in the German consumer price index has the expected positive sign and one of the changes in earning assets, the expected negative one. They are statistically significant at the 1 percent and at the 2.5 percent level, respectively. The coefficient of changes in domestic earning assets is within two standard errors of

⁵The domestic assets of the foreign central banks were obtained by adding up the earning assets of the six European central banks for which the data were available from Vergleichende Notenbankstatistik (1925). The countries are the United Kingdom, France, Russia, the Netherlands, Belgium, and Austria-Hungary. These earning assets are period averages and not end-of-period data as would have been preferable.

TABLE 1
GOLD AND SILVER FLOWS BETWEEN GERMANY AND THE REST OF THE WORLD
Annual Data, 1880-1912 (two-stage least squares)

Regr. No.	Dependent variable	Δp	Δy	$\Delta y(-1)$	$\Delta(\text{ppy})$	$[\Delta(\text{py}) - \Delta(\text{ppy})]$	ΔDA	ΔG_w	R ²	D-W	SER
1	B ¹	27.35 (2.22)	-1.78 (0.14)	22.34 (3.03)	-20.70 (2.31)	—	-0.51 (0.91)	20.16 (4.46)	0.78	2.09	71.33
2	B	28.41 (3.01)	—	22.47 (3.13)	-20.40 (2.38)	—	-0.58 (2.05)	19.95 (4.77)	0.78	2.08	70.07
3	B	—	—	—	—	11.00 (1.42)	-0.56 (2.04)	25.08 (5.96)	0.63	2.46	88.63
4	B1 ²	34.91 (2.54)	1.10 (0.08)	21.49 (2.62)	-22.60 (2.27)	—	-0.75 (1.19)	19.43 (3.85)	0.73	2.11	79.47
5	B1	34.25 (3.26)	—	21.41 (2.67)	-22.80 (2.39)	—	-0.70 (2.23)	19.56 (4.20)	0.73	2.10	78.06
6	B1	—	—	—	—	10.10 (1.18)	-0.63 (2.07)	24.21 (5.23)	0.55	2.51	97.51

¹ Gold flows, silver flows, and changes in foreign currency holdings of the Reichsbank
² Excluding silver flows

minus one, the theoretically expected value, for both definitions of the balance of payments.⁶ Stability tests of the coefficients have been performed by estimating regressions 2 and 5 alternatively from 1878, 1885, 1890, and 1895 to 1912. The only noticeable parameter change is the increase through time of the coefficient of ΔDA . This is probably the result of the higher degree of capital market integration in the latter part of the gold standard period. The coefficient of the world stock of monetary gold has the expected positive sign and is statistically significant at the one percent level. The regressions with unconstrained coefficients of nominal incomes (regressions 1, 2, 4, and 5) have a very high explanatory power and there is no evidence of autocorrelation of the residuals.

Regressions that exclude from the balance of payments changes in foreign currency reserves of the Reichsbank (not shown here) all have a lower explanatory power as has to be expected in the light of their increasing importance in international reserves of the Reichsbank towards the end of the sample period.

3. SUMMARY AND CONCLUSIONS

This paper has presented in section 1 a stylized model of the German monetary system under the gold standard. An equation has been derived explaining German international gold and silver flows in the spirit of the monetary approach to the balance of payments. The estimates of this equation presented in section 2, show first that an increase in the domestic assets of the Reichsbank led to an outflow of gold and silver, as predicted by the monetary approach. Second, they show that an increase in German output and in the German price level led to a flow of gold into Germany. As far as German output is concerned, the effect was found to be lagged rather than contemporaneous. Third, foreign nominal income and the world stock of monetary gold influenced German gold and silver flows as predicted by the theory. Fourth, the estimates suggest that the negative correlation between domestic and foreign assets of the central banks observed by Bloomfield is not a sufficient criterion to judge whether a central bank followed the "rules of the game" of the classical gold standard, since the causation was probably bi-directional.

APPENDIX

Symbols and Sources of Data Used

B = Germany's international gold, silver, and foreign exchange flows defined as $\Delta G^R + \Delta G^c + \Delta S^R + \Delta S^c + \Delta F^R$ where G^R is gold reserves of the Reichsbank (Deutsche Bundesbank 1976, p. 329) and G^c is

⁶The main difference between the estimates of equation (4c) obtained by the two-stage-least-square method and the ordinary-least-square method is that the estimates of the coefficient of ΔDA is much smaller and significantly different from minus one when the latter method is used. The values and the statistical significance of the other coefficients do not change much.

gold in circulation in Germany (Deutsche Bundesbank 1976, p. 14), S^R is silver and metals other than gold in circulation (source: same as for G^R), S^c is silver and metals other than gold in circulation (source: same as for G^c), F^R are Reichsbank holdings of foreign currencies (Deutsche Bundesbank 1976, p. 329).

$$B1 = B - \Delta S^c - \Delta S^R.$$

DA = domestic assets of the Reichsbank, sum of claims on the government and on the private sector (Deutsche Bundesbank 1976, pp. 36-7; see also Sommariva and Tullio 1987).

DA_f = sum of earning assets of the central banks of the United Kingdom, Austria-Hungary, Belgium, the Netherlands, Russia, France, in millions of marks, yearly averages (Vergleichende Notenbankstatistik 1925).

G_w = index of the world monetary gold stock, (1876 = 100) (Duprier 1966).

p = German consumer price index (Deutsche Bundesbank 1976, p. 6).

p_f = foreign consumer price index = $0.43 p_{UK} + 0.18 p_F + 0.39 p_{US}$ where the subscripts UK , F and US stand for the United Kingdom, France and the United States. The weights 0.43, 0.18, and 0.39 are the 1890 share of German imports of goods from these 3 countries. The source of the weights and of p_{UK} and p_F is Mitchell (1975). The source of p_{US} is U.S. Department of Commerce (1979).

r = private short-term interest rate in Berlin, yearly averages (Deutsche Bundesbank 1976, p. 278).

r_f = private short-term interest in London (Vergleichende Notenbankstatistik 1925, p. 212-30).

y = German real net national product (Hoffmann 1965).

y_f = foreign real output index 1913 = 100, defined as $0.43 y_{UK} + 0.18 y_F + 0.39 y_{US}$, where the subscripts stand for the United Kingdom, France, and the United States. The source of y_{UK} is Mitchell (1975), of y_F Bourguignon and Levy-Leboyer (1984) and of y_{US} , U.S. Department of Commerce (1979). It should be pointed out, however, that the growth rates of y_f by decades of Bourguignon and Levy-Leboyer do not correspond to the ones of Perroux (1955). The latter supplies only estimates every 10 years.

LITERATURE CITED

- Bloomfield, Arthur. *Monetary Policy Under the International Gold Standard, 1880-1914*. New York: Federal Reserve Bank, 1959.
- . *Short-Term Capital Movements Under the Pre-1914 Gold Standard*. Princeton Studies in International Finance, No. 11. Princeton, 1963.

- Bourguignon, François, and Maurice Levy-Leboyer. "An Econometric Model of France during the 19th Century." *European Economic Review* (25 April 1984), 107-41.
- Deutsche Bundesbank. *Deutsches Geld und Bankswesen in Zahlen 1876-1975*. Frankfurt am Main, 1976.
- Duprier, Léon. *Des mouvements économiques généraux*. Tome II, Editions Nauwelaerts. Louvain, 1966.
- Frenkel, Jacob A., and Harry G. Johnson. *The Monetary Approach to the Balance of Payments*. London: Allen & Unwin, 1976.
- Goodhart, Charles. *The Business of Banking*. London: Weidenfeld and Nicolson, 1972.
- . "The Bank of England and the Gold Standard: 1890-1914." Comments to Dutton in *A Retrospective on the Classical Gold Standard: 1821-1931*, edited by Michael D. Bordo and Anna Schwartz. New York: National Bureau of Economic Research, 1984.
- Hoffmann, Walter. *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. Heidelberg: Springer Verlag, 1965.
- Johnson, Harry G. "The Monetary Approach to the Balance of Payments Theory." In *International Trade and Money*, edited by Michael B. Connolly and K. Alexander Swoboda, pp. 206-24. London: Allen & Unwin, 1973.
- . "Towards a General Theory of the Balance of Payments." In *International Trade and Economic Growth*, edited by Harry G. Johnson, pp. 153-68. London: Allen & Unwin, 1958.
- McGouldrick, Paul. "Operations of the Reichsbank under the Gold Standard, 1879-1913." In *A Retrospective on the Classical Gold Standard: 1821-1931*, edited by Michael D. Bordo and Anna J. Schwartz. New York: National Bureau of Economic Research, 1984.
- Mitchell, Brian R. *European Historical Statistics, 1750-1970*. London: Macmillan & Co., 1975.
- Morgenstern, Oscar. *International Financial Transactions and the Business Cycle*. Princeton: Princeton University Press for National Bureau of Economic Research, 1959.
- Perroux, François. "Prise de vues sur la Croissance de l'Economie Française, 1780-1950." In *Income and Wealth*, Vol. 3, edited by J. Kuznets, pp. 45-100. London: Bowes and Bowes, 1955.
- Sommariva, Andrea, and Giuseppe Tullio. *German Macroeconomic History 1880-1979 — A Study of the Effects of Economic Policy on Inflation, Currency Depreciation and Economic Growth*. London: Macmillan, 1987.(a)
- . "The Determinants of the Official Discount Rate and of Liquidity Ratios during the Classical Gold Standard: An Econometric Analysis of the Objectives of Monetary Policy in Germany: 1876-1913." Economic paper no. 58. Brussels, September 1987.(b)
- Tullio, Giuseppe. "Monetary Equilibrium and Balance of Payments Adjustment: An Empirical Test of the U.S. Balance of Payments (1951-73)." *Journal of Money, Credit, and Banking* 11 (February 1979), 68-79.
- . *The Monetary Approach to External Adjustment: A Case Study of Italy*, Ch. 2. London: Macmillan. New York: St. Martin's Press, 1981.
- U.S. Department of Commerce. *Historical Statistics of the United States*. Department of Commerce, Washington, D.C., 1979.
- Vergleichende Notenbankstatistik. *Organisation aund Geschäftsverkehr Europäischer Notenbanken, 1876-1913*. Berlin: Reichsdruckerei, 1925.
- Zecher, Richard J. "Monetary Equilibrium and International Reserve Flows in Australia." *Journal of Finance* 19 (December 1974), 1523-30.