PRINCETON STUDIES IN INTERNATIONAL FINANCE, NO. 10

Reserve-Asset Preferences of Central Banks and Stability of the Gold-Exchange Standard

Peter B. Kenen

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
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FRITZ MACHLUP
Director

Princeton University
April 1963

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PREFACE

This monograph sets out the result of two years' work on the composition of official reserve-assets. It is the successor to my essay on the theory of the gold-exchange standard,[1] but goes much further than that essay in an effort to answer three sets of questions:

1. Do gold and foreign-exchange balances have different roles as central-bank reserve-assets? Are foreign-exchange holdings merely working balances, or do governments hold more foreign exchange than required for daily operations in the foreign-exchange markets?
2. Are there stable "marginal propensities" to hold gold and complementary "marginal propensities" to hold foreign exchange? If so, do they differ from country to country and from the corresponding "average propensities"?
3. What part did central banks play in the much-discussed "gold rush" of 1960? Were central-bank gold purchases abnormally large or frequent? Which central banks, if any, took part in the "gold rush"?

The tentative answers supplied by this monograph may help us to assess the prospects for today's gold-exchange standard and appraise proposals for reform of the international monetary system. One should not employ my results mechanistically; my data relate to the 1950's, and much has been done in the last two years to alter central-bank behavior and to defend the gold-exchange standard against speculative onslaughts. But the statistics can help to locate our starting point and thereby to determine how far we have come and how far we have yet to go to strengthen the system.

My statistical procedures may be too crude to satisfy some readers. But I think they are at least as powerful as the methods usually employed in this area. The study of international finance has been perversely distinguished from other economic inquiries by the specialists' delight in peculiarities and their neglect of general tendencies. Too much effort is expended on the special cases and too much importance is attached to conversations with those who are "in the know." This mode of investigation is not barren, but should not be considered a substitute for the different regime that has transformed most other economic research. International monetary problems can and should be subjected to formal statistical analysis.

[1] Peter B. Kenen, "International Liquidity and the Balance of Payments of a Reserve-currency Country," *Quarterly Journal of Economics*, November 1960.

I have incurred a number of debts while working on this study. Professors Albert O. Hirschman, James W. Angell, Henry C. Aubrey and Robert Triffin have helped me to organize my thoughts and offered criticism and advice along the way. I have also exploited the members of the Workshop in International Economics at Columbia University and have had the benefit of stimulating criticism from Professor Milton Friedman and his associates in the Money and Banking Workshop at the University of Chicago. Mr. Robert Harris rendered vital aid with several problems of statistical inference, while Mrs. Patricia Pack and Messrs. Benjamin Jerry Cohen, Dietrich Weismann and Richard Magidoff gathered and processed much of the data. The study was financed by the School of International Affairs and by the Workshop in International Economics, both of Columbia University.

New York
June 30, 1962

1. THE PROBLEM

THE ROLE OF RESERVE-ASSET PREFERENCES

The past few years have witnessed a tardy renascence of international monetary studies. The problems of balance-of-payments adjustment have engaged professional attention ever since the Second World War, as have the size and distribution of national reserves.[1] But the international monetary system—the processes that generate reserve-assets and decide the forms they take—was taken much for granted for several years.

The International Monetary Fund was, of course, the product of detailed thought. But the IMF does not manage the monetary standard, even though some of its founders wanted it to do so. It is a financial intermediary, working to use the stock of reserve-assets more efficiently, whatever form that stock may take. The postwar gold-exchange standard has grown up very much like Topsy, bereft of a charter or plan. It did not have a Genoa resolution to give it formal sanction, and the United States became the major reserve center almost by absence of mind.

The postwar hiatus in international monetary studies is easily explained; it was more fun to theorize about the "dollar shortage" and more useful to promote the recovery of trade and restoration of convertibility. In the meantime, however, the gold-exchange standard has evolved much further than it did during the interwar years. In 1928, just before it collapsed, the international monetary system was still quite heavily weighted with gold. Today, by contrast, slightly more than half of total official reserve-assets (excluding those of the United States) are foreign exchange (Table 1.1). The gold ratio has risen since 1948, but the increase from 38 per cent to 48 per cent conceals a huge rise in total foreign-exchange holdings and a major change in composition; the total rose by half from 1951 to 1960 and the U.S. dollar component was much more than doubled (Table 1.2).[2]

[1] Throughout this monograph, I shall use "reserve-assets" or, simply, "reserves" to mean central-bank and government holdings of gold and foreign exchange. Some authors prefer "international liquidity" or "liquid assets," but "liquidity" has too many normative overtones and alternative uses. (*See* James W. Angell, "The Reorganization of the International Monetary System," *Economic Journal*, December 1961, p. 692.)

[2] The rise in the gold ratio since 1948 should not be confused with the "drift toward gold" I shall describe below. It chiefly corresponds to a decline in the total reserve-assets of the outer sterling area during 1949. For a more detailed treatment of these early events, *see* International Monetary Fund, *International Reserves and Liquidity*, 1958, Chapter 2.

With the very rapid growth of U.S. liabilities in the 1950's, students of American monetary policy began to take interest in the situation.[3] But the structure of the international monetary system did not begin to claim close expert attention until Robert Triffin fired his first salvoes at the present gold-exchange standard[4] and, at about the same time, the U.S. balance of payments swung into gaping deficit.

TABLE 1.1

Official Gold and Foreign-exchange Holdings[a]

(Millions of dollars)

Year	*Gold*	*Foreign Exchange*	*Total*	*Percentage in Gold*
1928[b]	6,054	3,250	9,300	65
1938[b]	11,358	1,800	13,108	86
1948[b]	8,351	13,700	22,051	38
1958[c]	17,483	19,215	36,698	48
1960[c,d]	20,246	21,670	41,916	48

[a] Excludes the United States and international organizations.

[b] From International Monetary Fund, *International Reserves and Liquidity*, 1958, p. 102. The source gives an explanation for the arithmetical discrepancies in 1928 and 1938.

[c] From International Monetary Fund, *International Financial Statistics*, December 1961; not strictly comparable with earlier data.

[d] Excludes European Payments Union liabilities (included in the 1958 data); at the end of 1958, these totalled $1,374 million.

Triffin has dramatized the long-run problem as an ugly dilemma: If the present monetary system is to generate sufficient reserve-assets to lubricate payments adjustment, the reserve-currency countries must willingly run payments deficits, enduring a deterioration of their net reserve positions that could erode foreign confidence in the reserve currencies. If, contrarily, the reserve-currency countries are to maintain their net reserve positions, there must some day be a shortage of reserve-assets and this will cause serious frictions in the process of pay-

[3] *See*, e.g., Fred H. Klopstock, *The International Status of the Dollar*, Essays in International Finance, No. 28, Princeton University, 1957.

[4] Robert Triffin, *Gold and the Dollar Crisis*, Yale University Press, 1960. For an algebraic treatment of Triffin's argument, *see* my "International Liquidity and the Balance of Payments of a Reserve-currency Country," *Quarterly Journal of Economics*, November 1960; and for arithmetic projections of the international monetary situation under the present regime and under the Triffin plan, my testimony before the Subcommittee on International Exchange and Payments of the Joint Economic Committee, *Hearings: International Payments Imbalances and Need for Strengthening International Financial Arrangements*, Government Printing Office, 1961, pp. 193-196.

ments adjustment. To skirt this dilemma, Triffin wants to overhaul the monetary system—to transform the IMF into a central bankers' bank, capable of generating reserve-assets.[5]

The large U.S. payments deficits of 1958-1961 recast Triffin's dilemma into an urgent present tense. They enlarged the global stock of reserve-assets, but impaired the reserve position of the United States. In just

TABLE 1.2

The Composition of Official Foreign-exchange Holdings[a]

(Millions of dollars)

Type of Asset	*1951*	*1954*	*1957*	*1960*
Gross Assets[b]	14,420	17,137	17,646	21,645
U.S. Dollars	4,014	7,067	8,231	10,484
Sterling[c]	8,694	8,157	7,222	7,563
French Francs	....	263	576	459
BIS Deposits	129	324	272	477
Other (and net error)[d]	1,383[e]	1,326	1,345	2,662

[a] All countries (but U.S. holdings zero before 1961). Data from International Monetary Fund, *International Financial Statistics* (IFS), January 1962, p. 27.

[b] Excludes European Payments Union liabilities (included in the IFS data for 1951-1957).

[c] Includes Commonwealth liabilities; total Commonwealth securities held by the sterling countries (including their commercial banks) did not exceed $350 million in the years listed above.

[d] Includes all other assets and the net error arising from the exclusion of Soviet-bloc countries from the total assets data and their inclusion in some of the liabilities data. For details, *see* IFS, January 1962, p. 28.

[e] Differs slightly from the corresponding IFS entry (which does not jibe with the other IFS data for 1951).

four years, U.S. short-term liabilities to foreign central banks and governments rose by $4.5 billion, and the U.S. gold stock fell by $5.9 billion.[6] During the last months of 1960, there was a first flurry of speculation anent an increase in the dollar price of gold; and in the

[5] Triffin's own proposal is just one of many recent plans for international financial reform, some constructed as alternatives to the Triffin plan, others independently conceived. For a collation of the more important proposals, *see* Subcommittee on International Exchange and Payments of the Joint Economic Committee, *Report: International Payments Imbalances . . . ,* Government Printing Office, 1961; also Angell, cited above. For a critique of Triffin's plan, *see* Oscar L. Altman, "Professor Triffin on International Liquidity and the Role of the Fund," IMF *Staff Papers*, May 1961.

[6] Changes from December 31, 1957 to December 31, 1961; IMF, *International Financial Statistics*, May 1962.

spring of 1961, after the revaluation of the deutsche mark and the guilder, there was a sharp speculative assault on the pound. As some observers see it, a reform is urgently required to consolidate and strengthen the present monetary system, not merely to provide for future reserve-asset needs.

This monograph does not seek to assess the existing payments system in its entirety, nor to appraise the several plans for long-run reform. But it is directly relevant to both these tasks. If official reserve-asset preferences are unstable, any monetary regime can be subjected to rude shocks that could damage confidence in the reserve media. If they are stable but encompass high "marginal propensities" to hold gold, continued growth in the stock of reserve-assets could drain gold from the center of the system—from the United States and Britain under the present regime, or from the IMF under the Triffin plan—and this could also damage confidence.

Short-run instability. During 1960 and the first three quarters of 1961, the United States ran one small quarterly balance-of-payments surplus and six quarterly deficits. The U.S. gold stock increased with the surplus and decreased with the deficits. But the gold flows varied widely in relation to the net payments data (Table 1.3).

Some of the net variation in gold flows was due to a turn-around in private foreign short-term capital.[7] In 1959 and the first half of 1960, foreign funds came into the United States, reducing the need for official financing and the scope for gold flows linked to current financing; in the second half of 1960, they moved out again, increasing the need for official financing and the scope for gold losses. But the gold flows were also erratic in relation to official financing; they ranged from a mere 13 per cent of official financing in the second quarter of 1960 to peaks of 70 and 80 per cent at the end of 1960 and the start of 1961.

A part of this remaining variation may be indirectly linked to movements of private capital. During the fourth quarter of 1960, foreign central banks bought $1,221 million of gold from the United States, but added only $821 million to their own reserves.[8] Most of the "excess" went to calm the private gold markets; the Bank of England sold gold

[7] In the official tabulations and in Table 1.3, some types of private foreign short-term investment in the United States are treated as forms of financing, not as part of the surplus or deficit; they are put "below the line" rather than "above the line." This procedure has been criticized (*see*, e.g., Walter Gardner, "An Exchange-market Analysis of the U.S. Balance of Payments," IMF *Staff Papers*, May 1961, pp. 195-205), and I am inclined to agree with the critics. But I have used the standard presentation here because it is more familiar.

[8] *International Financial Statistics*, January 1962, p. 24.

TABLE 1.3

The U.S. Payments Deficit and Gold Losses, 1959-1961[a]

(Millions of dollars)

Year and Quarter	Total US Deficit[b]	Private Foreign Financing[c]	Official Foreign Financing			Gold Flow as a Percentage of	
			Total	Dollars	Gold	Total Deficit	Official Financing
1959[d]	3,826	1,462	2,364	1,633	731	19	22
1960 I	640	356	284	234	50	8	18
II	888	185	703	609	94	11	13
III	1,191	—52	1,243	606	635	54	51
IV	1,210	—523	1,733	512[e]	1,221[e]	101	70
1961 I	334	—130	464	93[f]	371[f]	111	80
II	—69	546	—615	—446[f]	—169[f]	245	28
III	906	161	745	450[e, f]	295[e, f]	33	40
IV	1,281	529	752	242	510[f]	40	68

[a] From U.S. Department of Commerce, *Survey of Current Business* (various issues), and Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin* (various issues).

[b] Increase in short-term U.S. liabilities to foreigners *plus* U.S. gold loss *less* increase in U.S. official holdings of convertible currencies.

[c] Includes the unallocated change in foreign dollar holdings (mainly U.S. government securities with original maturities of more than one year).

[d] Excludes the $1,375 million U.S. subscription to the International Monetary Fund.

[e] Adjusted to exclude two U.S. purchases of gold from the IMF ($300 million in IV 1960 and $150 million in III 1961).

[f] Adjusted to exclude the changes in U.S. official holdings of convertible currencies (+$25 million in I 1961, +$161 million in II 1961, —$124 million in III 1961, and +$54 million in IV 1961); made on the assumption (only approximately true) that the changes in U.S. official holdings were matched by (same-signed) changes in foreign official holdings of U.S. dollars.

in London and bought gold in New York to reconstitute its holdings.[9] But the increase in official gold holdings was still quite large, as was the U.S. gold loss after all allowances; the $821 million net increase in official holdings was still half of all official financing in the fourth quarter of 1960. Hence, two possibilities remain:

1. Central-bank reserve-asset preferences may have been stable during the 1960-1961 episode, but the separate national "marginal propensities" to hold gold may be so very different that a change in the *destination* of the U.S. deficit (and third-country reserve movements) augmented its gold content.
2. Central-bank reserve-asset preferences may actually have changed in 1960-1961 because of the very large U.S. deficit or because of the rise in the free-market price of gold.

These explanations are not mutually exclusive, but convey very different implications. The first forecasts a large gold flow from time to time, but does not foretell damage to the gold-exchange standard unless the countries with high "marginal propensities" also have large reserve-asset appetites. The second also forecasts large gold flows but does not promise to reverse them; it could be far more damaging to the monetary system.

We cannot choose between these two hypotheses or attach the proper weight to each unless we can describe the reserve-asset preferences of the major central banks. We cannot assign part of the gold-flow variation to a spread in *stable* asset preferences unless we can measure the spread. Nor can we appraise the variation that remains after we allow for national differences unless we know the normal variation in central-bank "marginal propensities."

Long-run prospects. If reserve-asset preferences are indeed unstable, a large swing in the U.S. payments posture could trigger governmental gold buying large enough to undermine the monetary system. If they are stable, the threat is not acute. But the gold-exchange standard may not be long-lived even if the "marginal propensities" to buy gold are perfectly firm. A large accumulation of reserves by countries with high

[9] From September 31, 1960 to March 31, 1961, British gold holdings actually declined $50 million; yet Britain bought $500 million of gold from the United States. These two figures fix the net cost of support for the free-market gold price at $550 million, but neglect new gold used. The OEEC puts the net gold "disappearance" at $480 million for the fourth quarter of 1960 and $800 million through the end of January 1961. (*Second Annual Report of the Board of Managers of the European Monetary Agreement*, Paris, 1961, p. 51.) Net "disappearance" includes the normal industrial demand for gold, but was very much larger than the normal drain during the winter of 1960-1961.

"marginal propensities" could cause a continuing flow of gold from the countries that create new reserve-assets by running payments deficits. This sort of drain could also be corrosive, for few central banks would have continued confidence in the reserve currencies if the center countries were always losing gold.[1] The same disease could also afflict the IMF if it is reformed as Triffin suggests. It would suffer gold losses if the aggregate demand for gold were sufficiently elastic with respect to reserve-assets.[2]

[1] The rate of change in the net reserve position of the center countries is not affected by other countries' "marginal propensities" to acquire gold. But the composition of the change (whether an increase in liabilities or a decrease in assets) does depend on the "marginal propensities." Denote the global monetary gold stock by ${}_{w}G$, the gold holdings of the center countries by ${}_{c}G$, and the gold holdings of other countries by G ($G = {}_{w}G - {}_{c}G$). Denote the foreign-exchange holdings of the other countries by F, and their reserve-assets by R ($R = F + G$). Suppose that the global gold stock and total reserve-assets outside the center are given at time t by:

$$ {}_{w}G_t = {}_{w}G_o e^{gt} \text{ and } R_t = R_o e^{rt}, $$

g and r being the observed rates of change over the relevant intervals of time (devoid of normative import). Define the demand for gold outside the center in terms of a reserve-assets elasticity, η (and neglect any relationships between η and r). Then:

$$ G_t = G_o + \eta G_o(R_t - R_o)/R_o = G_o[1 + \eta(e^{rt} - 1)]. $$

Next, define the net reserve position of the center countries:

$$ {}_{c}G_t - F_t = {}_{w}G_t - R_t = {}_{w}G_o e^{gt}[1 - ({R_o}/{{}_{w}G_o})e^{(r-g)t}]. $$

The reserve-assets elasticity of demand for gold, η, does not appear in this equation. But it does appear in the separate equations describing the evolution of ${}_{c}G$ and F. Thus:

$$ {}_{c}G_t - {}_{c}G_o = {}_{w}G_o(e^{gt} - 1)\left[1 - \eta({G_o}/{{}_{w}G_o})\frac{e^{rt} - 1}{e^{gt} - 1}\right], $$

so that:

$$ \partial({}_{c}G_t - {}_{c}G_o)/\partial\eta = - G_o(e^{rt} - 1), $$

which says that the increase in ${}_{c}G$ will be smaller (the decrease will be larger) the larger the reserve-assets elasticity of demand for gold.

[2] Under Triffin's plan, each central bank would have to hold a fraction of its total reserve-assets as deposits at the IMF. The IMF would create additional deposits sufficient to make good the gap between a desired rate of growth of reserves and the rate of growth of monetary gold stocks. With such a scheme, there is the double danger that central banks would be endowed with "excess" IMF deposits they could use to buy gold from the IMF and that the demand for gold would exceed the supply. Denote the IMF reserve requirement by k, total IMF deposits by B, and the desired rate of growth of total reserve-assets by $\dot{r}$; use the other symbols from note 1, above. Define "excess" deposits at the IMF by E, where:

$$ E_t = B_o + (R_t - R_o) - ({}_{w}G_t - {}_{w}G_o) - kR_t. $$

But, to start, $B_o = kR_o$, so that:

$$ \begin{aligned} E_t &= (R_t - R_o)(1 - k) - ({}_{w}G_t - {}_{w}G_o) \\ &= R_o(e^{\dot{r}t} - 1)\left[(1 - k) - ({}_{w}G_o/R_o)\frac{e^{gt} - 1}{e^{\dot{r}t} - 1}\right]. \end{aligned} $$

All of the 61 countries studied in this paper hold some foreign exchange; most of them hold gold. What rules of thumb might they be using to select their reserve-assets?

Most central banks need a working balance of foreign exchange in order to intervene in the foreign-exchange markets. They support their currencies by spot and forward foreign-exchange operations, not by standing ready to buy or sell gold passively at a predetermined parity. Yet most observers are agreed that central banks also hold foreign exchange as a store of value, not just as a medium of settlement. This must be so, Klopstock points out, as they do not need some $20 billion of foreign exchange for operating purposes.[3] They earn interest on their foreign-exchange balances by holding money-market assets and, sometimes, long-term bonds.[4] Some of them cover their operating costs with the income from their reserve-assets, thereby working to preserve their domestic independence from finance ministries and legislatures.[5]

But gold still casts an aura of respectability and has advantages. The exchange rates between reserve currencies have moved up and down, but their gold parities have fallen much more often than they have risen and have fallen farther than they have risen. Central banks that hold gold may forego occasional windfall gains, but are also the more certain to avoid windfall losses. Those that held deutsche marks in the spring of 1961 made small gains, but those that held sterling in 1931 or 1949, or dollars in 1934, suffered very large losses. Furthermore, the very strength of the gold tradition is itself a promise that a gold reserve can be used to buy foreign exchange whenever it is needed and, therefore, to buy goods and services. Few currencies, by contrast, have always been convertible into all the others a nation might desire.

Each central bank must weigh the costs and benefits of rival reserve-

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Denote the excess demand for gold by G′ and assume $G_o' = 0$, so that:

$$G_t' = G_o(e^{it} - 1)\left[\eta - ({}_wG_o/G_o)\frac{e^{gt} - 1}{e^{it} - 1}\right].$$

Both of these arguments can be positive if k is small and η is large. And if both are positive, the central banks could "raid" the IMF to obtain the extra gold they desire.

[3] *The International Status of the Dollar*, p. 9; Klopstock is also the author of the analogy with domestic monetary theory used in the text.

[4] On long-term holdings, *see* the country notes in Appendix A. Many of the countries that report long-term securities as reserve-assets would seem to have acquired them when they were dependent territories and "backed" their domestic currencies with metropolitan securities.

[5] Klopstock, p. 11.

asset patterns and take account of its special situation, including the requirements of domestic monetary legislation. But the data argue that there are three basic asset-preference rules:

1. *The simple working balance.* Some central banks would seem to hold all their reserve-assets as gold, save for a small working balance of foreign exchange. They apparently prefer to forego income rather than risk capital losses.

2. *Proportionality.* Some central banks would seem to use a simple rule of thumb, buying gold with a constant fraction of their total reserve-assets and lodging the rest in foreign exchange. The gold-to-reserve-assets ratio is sometimes so high as to imply a strong risk aversion; but it sometimes dips below 50 per cent.

3. *The "basic" gold reserve.* Some central banks would seem to hold a basic gold reserve, a nest egg or war chest, call it what you will, then to lodge all or part of their "excess" reserve-assets in foreign exchange. They seem willing to take risks for income, but not with all their reserve-assets.

These three rules may be much too simple to describe central-bank attitudes. And even when they fit the data, it may be by accident. The working-balance rule fits the British data with striking success, but one must remember that these data omit Britain's long-term dollar assets. Yet these three archetypical reserve-asset patterns give good fits in a remarkable number of cases. They can often forecast central-bank behavior, even if they cannot simulate central-bank attitudes.

2. THE FREQUENCY OF CHANGES IN GOLD HOLDINGS

THE DATA

This chapter studies the frequency of change in the gold holdings of 61 countries. The data used here and in the next chapter are drawn from the country pages of *International Financial Statistics.* Most of the series span the 42 quarters ending with September 1960. Some cover shorter periods, mainly because there are large gaps and discontinuities in the official foreign-exchange data.[1] Data on the fourth quarter of 1960 were also available when the computations began. But these were set aside for separate analysis; I have developed and tested my hypotheses using the earlier data, then applied my hypotheses to the fourth quarter so as to appraise central-bank behavior in the 1960 "gold rush."

For the most part, the data refer to central-bank reserve-asset holdings. I have even extracted some of these holdings from broader aggregates in order to infer a unique asset-preference pattern from each set of national statistics; data on total national holdings can only yield inferences concerning an *average* of preferences. I have also adjusted the data to exclude official foreign-exchange balances arising from payments agreements, notably net credit positions *vis-à-vis* the European Payments Union (EPU). The central banks with these credit balances may have viewed them as though they were dollars and fully usable; the European central banks must have scanned their EPU positions when looking at their reserve-assets, for net creditors could settle monthly European deficits without using large amounts of gold or foreign exchange. Nevertheless, these balances could not be swapped for gold and should not be treated as though they were explicitly preferred to gold.

My use of quarterly data represents a compromise between conflicting *desiderata.* Monthly data might have revealed many important details—the gold-stock changes occurring inside each quarter and the short, sharp reserve losses that sometimes force a central bank to sell gold. But the use of monthly data might also have increased the autocorrelation which looms so large in the next chapter. And in some key cases, quarterly data are the only ones we have. I have even been obliged to interpolate a few of the quarterly figures some of the reserve-asset series.

[1] For detailed comments on the data, including notes on each country, *see* Appendix A.

The data have many deep defects that cannot be corrected by adjustments or interpolations. Some of the gold-stock series are incomplete. Denmark, for instance, seems to hold more gold than the $31 million reported in *International Financial Statistics*; the rest masquerades as foreign exchange. Some of the foreign-exchange statistics may also be misleading, as central banks have also tried to conceal foreign-exchange assets. Germany and Italy have sometimes encouraged their commercial banks to hold larger foreign-exchange balances by offering to repurchase foreign currencies at a premium. In effect, the Bundesbank and Bank of Italy have swapped spot for forward foreign exchange to disembarrass themselves of unwanted reserve-assets.[2] Finally, the data do not show the composition of official foreign-exchange holdings; they usually relate to total foreign-exchange balances or convertible currencies. For most of the period 1950-1960, of course, the dollar and pound were dominant, but several central banks held Commonwealth securities, some held French francs, and a few may have held Swiss francs or deutsche marks.[3] In a few interesting instances, the *International Financial Statistics* data tell us something about the mix of foreign currencies. The data for Iraq break out sterling from other currencies and describe a shift away from sterling; at the end of 1952, Iraq held $125 million of sterling and $4 million of other currencies, but at the end of 1959, Iraq held $110 million of sterling and a full $102 million of other currencies. Yet these revelations are quite rare, as perhaps they should be. Hence, I have simply sought to locate the margin between gold and the *composite* of foreign moneys that serve as reserve-assets.

A PRELIMINARY CLASSIFICATION

Table 2.1 classifies 61 countries into five large groups according to the frequency of change in their reported gold holdings.[4] It also gives

[2] *See* Oscar L. Altman, "Foreign Markets for Dollars, Sterling, and Other Currencies," IMF *Staff Papers*, December 1961, pp. 339-341. Concealment, however, may not have been their chief reason.

[3] The U.S. Treasury and Federal Reserve System publish separate data on the dollar balances of all foreign governments and central banks, but do not break them down by country; the detailed data in the *Federal Reserve Bulletin* encompass the dollar assets of foreign governments and commercial banks.

[4] The classification is based on gold-stock data identical in time-span to the corresponding foreign-exchange series; this is done to permit comparisons between the computed frequencies and statistics used later on. If all the available gold-stock data had been used, some of the frequencies would have been slightly different (*see* the note to Table 2.1), but the overall outcome would have been much the same.

TABLE 2.1

The Frequency of Changes in Gold Holdings

Country and Number of Observations	*Quarters Showing Changes in Gold* +	—	0	*Frequency of Change*[a]	*Gold Ratio June 1960*
Group I. No gold or no change in gold:					
Burma (42)	no gold			.000	.000
Ceylon (42)	no gold			.000	.000
Costa Rica (42)	0	0	42	.000	.200
Ghana (19)	no gold			.000	.000
Honduras (42)	0	0	42	.000	.007
Iceland (42)	0	0	42	.000	.067
India (42)	0	0	42	.000	.360
Jordan (42)	no gold			.000	.000
Malaya (19)	no gold			.000	.000
Panama (42)	no gold			.000	.000
Sudan (19)	no gold			.000	.000
Vietnam (19)	no gold			.000	.000
Group II. "Rare" changes (in fewer than 20 per cent of the quarters studied):					
Denmark (42)	0	5	37	.119	.123
Dominican Rep. (42)	6	2	34	.191	.233
Egypt (39)	4	1	34	.128	.615
Ethiopia (19)	0	1	18	.053	.060
Guatemala (42)	1	3	38	.095	.470
Haiti (23)	1	3	19	.174	.135
Iran (42)	2	5	35	.167	.757
Iraq (42)	6	0	36	.143	.284
Ireland (42)	1	0	41	.024	.075
Israel (29)	3	5	21	.191	.000
New Zealand (39)	6	0	33	.154	.114
Nicaragua (42)	0	2	40	.048	.029
Pakistan (31)	5	1	25	.194	.174
Thailand (42)	1	5	36	.143	.343
Turkey (31)	3	3	25	.193	.937
Group III. "Infrequent" changes (in as many as 20 per cent but fewer than 50 per cent of the quarters studied):					
Bolivia (39)	8	9	22	.436	.409
Brazil (19)	5	2	12	.368	.834
China (19)	2	2	15	.211	.067
Cuba (42)	3	5	24	.429	.054
Ecuador (42)	8	7	27	.357	.485
Finland (42)	10	4	28	.333	.131
Japan (15)	6	0	9	.400	.168
Korea (23)	7	1	15	.348	.013
Lebanon (39)	18	0	21	.462	.777
Peru (42)	10	9	23	.465	.582
Spain (11)	3	1	7	.364	.192
Venezuela (39)	6	4	29	.256	.846

TABLE 2.1 (continued)

Country and Number of Observations	*Quarters Showing Changes in Gold*			*Frequency of Change*[a]	*Gold Ratio June 1960*
	+	−	0		
Group IV. "Frequent" changes (in as many as 50 per cent but fewer than 80 per cent of the quarters studied):					
Argentina (19)	1	14	4	.789	.121
Austria (31)	16	0	15	.507	.434
Colombia (23)	12	3	8	.652	.372
El Salvador (42)	5	23	14	.667	.746
Greece (23)	12	1	10	.565	.116
Indonesia (39)	6	16	17	.562	.089
Norway (42)	11	14	17	.595	.112
Philippines (42)	24	6	12	.714	.128
Sweden (35)	12	13	10	.762	.372
Group V. "Continuous" changes (in 80 per cent or more of the quarters studied):					
Australia (42)	28	9	5	.881	.130
Belgium (42)	24	18	0	1.000	.891
Canada (42)	26	15	1	.976	.512
Chile (42)	19	16	7	.833	.296
France (15)	10	4	1	.933	.781
Germany (31)	29	2	0	1.000	.500
Italy (15)	14	0	1	.933	.689
Mexico (31)	16	12	3	.903	.365
Netherlands (35)	24	8	3	.914	.846
Portugal (31)	25	5	1	.969	.710
Switzerland (42)	25	16	1	.976	.931
Un. S. Africa (42)	27	12	3	.929	.771
United Kingdom (41)	21	16	4	.903	.873

[a] Number of changes divided by number of observations. In several cases, the available gold data span more quarters than the corresponding foreign-exchange data. When the additional gold data are used the frequencies work out as follows:

Haiti (27) .148; New Zealand (42) .171; Pakistan (42) .167; Turkey (42) .310; Bolivia (42) .405; Brazil (42) .238; Japan (31) .419; Argentina (28) .592; Greece (39) .667; Indonesia (42) .548; Sweden (42) .714; Germany (35) .912; Italy (42) .500; Mexico (42) .929; Netherlands (42) .809; Portugal (42) .905.

But only two countries change Groups: Turkey (II to III) and Italy (V to III).

each country's gold ratio (gold holdings divided by total reserve-assets) as of June 30, 1960, thereby providing vivid testimony to the range of central-bank reserve-asset patterns. The computed frequencies of gold-stock change climb from zero to unity, with countries all along the way. The gold ratios also start at zero and sometimes exceed 90 per cent.

The numbers in Table 2.1 are not perfect indexes of attitudes toward gold. The frequencies do not really tell us how often gold stocks changed; they merely count the quarters that witnessed a net change. At the same time, they may overstate the incidence of *voluntary* gold-stock change; they do not segregate the gold sales that central banks had to make because their reserves were falling. One can sometimes isolate one of these "forced breaks" in the gold statistics, as when a central bank reports a reserve loss larger than the foreign-exchange balance with which it began the quarter when the loss occurred. But I have not tried to pinpoint these situations because so many similar cases can pass unnoticed. Central banks may have had to sell gold although their initial foreign-exchange holdings exceeded the drop in their reserves. Those that have posted foreign-exchange assets as collateral for foreign loans and those that list inconvertible currencies as reserve-assets may have had to draw down their gold stocks before consuming all their foreign-exchange holdings. Similarly, those that hold long-term securities as reserve-assets may have to accept large capital losses on their bonds in order to use all of their foreign-exchange assets.[5]

Finally, an attempt to describe attitudes toward gold by a single ratio or a pair of ratios is bound to suppress evidence on changing asset preferences. Israel is listed in Table 2.1 as making "rare" gold transactions, but actually engaged in a brief flirtation with gold in 1956-1957; Israel held no gold before and ran down her holdings afterward.[6] Greece, Italy, Egypt, and some other countries made a cluster of gold purchases in 1951-1952, then held their gold stocks steady for some

[5] In this same connection, I have been urged to make allowance for the gold-stock changes that correspond to transfers between central banks and the International Monetary Fund, these being mandatory rather than voluntary. When, in 1959, there was a general increase in IMF quotas, member governments had to make additional gold payments; in a few instances, these payments accounted for the whole gold-stock change. Furthermore, some countries have had to pay gold to the IMF to unwind past drawings from the Fund; the composition of a repayment depends on the mixture of reserve-assets held by the government involved. But I have not tried to exclude these transactions, as most of the countries concerned had some choice in the matter. Those with sufficient foreign exchange could have bought more gold to fulfill their obligations to the IMF. In 1960, for example, France bought gold from the United States to repurchase francs from the IMF. In some cases, moreover, countries may have had to *refrain* from holding as much gold as usual because of their transactions with the IMF. The United Kingdom apparently undertook not to buy gold with the currencies she drew from the Fund in 1961 (*see* the Bank of England's *Quarterly Bulletin*, September 1961, p. 9).

[6] Israel may therefore belong in Group I rather than Group II; this is why she has been excluded from some of the calculations described below.

time. But Ecuador also made large purchases in 1951, then made many smaller purchases in the years that followed. And Lebanon made several small gold purchases early in the 1950's, then went on to make large purchases, but much less frequently. Iraq and Brazil made regular gold purchases in the 1950's, but Iraq made large ones while Brazil bought a mere $1 million at a time. Finally, Argentina is listed as having a low gold ratio, but held a large amount of gold before her recent payments crisis, lost most of it during the crisis, and did not reconstitute her holdings right after she regained reserves.[7] Bolivia and Colombia, by contrast, also lost gold during payments crises, but started to rebuild their gold holdings as soon as their reserves began to rise.

Yet it may be more useful to generalize than to recite the national idiosyncrasies. For the ratios in Table 2.1 are pervasively related to other financial parameters:

The central banks with the largest reserve-assets hold the most gold per dollar of total reserves. Ranking the 48 countries that held gold in 1960 (all those in Groups II through V except Israel) by the mean of each country's reserve-assets for 1950-1960 and by the gold ratio for June 30, 1960,[8] then applying Spearman's coefficient of rank correlation (r_r) as the simplest of the relevant statistical tests:

$$r_r = .378 \qquad (r_r/s_r = 2.59)$$

This correlation is not high but is statistically significant at the 0.05 level, a result that is the more striking because there is a bias built into the rankings that works to dilute the correlation; the mean of reserve-assets correlates with the denominator of the gold ratio.[9]

Consider, next, several interpretations one might attach to this correlation:

1. That the global demand for gold is elastic with respect to total reserve-assets. This interpretation is trivially true if merely a restatement of the cross-sectional generalization. But it is not true of the separate countries moving through time; the regression analysis in

[7] Argentina has borrowed heavily in recent years and may not be fully free to transform her newly-acquired reserve-assets into gold.

[8] For mean reserve-assets and the other financial parameters used in the tests below, *see* Appendix B (Tables A and B).

[9] This is an instance of the bias studied by Kuh and Meyer (*see* Edwin Kuh and John R. Meyer, "Correlation and Regression Estimates when the Data are Ratios," *Econometrica*, October 1955). When one recomputes the same test using mean gold holdings divided by mean reserve-assets, instead of the 1960 gold ratio, the bias increases sufficiently to give $r_r = .225$, which is not statistically significant at the 0.05 level.

Chapter 3 gives a set of national "marginal propensities" to hold gold that are smaller than the corresponding gold ratios, so the short-run demand for gold is distinctly assets-inelastic.

2. That the less-developed countries are more anxious to earn income on their reserve-assets and therefore hold more foreign exchange per dollar of reserves than the advanced countries. This interpretation squares with what we know about the low-income countries. First, they are the low-reserve countries; correlating total reserve-assets with Gross National Product *per capita*:

$$r_r = .593 \qquad (r_r/s_r = 4.00)$$

Furthermore, the less-developed countries are striving to enlarge their foreign-exchange earnings, and their central banks may be heavily dependent on foreign-source income because they do not have well-articulated markets for domestic government securities and commercial paper. But while the gold ratios correlate with total reserve-assets and reserve-assets correlate with income *per capita*, there is no apparent intercorrelation between the gold ratios and income *per capita*:

$$r_r = .078 \qquad (r_r/s_r = 0.53)$$

3. That foreign-exchange holdings are primarily working balances, and that working-balance needs do not correlate with total reserve-assets. If this interpretation were valid, one would expect countries having low reserves to carry foreign-exchange balances as large as countries having large reserves, and the gold ratios would have to be small for countries having small reserves merely to make room for the foreign-exchange balance.[1]

One can adduce several facts to support the first part of this hypothesis. Central banks support the exchange-rate structure by intervening directly in the foreign-exchange markets, not by transferring gold from one to another. This practice is sanctioned by the IMF Articles of Agreement, which provide that governments may even fix par values in terms of the U.S. dollar,[2] and by the whole series of European financial arrangements (the 1953 arbitrage agreements, the European Payments Union and the more recent European Monetary Agreement), which require the stabilization of European currencies *vis-à-vis* the dollar and

[1] If, in the extreme case, the foreign-exchange working balance were fixed at F_o for all countries, the gold ratio, G/R, would equal $1 - F_o/R$, and F_o/R would fall apace with increases in R, raising G/R.

[2] *Articles of Agreement*, IV, sec. 1.

permit intra-European settlements in gold or dollars.[3] And one can find statistical support for the supposition that foreign-exchange holdings are working balances. If they were, changes in the banks' foreign-exchange holdings would be more nearly random (less highly autocorrelated) than the changes in their total reserve-assets, and the changes in their gold stocks would be less nearly random (more highly autocorrelated) than those in their total reserve-assets. And this turns out to be the case. The 48-country mean for von Neumann's ratio is significantly higher for foreign-exchange holdings than for total reserve-assets, and significantly lower for gold holdings than for total reserve-assets.[4]

If, moreover, foreign-exchange holdings are working balances and are maintained at levels sufficient to finance day-to-day exchange-market operations, one would expect foreign-exchange balances to absorb most of the variation in total reserves, so that countries which hold most of their reserves in gold need not vary their gold holdings with greater frequency than those which hold most of their reserves in foreign currencies. This inference is also borne out by the data. On the assumption that past reserve changes are an index of prospective volatility, I have used the coefficient of variation of reserve-assets to rank the countries by reserve volatility and the frequencies in Table 2.1 to rank their gold-stock changes:

$$r_r = .065 \qquad (r_r/s_r = 0.44)$$

Using a deflated mean of the squared reserve-asset differences, $\frac{\sqrt{\Sigma \Delta R^2/n}}{\bar{R}}$, to rank volatility and, again, the frequencies in Table 2.1:

$$r_r = -.037 \qquad (r_r/s_r = -0.26)$$

[3] *See* Fred H. Klopstock, *The International Status of the Dollar*, Essays in International Finance, No. 28, Princeton University, 1957, p. 9; also Robert Triffin, *Europe and the Money Muddle*, Yale University Press, 1957, chapters V-VI.

[4] Von Neumann's ratio is the ratio of the mean of squared successive differences to the variance. It is an index of autocorrelation (with values smaller than 2.0 indicative of a positive sequential relationship). Using v_F, v_G, and v_R to denote von Neumann's ratio for foreign-exchange, gold, and total reserve-assets:

$$(\bar{v}_F - \bar{v}_R)/[(s^2_{v_F} + s^2_{v_R})/n] = 2.45$$

$$(\bar{v}_G - \bar{v}_R)/[(s^2_{v_G} + s^2_{v_R})/n] = -3.55$$

The justification for using a Gaussian test at this point is not that von Neumann's ratio has a normal distribution (it does not), but that the means of most sample variates will be normally distributed if the samples from which they are calculated are sufficiently large. The tests used here, incidentally, understate the normalized differences because the three ratios v_F, v_G and v_R are positively correlated, so that the true variance of a difference between any two of the means is smaller than a simple sum of the separate variances.

Neither correlation is significant at the 0.05 level; the countries with volatile reserves do not change their gold holdings with greatest frequency.[5]

If, finally, this third interpretation were correct, one would expect the countries with volatile reserves to hold more foreign exchange per dollar of reserves (and, therefore, less gold) than those with less volatile reserves. There is weak evidence to this effect. Using the coefficient of variation of reserves to rank volatility and the gold ratio for June 1960 to rank gold holdings:

$$r_r = -.074 \qquad (r_r/s_r = -0.51)$$

Using the deflated mean of squared reserve-asset differences to rank volatility and the same gold ratio to rank gold holdings:

$$r_r = -.243 \qquad (r_r/s_r = -1.67)$$

Neither correlation is statistically significant at the 0.05 level, but both have the "correct" sign.[6]

But if working-balance needs explain asset choices, one would not expect the countries with high gold ratios to change their gold stocks most frequently. Yet the ratios in Table 2.1 are positively correlated:

$$r_r = .430 \qquad (r_r/s_r = 2.95)$$

Furthermore, the countries that change their gold stocks most often also make the largest gold-stock changes per dollar of change in reserves. Ranking countries by the ratio of the gold-stock variance to the reserve-asset variance, (s_G^2/s_R^2), and by the frequency of gold-stock changes:

$$r_r = .669 \qquad (r_r/s_r = 4.58)$$

[5] Note, moreover, that when von Neumann's ratio is used to rank reserve volatility (the country with the highest ratio being put first), $r_r = -.226$ $(r_r/s_r = -1.83)$. This result fails of significance at the 0.05 level if a two-tailed test is used, but is significant if a one-tailed test is used. The countries ranked first by von Neumann's ratio are those that have been least susceptible to cumulative reserve movements, and the weak negative rank correlation between von Neumann's ratio and the frequency of gold-stock changes is evidence that the central banks have not tried to hold working balances large enough to cope with cumulative movements.

[6] Once again, moreover, there is a built-in bias that cuts across the test. The denominator (mean reserve-assets) in each coefficient of reserve volatility correlates with the denominator of the gold ratio, diluting the negative rank correlation.

Ranking them by the ratio of the mean squared gold-stock difference to the mean squared reserve-asset difference, $(\Sigma\Delta G^2/n)/(\Sigma\Delta R^2/n)$, and by the frequency of gold-stock changes:

$$r_r = .388 \qquad (r_r/s_r = 2.66)$$

Both these correlations are significant at the 0.05 level.[7]

To sum up, it would seem that central banks hold foreign exchange as a working balance but do not always hold as much as they would require to cope with anticipated reserve-asset changes. They willingly incur the costs of swapping gold for currency rather than submit to capital risks on a larger fraction of their total reserves. Prestige and sensitivity to foreign attitudes also seem to play a part in asset choices. The key-currency central banks appear to believe that they are constrained to hold gold rather than foreign exchange so as to sustain foreign confidence in their currencies. It is, of course, difficult to define a key currency. But most authorities would probably select seven of the countries in Table 2.1: Belgium, France, Germany, Italy, the Netherlands, Switzerland, and the United Kingdom. And the 1960 mean gold ratio for these seven countries was a full .787, significantly higher than the mean for the 41 other countries in Groups II through V.

GOLD-STOCK AND RESERVE-ASSET CHANGES

The data and parameters used thus far treat the gold-stock and reserve-asset changes separately. Now it is time to combine them, for most of the questions I shall ask about asset preferences deal with the synchronization of gold and reserve movements.

To explore the degree of association between these two sets of changes, I have arrayed another set of frequencies in Table 2.2. They show how often gold stocks rose and fell when reserves were rising and how often they rose and fell when reserves were falling. These "conditional frequencies" descend from the same basic data as the simple frequencies in Table 2.1, but have additional peculiarities. First, they neglect the occasional quarter in which a country's reserves did not change. Second and more important, they are often based on small samples. This is especially true for the frequencies of gold-stock change

[7] Oddly enough, moreover, the last r_r rises to .650 (with $r_r/s_r = 4.46$) when n in the numerator of the ratio $(\Sigma\Delta G^2/n)/(\Sigma\Delta R^2/n)$ is reduced by the number of quarters in which there was no gold-stock change, so that the ratio compares the non-zero gold-stock changes to the reserve-asset changes.

TABLE 2.2

The Frequency of Changes in Gold Holdings, Reserves Rising and Falling

Country	*Reserves Rising*				*Reserves Falling*[a]			
		Proportion in which Gold Holdings				*Proportion in which Gold Holdings*		
	Quarters	*Incr.* (f_{++})	*Decr.* (f_{+-})	*Const.* (f_{+o})	*Quarters*	*Incr.* (f_{-+})	*Decr.* (f_{--})	*Const.* (f_{-o})
Group II								
Denmark	26	.000	.115	.885	16	.000	.125	.875
Dominican Rep.	24	.167	.042	.792	17	.118	.059	.823
Egypt	11	.182	.000	.818	28	.071	.036	.893
Ethiopia	8	.000	.000	1.000	11	.000	.091	.909
Guatemala	20	.000	.050	.950	22	.045	.091	.864
Haiti	10	.100	.100	.800	13	.000	.154	.846
Iran	20	.050	.050	.900	21	.048	.190	.762
Iraq	27	.148	.000	.852	15	.133	.000	.867
Ireland	20	.000	.000	1.000	20	.050	.000	.950
Israel	21	.095	.190	.714	8	.125	.125	.750
New Zealand	21	.143	.000	.857	18	.167	.000	.833
Nicaragua	22	.000	.000	1.000	20	.000	.100	.900
Pakistan	18	.222	.055	.722	13	.077	.000	.923
Thailand	20	.000	.150	.850	18	.055	.111	.833
Turkey	15	.067	.067	.867	16	.125	.125	.750
Group III								
Bolivia	16	.125	.188	.687	21	.286	.286	.429
Brazil	10	.300	.100	.600	9	.222	.111	.667
China	8	.000	.000	1.000	8	.250	.125	.625
Cuba	20	.150	.200	.650	22	.000	.500	.500
Ecuador	23	.217	.217	.565	19	.158	.105	.737
Finland	24	.292	.125	.583	18	.167	.056	.778

TABLE 2.2 (continued)

Country	Reserves Rising				Reserves Falling[a]			
		Proportion in which Gold Holdings				Proportion in which Gold Holdings		
	Quarters	Incr. (f_{++})	Decr. (f_{+-})	Const. (f_{+o})	Quarters	Incr. (f_{-+})	Decr. (f_{--})	Const. (f_{-o})
Group III (cont.)								
Japan	12	.500	.000	.500	3	.000	.000	1.000
Korea	13	.385	.000	.615	9	.222	.111	.667
Lebanon	26	.538	.000	.462	13	.308	.000	.692
Peru	20	.350	.150	.500	22	.136	.273	.591
Spain	7	.249	.000	.571	13	.000	.333	.667
Venezuela	16	.312	.000	.687	19	.053	.210	.737
Group IV								
Argentina	7	.143	.571	.286	12	.000	.833	.167
Austria	24	.542	.000	.458	7	.429	.000	.571
Colombia	12	.667	.083	.250	11	.364	.182	.454
El Salvador	20	.100	.350	.550	22	.136	.727	.136
Greece	16	.563	.062	.375	7	.429	.000	.571
Indonesia	18	.222	.222	.556	21	.095	.571	.333
Norway	25	.200	.400	.400	17	.353	.235	.412
Philippines	20	.600	.150	.250	19	.579	.105	.316
Sweden	23	.522	.174	.304	11	.000	.818	.182
Group V								
Australia	21	.667	.143	.190	21	.667	.286	.048
Belgium	22	.909	.091	.000	19	.210	.790	.000
Canada	26	.692	.269	.039	16	.500	.500	.000
Chile	21	.429	.381	.190	21	.476	.381	.143
France	10	.900	.100	.000	5	.200	.600	.200
Germany	27	1.000	.000	.000	4	.500	.500	.000

TABLE 2.2 (continued)

Country	*Reserves Rising*				*Reserves Falling*[a]			
		Proportion in which Gold Holdings				*Proportion in which Gold Holdings*		
	Quarters	*Incr.* (f_{++})	*Decr.* (f_{+-})	*Const.* (f_{+o})	*Quarters*	*Incr.* (f_{-+})	*Decr.* (f_{--})	*Const.* (f_{-o})
Group V (cont.)								
Italy	12	1.000	.000	.000	3	.667	.000	.333
Mexico	19	.684	.263	.053	12	.250	.583	.167
Netherlands	25	.880	.080	.040	10	.200	.600	.200
Portugal	20	.850	.150	.000	11	.727	.182	.091
Switzerland	27	.778	.185	.037	14	.214	.786	.000
Un. S. Africa	18	.833	.167	.000	23	.522	.348	.130
United Kingdom	26	.769	.154	.077	14	.071	.786	.143

[a] To adjust for the known "forced breaks" in the national gold statistics, I have treated each such occurrence as though the gold stock were constant, then recomputed the national frequencies. When this was done, the following frequencies emerged for $\Delta R<0$:

Turkey	16	.125	.041	.834
Bolivia	21	.286	.143	.571
Brazil	9	.222	.000	.778
Peru	22	.136	.227	.637
Spain	3	.000	.000	1.000
Venezeula	19	.053	.105	.842
Argentina	12	.000	.333	.667
Belgium	19	.210	.632	.158
France	5	.200	.400	.400
Mexico	12	.250	.500	.250
Netherlands	10	.200	.500	.300
Switzerland	14	.214	.714	.072
United Kingdom	14	.071	.286	.743

when reserves were falling; those for Japan and Italy used only three observations; those for Germany, four; and those for France, five.[8]

The "conditional frequencies" reveal an important asymmetry in central-bank behavior and give evidence of a drift toward gold in the 1950's:

Central banks have more often bought gold when reserves were rising than sold gold when reserves were falling. To demonstrate this asymmetry, select the relevant mean frequencies from Table 2.3, the mean frequency of increases in gold stocks when reserves were rising ($\bar{f}_{++}$) and the mean frequency of decreases in gold stocks when reserves were falling ($\bar{f}_{--}$). Then test the differences between the paired means.[9]

Difference	*II*	*III*	*IV*	*V*	*All countries*
$\bar{f}_{++} - \bar{f}_{--}$	—.0022	.1240	.0095	.3116	.1141
Normalized	— 1.09	1.98	0.07	3.98	1.94

Two of the separate Group differences, III and V, are statistically significant at the 0.05 level; indeed, the probability of a chance outcome as large as or larger than the Group V difference is only .00003. The all-countries difference does not survive a two-tailed test, but would pass the relevant one-tailed test; the probability of a chance outcome as large as or larger than 1.94 is only .0262. These results are especially impressive, as countries are not forced to buy gold when their reserves rise (except, perhaps, by domestic legislation), but can be compelled to sell gold when their reserves fall. One would expect a

[8] This would perhaps suggest that the mean values in Table 2.3 below might better be calculated by weighting each national frequency with the number of observations used to compute it; this procedure gives the greatest weight to the most "reliable" estimates. But the substitution of weighted frequencies for those in Table 2.3 would have posed some tricky theoretical problems and would not have altered the results in the text below. One or two Group differences would have changed sufficiently to alter their statistical significance. But none of the all-country results would have been affected, as the all-country mean frequencies do not differ by much more than 0.01 from the corresponding weighted mean frequencies.

[9] This test and several that follow use a simple sum of variances to normalize the difference between mean frequencies. This procedure assumes that the frequencies entering into one mean are independent of those entering into the other. In fact, some of the separate national frequencies are positively correlated (notably f_{++} and f_{--}), so that the normalized differences in the text are sometimes *smaller* than the true differences.

TABLE 2.3

The Mean Frequency of Changes in Gold Holdings, Reserves Rising and Falling

Frequency	*Group* II	III	IV	V	*All Countries*
Reserves Rising					
Gold Increasing ($\bar{f}_{++}$)	.0782	.2999	.3953	.7993	.3821
Gold Decreasing ($\bar{f}_{+-}$)	.0546	.0817	.2237	.1525	.1183
Gold Constant ($\bar{f}_{+o}$)	.8672	.6184	.3810	.0482	.4996
Reserves Falling					
Gold Increasing ($\bar{f}_{-+}$)	.0676	.1501	.2649	.4004	.2123
Gold Decreasing ($\bar{f}_{--}$)	.0804	.1759	.3858	.4877	.2680
Gold Constant ($\bar{f}_{-o}$)	.8520	.6740	.3493	.1119	.5197

closer association between gold and reserve changes when reserves were falling than when they were rising.[1]

This test shows that there has been a distinct asymmetry in gold-stock policies, but the asymmetry is still susceptible of two or more interpretations (which may be complementary rather than rivals):

1. It may merely confirm the suggestion I made in Chapter 1 that central banks hold a "basic" gold reserve, enlarge it when it seems safe to do so, and dip into it reluctantly.
2. It may mean that there was a change in asset preferences during the 1950's—a drift toward gold irrespective of total reserve movements.

The evidence, however, causes me to lean toward the second explanation. Even in the absence of a trend toward gold, one would expect the central banks to buy gold more frequently when their reserves were rising than when they were falling, and the data are consistent with this forecast:

Difference	II	III	IV	V	*All countries*
$\bar{f}_{++} - \bar{f}_{-+}$	.0106	.1498	.1304	.3989	.1698
Normalized	0.34	2.13	0.93	29.12	2.75

[1] I have warned that one cannot identify all the "forced breaks" in the gold statistics. Enough are evident, however, to justify a recomputation of this test. I have allowed for the "forced breaks" by treating the relevant gold-stock changes as though the gold stock were constant (*see* the note to Table 2.2). I have then constructed new mean values and normalized mean-value differences. All the latter turn out positive and the normalized all-countries difference, at 2.57, is significantly different from zero.

As before, the Group III and Group V differences are statistically significant at the 0.05 level. This time, moreover, the all-countries difference is also significant, and all the differences are positive.

Going a step further, one might forecast more frequent increases in gold when reserves were falling than decreases in gold when reserves were rising, and this was also true in the 1950's:

Difference	*II*	*III*	*IV*	*V*	*All countries*
$\bar{f}_{-+} - \bar{f}_{+-}$	.0130	.0684	.0412	.2479	.0940
Normalized	0.61	2.14	0.44	3.68	2.77

Again, the Group III, Group V, and all-countries differences are statistically significant.

But, without a drift toward gold, one would surely forecast more frequent sales than purchases when reserves were falling. Yet the difference between the relevant mean frequencies is not significant:

Difference	*II*	*III*	*IV*	*V*	*All countries*
$\bar{f}_{--} - \bar{f}_{-+}$	.0128	.0258	.1209	.0073	.0557
Normalized	0.46	0.37	0.73	0.60	0.98

This test, I submit, offers *prima facie* evidence of a trend toward gold.[2]

It would be worth knowing whether this drift toward gold proceeded evenly in the 1950's. Unfortunately, I could not calculate separate "conditional frequencies" for each year or pair of years; too many cells were empty. To subdivide the 42 quarters into five time-periods (1950-1951, 1952-1953, 1954-1955, 1956-1957, and 1958-1960), I needed a minimum of 15 quarters in which reserves were falling and 15 more in which they were rising, merely to avoid an arithmetic exclusion of some combinations. And each such group of 15 quarters had to be spread evenly across the subperiods. Several countries, however, did not even give 15 quarters with falling reserves, let alone 15 evenly distributed. I have

[2] There is no correlation between the individual f_{--} and f_{-+} so that the normalized differences are not too small in this instance. When, incidentally, I allowed for the "forced breaks" in the gold statistics, the differences between the paired mean frequencies became even smaller; in the all-countries case, the difference dropped to .0149.

nevertheless been able to glean scraps of information by a hybrid of the methods used with the simple frequencies (Table 2.1) and the "conditionals" (Table 2.2):

1. I counted the number of quarters in which gold stocks were constant, making a separate count for each of the five subperiods listed above.[3] Then I computed a mean frequency, $\bar{f}_o$, for each subperiod, and made a one-way variance analysis of the five $\bar{f}_o$'s to test the nul hypothesis that they are the same. Using the 37 countries that published continuous gold statistics for 1950-1960,[4] I obtained these mean values:

Period	$\bar{f}_o$
1950-1951	.467
1952-1953	.510
1954-1955	.537
1956-1957	.510
1958-1960	.489
1950-1960	.503

And the F-test was consistent with the nul hypothesis.[5]

2. I counted the number of quarters in which gold stocks and total reserves moved in the same direction, making a separate count for each subperiod.[6] Then I computed a mean frequency, $\bar{f}_s$, for each subperiod, and made an analysis of variance to test the nul hypothesis that these means are also identical. Using the 28 countries that published gold and foreign-exchange data for all of 1950-1960,[7] I obtained these mean values:

[3] This count is given in Appendix B (Table C). The count for the first subperiod is based on seven observations (in a few instances, fewer than seven); the count for the final subperiod is based on eleven, excluding, as usual, the last quarter of 1960.

[4] The countries in Groups II through V, except Argentina, Austria, China, Colombia, Ethiopia, France, Germany, Haiti, Israel, Japan, Korea, and Spain. The countries that gave gold data but not the corresponding foreign-exchange data were included in this sample.

[5] Dividing the estimate of $s^2_{\bar{f}_o}$ obtained from the inter-cell variation by the estimate obtained from the intra-cell variation, F = .171.

[6] This count is given in Appendix B (Table D). It has the same peculiarities as the one above.

[7] The 37 countries used in the previous test, *less* Brazil, Greece, Italy, Mexico, the Netherlands, Pakistan, Portugal, Sweden, and Turkey, all of which gave gold data for 1950-1960, but no foreign-exchange data for part of the period.

Period	$\overline{f}_s$
1950-1951	.393
1952-1953	.290
1954-1955	.309
1956-1957	.286
1958-1960	.286
1950-1960	.312

Again, the F-test was consistent with the nul hypothesis.[8]

Taken together, these two tests suggest that the association between gold and reserve changes was uniform during the 1950's. The drift into gold described earlier was indeed a steady drift, rather than a lunge.[9]

THE FREQUENCIES AS PROBABILITIES AND THE FOURTH QUARTER OF 1960

During the last weeks of 1960, 21 of the 49 countries in Groups II through V added to their gold holdings (Table 2.4); a number bought gold directly from the United States. Were these events consistent with earlier behavior or a departure from established patterns? The computed frequencies of gold-stock change used in this chapter can answer this question. By treating a frequency as an estimate of the *probability* of a gold-stock change, one can calculate the joint probability that 21 or more countries would buy gold in a given quarter if the central banks were behaving normally.

To use the frequencies as probabilities, one must make several assumptions: (1) That each central bank's transactions in any one quarter are fully independent of those made by other banks; (2) that they are also independent of what the same central bank did before; and (3) that each central bank's behavior was sufficiently uniform in the 1950's to justify the "averaging" involved in forming an expectation from separate events. An improbable fourth-quarter outcome might merely mean that these assumptions are invalid, not that there was a change

[8] In this case, $F = .563$.

[9] Note, however, that $\overline{f}_o$ for 1950-1951 was somewhat lower than the grand mean, while $\overline{f}_s$ for 1950-1951 was significantly higher than the grand mean at the 0.05 level of significance. When, moreover, I recomputed the frequencies in Table 2.2 to exclude the 1950-1951 data, there were reductions in the all-countries means for f_{++} and f_{-+} (but not by enough to alter the significance or nonsignificance of the several mean-value tests using these frequencies). All this suggests that there was a "lunge" toward gold during the Korean war. (For further comments on this episode, *see* Miroslav A. Kriz, *Gold in World Monetary Affairs Today*, Essays in International Finance, No. 34, Princeton University, 1959, pp. 19-20.)

TABLE 2.4

Gold Stocks and Total Reserve-assets in the Fourth Quarter of 1960

(Millions of dollars)

Country	Holdings at 12.31.60		Change in the Fourth Quarter	
	Gold	Reserves	Gold	Reserves
Group II				
Denmark	31.0	262.7	0	+ 23.5
Dominican Republic	10.4	25.8	0	− 19.3
Egypt	174	291	0	+ 11
Ethiopia	3.2	54.9	− 0.5	− 1.5
Guatemala	23.6	50.3	0	+ 4.8
Haiti	0.7	5.0	0	+ 1.1
Iran	130	183	− 1	+ 5
Iraq	98.0	253.6	+ 14.1	− 18.7
Ireland	18	268	0	+ 14
Israel	0	206.9	0	+ 31.4
New Zealand	35	177	0	−100
Nicaragua	0.4	10.0	0	+ 0.4
Pakistan	52	313	0	+ 25
Thailand	104	360	0	+ 21
Turkey	134	174	+ 1	+ 34
Group III				
Bolivia	0.9	6.7	0	+ 2.2
Brazil	287	345	0	0
China	7	117	0	+ 12
Cuba	1	144	− 2	−142
Ecuador	20.0	37.0	0	− 6.7
Finland	41.0	314.1	+ 2.9	+ 5.9
Japan	247	1824	0	+166
Korea	1.8	157.0	0	+ 7.6
Lebanon	119.2	137.0	+ 17.5	− 0.6
Peru	42.4	68.6	+ 15.1	+ 10.8
Spain	178	541	+ 80	+ 62
Venezuela	398	558	− 64	− 11
Group IV				
Argentina	104	526	+ 20	− 10
Austria	293	697	0	− 6
Colombia	78	154	+ 3	− 8
El Salvador	30.0	33.1	0	− 1.0
Greece	76.2	223.5	+ 45.4	− 6.2
Indonesia	57	340	+ 24	− 10
Norway	30.2	282.6	− 0.3	+ 18.3
Philippines	15	120	+ 2	− 22
Sweden	170	465	− 1	− 13

TABLE 2.4 (continued)

Country	Holdings at 12.31.60		Change in the Fourth Quarter	
	Gold	Reserves	Gold	Reserves
Group V				
Australia	147	843	− 12	−107
Belgium	1170	1411	+ 76	+203
Canada	885	1829	− 9	+ 16
Chile	45.1	110.6	+ 2.6	− 8.0
France	1641	2070	+ 14	− 40
Germany	2971	6737	+ 82	+398
Italy	2203	3079	+ 17	− 4
Mexico	136	392	+ 15	+ 41
Netherlands	1451	1742	+105	+193
Portugal	552	794	+ 2	+ 12
Switzerland	2185	2322	+205	+211
Un. S. Africa	178	241	− 26	− 30
United Kingdom	2800	3231	+125	+123

in central-bank behavior. But I shall treat such an outcome as *prima facie* evidence of a change in preferences.[1]

As the probability (computed frequency) of a gold-stock increase differs from country to country,[2] Poisson's generalization of the binomial distribution should be used to obtain the probability of X gold-stock increases in a single quarter, then successive computations on the Poisson formula should be summed to obtain the probability of X *or more* increases. But Poisson's binomial is very cumbersome when X can range as high as 49, and I shall therefore use two approximations:

The simple (Bernoulli) binomial. To calculate the probability of X

[1] I made a pilot study on the first assumption, using ten European countries (Austria, Belgium, Finland, Germany, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom), all of which gave data for 1953-1960. Employing contingency tables and the chi-square test, I looked for connections between the sign of each change in each country's gold stock and the number of same-signed simultaneous changes in the holdings of the other nine. I chose European countries because proximity could be expected to maximize interdependence, but there were no clear-cut connections. This pilot study, however, does not fully confirm my first assumption; one would have also to experiment with lags, then construct similar tests for every combination of the 48 countries under study here—matching each country with the other 47, all the sets of 46, all the sets of 45, and so on. I did not try to test the second and third assumptions, but would regard my findings on the uniformity of the $\bar{f}_o$ and $\bar{f}_s$ as indirect evidence of sequential independence and uniformity.

[2] *See* Appendix B (Table E); these probabilities are calculated from the count of gold-stock changes in the first few columns of Table 2.1, above.

or more gold-stock increases, I computed successive applications of the simple (Bernoulli) binomial:

$$p(X) = \frac{N!}{X!\,(N-X)!}\,\bar{f}_+^{\,X}\,(1-\bar{f}_+)^{(X-N)},$$

where X is the number of increases in national gold holdings during the fourth quarter of 1960, N is the number of countries under study (49), and $\bar{f}_+$ is the mean frequency of an increase in gold holdings in any one quarter. Then I computed:

$$p(X \geqq 21) = \sum p(X) \quad (X = 21, 22, \ldots, 49)$$

I followed the same procedure with the separate Groups II through V, obtaining these results:

	II	*III*	*IV*	*V*	*All countries*
Number of countries (N)	15	12	9	13	49
Mean frequency of a gold purchase ($\bar{f}_+$)	.071	.242	.339	.660	.318
Expected number of gold purchases ($N\bar{f}_+$)	1.0	2.9	3.0	8.6	15.6
Actual number of gold purchases (X)	2	4	5	10	21
Probability of X or more purchases	.287	.327	.155	.304	.069

These probabilities are not very low, the lowest (all countries) saying that a result like the fourth quarter outcome could occur by pure chance once in every four years.[3] But the Bernoulli binomial overstates the probability of X or more gold purchases if that probability is properly defined by the Poisson binomial and if X sufficiently exceeds $N\bar{f}_+$. The two distributions have the same means, $N\bar{f}_+$, but the Poisson binomial has the smaller variance.[4] In fact, Bernoulli's formula overstates

[3] At first glance, it might seem that the all-countries figure is out of line with its components. This is not so. All of the X's are higher than the expected values ($N\bar{f}_+$); the low all-countries probability reflects this fact.

[4] To be exact, $N\bar{f}_+(1-\bar{f}_+) = \sigma^2_b = \sigma^2_p + N\sigma^2_f$, where σ^2_b is the variance of the Bernoulli, σ^2_p is the variance of the Poisson, σ^2_f is the variance of the national frequencies of an increase in gold holdings, and N is the number of national frequencies entering into $\bar{f}_+$.

$p(X \geqq X_v)$ and $p(X \leqq X_u)$ for all $X_v \geqq N\bar{f}_+ + 1$, and all $X_u \leqq N\bar{f}_+ - 1$.[5] As each of the X's in my tabulation exceeds the corresponding $N\bar{f}_+$ by an integer or more, Bernoulli's formula overstates the Poisson value of $p(X \geqq 21)$, etc., and the bias may be substantial.[6]

A normal approximation. For sufficiently large N, there is another approximation to Poisson's binomial:

$$T = (X - N\bar{f}_+)/\sigma_p$$

has a normal distribution with zero mean and unit variance and serves as a good proxy for Poisson's binomial.[7]

I did not use this approximation for the separate Groups II through V, as the relevant N's are too small, but tried it on the all-countries estimate, obtaining $T = 2.01$. Hence the probability of 21 or more purchases of gold is a mere 0.022; this result could occur by chance once in a full 50 quarters (once in about 12 years).[8]

This last estimate is quite striking. It surely suggests that some central banks took part in the 1960 "gold rush"; more bought gold than one would have forecast from prior behavior. But there is a flaw in my procedure. I have shown that central banks are more apt to buy gold when their reserves rise than when they fall, and that those in Groups IV and V are more apt to buy gold than those in Groups II and III. If, then, the fourth quarter of 1960 saw a widespread increase in reserve-assets or an increase concentrated in Groups IV and V, 21 fourth-quarter gold-stock increases might still be consonant with the 1950-1960 pattern. To examine this possibility, I shall use the "conditional frequencies" (Table 2.2) and Bernoulli's formula.[9]

First, I computed mean "conditional frequencies" for the 27 countries that gained reserve-assets in the fourth quarter of 1960:

[5] W. Hoeffding, "On the Distribution of the Number of Successes in Independent Trials," *Annals of Mathematical Statistics*, 1956, pp. 713-721.

[6] For all countries taken together, $s^2_b = 10.63$, $s^2_f = 0.06788$, and $s^2_p = 7.26$.

[7] H. Cramer, *Mathematical Methods of Statistics*, Princeton University Press, 1946, pp. 214-218. This proposition is a special case of the central limit theorem.

[8] If I had excluded the 1950-1951 data when computing the separate national frequencies of gold-stock increase given in Table E of Appendix B, $\bar{f}_+$ for all countries would have fallen from .318 to .306, T would have risen from 2.01 to 2.29, and the probability of 21 or more purchases would have fallen from 0.022 to 0.011.

[9] The relevant N's are too small to allow a normal approximation, but knowing how the bias runs with the Bernoulli binomial, one should be convinced by the results below.

Countries whose reserves rose	*Change in gold stock*			
	All	+	—	*0*
Mean "conditional frequency" ($\bar{f}_{++}$, etc. for the 27 countries)	1.000	.354	.105	.541
Expected number of gold-stock changes ($N\bar{f}_{++}$, etc.)	27	9.6	2.8	14.6
Actual number of gold-stock changes	27	11	3	13

The fourth-quarter gold-stock changes are quite close to expectation—so close indeed that it does not pay to compute the corresponding probabilities.[1] But the result is very different for the 21 countries that lost reserves in the fourth quarter:

Countries whose reserves fell	*Change in gold stock*			
	All	+	—	*0*
Mean "conditional frequency" ($\bar{f}_{-+}$, etc. for the 21 countries)	1.000	.277	.262	.461
Expected number of gold-stock changes ($N\bar{f}_{-+}$, etc.)	21	5.5	5.8	9.7
Actual number of gold-stock changes	21	10	6	5

Many more of these bought gold than one would have forecast from the prior pattern, and far fewer held their gold stocks steady as reserves declined. Here are the computed probabilities for these extreme cases:

That ten or more would buy gold in one quarter	.028
That five or fewer would not buy or sell in one quarter	.031

And these probabilities are too high, for both outcomes differ from the corresponding $N\bar{f}$ by more than an integer.[2]

The countries that bought gold though losing reserves were mainly those in Groups IV and V. And the probability that eight or more such countries would buy gold when 13 were losing reserves works out to an upper limit of 0.045.

[1] This is as true of the separate Groups as of the all-countries computation in the text; few of the differences between X and the relevant $N\bar{f}$ were as large as ± 1.0.

[2] For gold purchases, $s^2_b = 4.06$ and $s^2_p = 2.97$; for constant gold stocks, $s^2_b = 5.22$ and $s^2_p = 3.50$. The bias may be very large.

This analysis leaves little doubt that there was a shift toward gold in the fourth quarter of 1960. To determine the importance of the shift—whether it was at the center or at the periphery of the international monetary system—and to decide what it portends for the future of the gold-exchange standard, I studied the behavior of the separate central banks.

3. A REGRESSION ANALYSIS OF RESERVE-ASSET PREFERENCES

THE RATIONALE

The analysis of gold-stock changes in Chapter 2 has revealed a number of regularities:

1. The positive correlations between the gold ratios, frequencies of change, and total reserves;
2. The different roles of gold and foreign exchange in official reserve-asset portfolios;
3. An asymmetry in central-bank gold policies between the quarters with rising reserves and those with falling reserves, suggesting a drift toward gold;
4. Apparent central-bank participation in the 1960 "gold rush."

But the frequencies of change and gold ratios also hint at large differences in national policies, even as they indicate "typical" attitudes. To describe asset preferences accurately, then, one must separately examine each set of national data. This, indeed, is absolutely necessary to assess the prospects for the gold-exchange standard. The fate of the monetary system rests with a handful of central banks, as foreign-exchange holdings are markedly concentrated. On September 30, 1960, a mere ten central banks out of 62 held as much as $400 million of foreign exchange,[1] and eight of the ten may have accounted for fully three-fourths of the U.S. dollars held by foreign governments.[2]

I therefore employed each country's data in a regression model, attempting to simulate reserve-asset choices.[3] First, I used a simple linear relationship:

$$G = B_o + B_R \cdot R + e \qquad (1)$$

which "explains" gold holdings, G, by total reserve-assets, R.[4] This

[1] Argentina ($452), Australia ($791), Austria ($410), Canada ($919), France ($483), Germany ($3450), Italy ($891), Japan ($1411), Malaya ($466), and the United Kingdom ($433).

[2] Most of the Australian and Malayan foreign-exchange holdings were sterling. If all the holdings of the other eight countries were in U.S. dollars, they would account for $8.4 billion (80 per cent) of total U.S. short-term liabilities to foreign governments. This subtotal is too high, but not far from accurate, as all the Canadian holdings were actually U.S. dollars, and most of the British, French, German, Italian, and Japanese holdings were probably dollars.

[3] I also tried a series of cross-sectional relationships, but without as much success. *See* Appendix C.

[4] The final term, e, in equation (1) is the residual in which we compound the omitted explanatory variables and the more complex interrelationships. Note that

basic equation and its several variants cannot assign a unique asset-preference pattern to each central bank, as the rival patterns tend to overlap. But it can discriminate among the three basic patterns suggested in Chapter 1, for each basic pattern implies a different pair of values for the coefficients B_o and B_R:

1. *The Simple Working Balance.* Suppose that a central bank holds a working balance of foreign exchange, F^*, no larger than it needs for daily intervention in the foreign-exchange market; it puts all of its other reserve-assets into gold. In this case, the demand for gold will look like the line Obe in Figure 3.1: If $0 < R < Ob$ (where $Ob = F^*$), $B_R = 0$; if $Ob < R$, $B_R = 1$.[5]

The kink at b in Obe could be very troublesome, but we may be able to ignore the possibility $0 < R < Ob$. A country on Ob would hold

---

equation (1) takes the level of reserves as predetermined, an assumption that plays a strategic role in the analysis below. If the level of reserves were endogenous, equation (1) should be replaced by a reduced form. As $R = G + F$, where F is foreign exchange:

$$G = B_o + B_R(G + F) + e = \frac{B_o}{1 - B_R} + \frac{B_R}{1 - B_R} F + \frac{e}{1 - B_R}$$

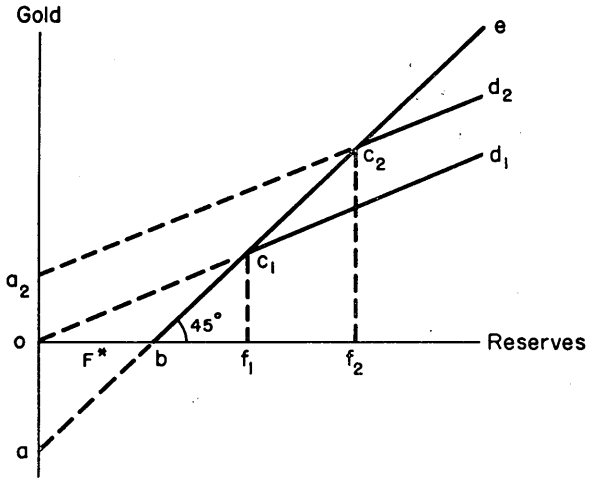
and a correlation between G and F would be prerequisite to an inference that gold stocks are, in turn, determined by the level of reserves. Then the correlations set out below would have to be dismissed as spurious, for G does not usually correlate with F. But I would argue that reserves *are* predetermined by the evolution of the balance of payments; the level of R does not depend on separate decisions ruling G and F. In other words, the identity $R = G + F$ does not define R (as, say, $C + I$ defines Y in a simple macroeconomic model), but is more closely analogous to the familiar budget restraint. One can conceive of situations in which G and F vary independently of one another, influencing R. Countries like Canada and the Union of South Africa can buy newly-produced gold against local currency; and, as in 1961-1962, central banks can increase their gross reserves by swap transactions with one another. For that matter, all central banks have a measure of control over the national balance of payments and, therefore, over the rate of change of total reserve-assets. But, by and large, R is the best candidate for independence in the period with which I am concerned and in the sort of quarterly model used below. And if this is so, the absence of a correlation between G and F will merely reflect the large variance of the error term, e. If reserves are predetermined, any unexplained variation in G will be at the expense of F. Hence, the correlation between G and F sought by the reduced form will be swamped by a large error term. There is, of course, the danger that errors of measurement will be shared by G and R and will generate a spurious correlation; as R is defined *ex post* as the sum of G and F, errors of measurement in G will find their way through to R, connecting G and R. The reduced form could cope with this problem—but only if it were appropriate to the underlying economic model. As my procedure does not preclude this sort of accidental correlation, and as the error terms are quite large, I cannot be too sure that my regression coefficients testify to stable asset-preference patterns.

[5] If $R = Ob$, $B_R = 0$ for decreases in R, and $B_R = 1$ for increases.

no gold; yet 48 of the 49 countries in Groups II through V held some gold throughout 1950-1960.[6] Hence, a regression equation for asset pattern (1) will look like abe in Figure 3.1, with $B_o = Oa\ (= -Ob)$ and $B_R = 1$.

Figure 3.1

Reserve-asset Preference Functions



2. *Proportionality.* Suppose that a central bank holds a working balance, F^*, but when $R > F^*$, divides its *total* reserve-assets between gold and foreign exchange using a simple rule of thumb: It holds a fraction, λ, as foreign exchange and the rest as gold. In this case, the demand for gold will look like Obc_1d_1 in Figure 3.1: If $0 < R < Ob$, $B_R = 0$; if $Ob < R < Of_1$, $B_R = 1$; and if $Of_1 < R$, $0 < B_R < 1$ ($B_R = 1 - \lambda$). The "marginal propensity" to hold gold, B_R, will be unity when $Ob < R < Of_1$ for the same reason as in (1) above; the central bank would prefer to keep $B_R = 1 - \lambda$ but must sell extra gold if its reserves dip below Of_1 so as to maintain its working balance at F^*.

[6] The one exception, moreover, does not seem to pertain to the situation $0 < R < Ob$. Israeli reserves were very high when Israel began to dispose of its gold. One or two countries in Group I may represent $0 < R < Ob$, but I do not deal with the Group I countries in the regression analysis.

Three distinct regression lines can emerge if a central bank adopts asset pattern (2):

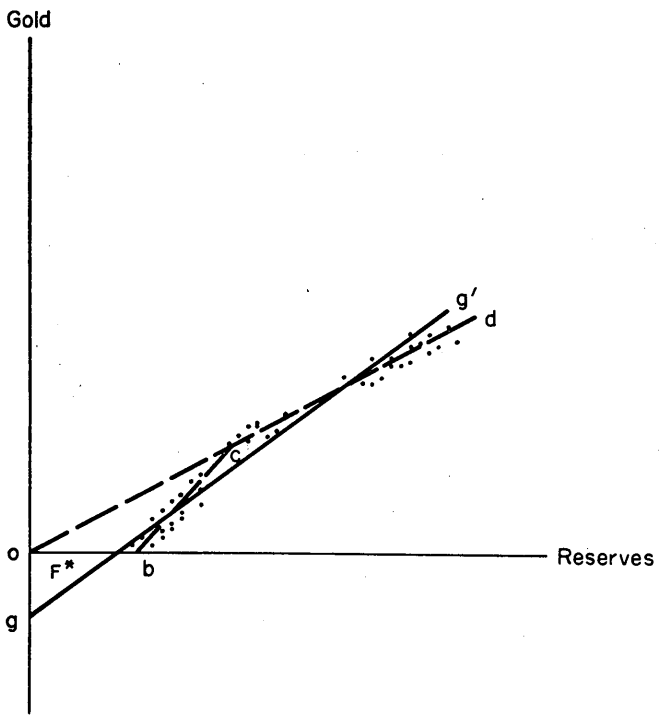
2.a. $Ob < R < Of_1$ in every quarter. If this happens, asset pattern (2) will give a regression line just like that of pattern (1); it will be like abe in Figure 3.1, with $B_o = Oa$ and $B_R = 1$.

2.b. $Of_1 < R$ in every quarter. If this happens, the regression line will look like Oc_1d_1 in Figure 3.1, with $B_o = 0$, and $0 < B_R < 1$.

2.c. $Ob < R < Of_1$ in some quarters, but $Of_1 < R$ in others. If this happens, the regression line will look like gg′ in Figure 3.2 with

Figure 3.2

Working – balance Needs and Bias in the Estimate



$B_o < 0$ and $0 < B_R < 1$. But the residuals, e, are apt to show positive autocorrelation. The central bank is quite likely to stay on bc for several quarters, then move onto cd for several more, rather than shuttle back and forth between bc and cd. Hence, a given

sequence of residuals will be positive or negative, not thoroughly mixed.

3. *The "Basic" Gold Reserve.* Suppose, finally, that a central bank holds a basic gold reserve, G^*, as well as a working balance of foreign exchange, F^*; but when $R < F^* + G^*$, it may hold all of the "excess" as foreign exchange or divide it between gold and foreign exchange using a rule of thumb.[7] In this case, its demand for gold will look like Obc_2d_2 in Figure 3.1: If $0 < R < Ob$, $B_R = 0$; if $Ob < R < Of_2$, $B_R = 1$; and if $Of_2 < R$, $0 \leq B_R < 1$.[8]

There are, again, three likely subcases:

3.a. $Ob < R < Of_2$ in every quarter. Like (2.a), above, this subcase gives a regression line just like that of asset pattern (1); it will be like abe in Figure 3.1, with $B_o = Oa$ and $B_R = 1$.

3.b. $Of_2 < R$ in every quarter. Here, the regression line will look like $a_2c_2d_2$ in Figure 3.1, with $0 < B_o = Oa_2$, and $0 < B_R < 1$.

3.c. $Ob < R < Of_2$ in some quarters, but $Of_2 < R$ in others. Once again, the regression line will be like gg′ in Figure 3.2 (with autocorrelated residuals), but with $B_o \gtreqless 0$. If $B_o > 0$, this case is distinct from (2.b) and (2.c); but if $B_o < 0$, it will look like its companions.[9]

One could construct a host of other asset-preference patterns, including some that cut across the three I have proposed. Suppose, for example, that a central bank applies a constant of proportionality, λ, to reserves in excess of F^*, holding $\lambda(R - F^*)$ as foreign exchange and $(1 - \lambda)(R - F^*)$ as gold. The regression line would look like abe in Figure 3.1, but with $Oa < B_o < 0$, and $0 < B_R < 1$, being identical to the lines produced by (2.c) and (3.c). But I shall neglect these permutations and assume that pairs of values for B_o and B_R which are consistent with one of the patterns (1), (2) or (3) do, in fact, represent one of those patterns. For even these three simple patterns can pose nasty problems; they can mingle into four separate categories:

Category A: $B_o < 0$, $B_R = 1$; this class includes patterns (1), (2.a) and (3.a).

[7] If it put all of the "excess" into gold, it would be following asset pattern (1), the simple working balance; reserves in excess of $F^* + G^*$ would be treated just like G^*.

[8] The special case $B_R = 0$ when $Of_2 < R$ might be described as a "pure" case; it is the one you would expect to meet among countries in Groups I through III.

[9] A regression line like gg′ with $B_o = 0$ and random residuals should probably be treated as an instance of (2.b). But one cannot reason conversely; autocorrelation may testify to a number of different flaws in a regression analysis, not merely to the "broken" asset pattern Obc_2d_2 in Figure 3.1.

Category B: $B_o < 0$, $B_R < 1$; this class includes patterns (2.c) and (3.c).

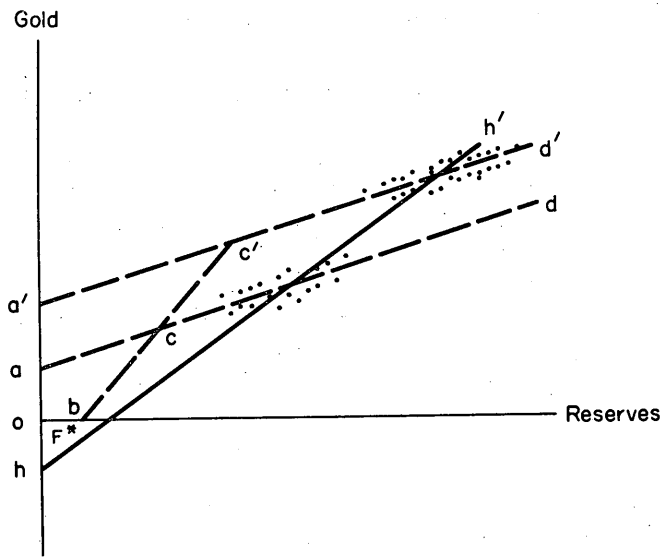
Category C: $B_o = 0$, $B_R < 1$; this class includes patterns (2.b) and (3.c).

Category D: $B_o > 0$, $B_R < 1$; this class includes patterns (3.b) and (3.c).

One might be able to sort out the contents of category (C) by testing the residuals for autocorrelation. But one cannot sort out the contents of category (B) or, more importantly, of category (A). Yet the patterns mingled into category (A) have very different implications for the future of the gold-exchange standard. If the countries that appear in (A) actually partake of asset pattern (1), their demand for gold will keep pace with their reserves; if, instead, they partake of patterns

Figure 3.3

Shifting Asset Preferences and Bias in the Estimate



(2.a) or (3.a), their demand for gold will grow more slowly once they reach segment cd in Figure 3.1.

To make matters much more complex, my four-way classification can be badly damaged by simple shifts in the demand for gold:

A drift toward gold. The frequencies of gold-stock change pre-

sented in Chapter 2 gave *prima facie* evidence of a trend toward gold. If this trend were superimposed on pattern (2), it would involve an increase in B_R; if superimposed on pattern (3), an increase in B_R or in B_o. In either case, a drift toward gold could bias my regression lines if it were coupled to a trend in total reserve-assets. Suppose that the demand function Obcd in Figure 3.3 shifted to Obc'd' (B_o increasing by aa') and that total reserves were higher after the shift than before. The regression line would look like hh', with $B_o < Oa$ and B_R larger than the true "marginal propensity."[1]

*An increase in F**. The working balance, F*, may also have increased in recent years. The growth of trade and of money flows may have enlarged the turnover in the foreign-exchange markets and, perhaps, the scale of official intervention when such intervention is required. An increase in F* coincident with rising reserves will tend to flatten the regression line for asset pattern (1). But it would have an opposite effect on the lines for (2) and (3), even if not correlated with an increase in reserves: If F* increased by bb' in Figure 3.4, and R fell below Om after the increase, the central bank would move along c'b' rather than cc', making the regression line look like jj'.

If the first of these two biases were frequent and large, some of the subcases (2.b) could bob up in categories (A) and (B), and some of the subcases (3.b) could bob up in (A), (B), or (C). But the trend toward gold will show up independently as a coefficient B_t in the variants of my basic equation. The B_t, moreover, will be quite distinct, even when reserves have shown an up-trend.

If the second bias were similarly strong, some of the asset patterns (1) might scatter into categories (B), (C), and (D), and some of the subcases (2.b) and (3.b) might scatter into (A) and (B). But I shall use a variant of the basic equation to produce a separate test for the working-balance rule, thereby spotting pattern (1) when it occurs.[2]

SIMPLE AND FIRST-DIFFERENCE REGRESSIONS

Simple Regressions. My first set of regression coefficients is summarized in Table 3.1. The B_o and B_R refer to equation (1) which was

[1] If, conversely, reserves were smaller after the shift than before, the regression line would be flatter than the true demand function, giving $B_o > Oa$ and B_R smaller than the true "marginal propensity." This possibility, however, is less important than the one mentioned in the text, as there was a pervasive up-trend to reserves during 1950-1960.

[2] I shall also show that $\overline{F}$ (the mean value for foreign exchange) is a fair approximation to F*, and this suggests that there has not been a marked drift in F*.

fitted to the data for each of the 49 countries in Groups II through V. The 31 countries listed in the table are those that gave an r^2 (the square of the correlation coefficient) that was statistically significant at the 0.05 level. The standard errors of estimate, s_e, are arrayed in the final column of the table.

The coefficients B_o and B_R scatter strangely through categories (A), (B), (C) and (D). Three countries fall into category (A), with B_R close to unity and B_o negative; ten fall into category (B); four fall into category (C); and ten fall into category (D). Yet category (C), the rule of "proportionality," is most often mentioned in the press and privately as the preferred asset pattern. Furthermore, some of the national parameters are rather odd: Four of the B_R are negative, and the number of significant regression results in Group II is suspiciously large, for the countries in Group II rarely changed their gold holdings. If,

Figure 3.4

Growth in Working-balance Needs and Bias in the Estimate

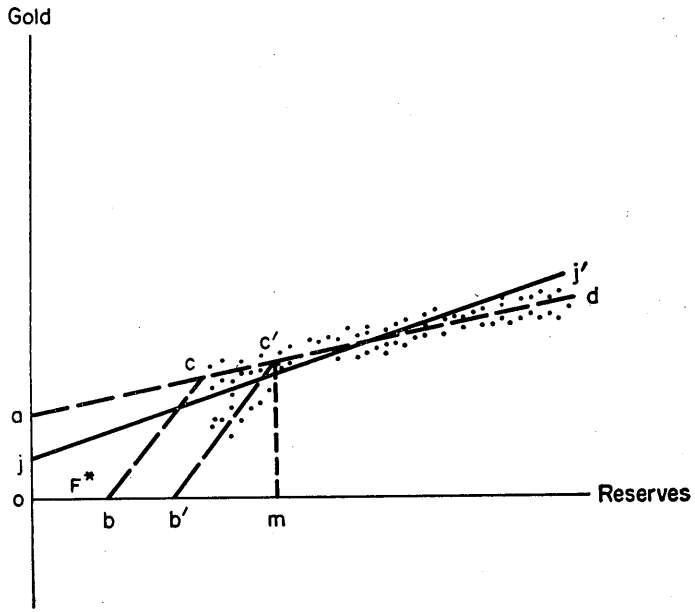


TABLE 3.1

Correlation and Regression Results: Total Gold and Total Reserve-assets.

Country	r^2	B_o[a]	B_R	s_e[a]
Group II				
Denmark	.426	31.5	— .002	0.14
Dominican Republic	.433	3.7	.205	1.89
Egypt	.231	195	— .037	14.6
Ethiopia	.217	3	.017	0.20
Haiti	.586	0.4	.152	0.45
Iran	.222	130	.036	2.0
Iraq	.281	— 22	.173	23.1
Pakistan	.234	35	.040	2.4
Turkey	.303	96*	.308	3.2
Group III				
Bolivia	.966	— 1.6	.873	1.84
Cuba	.349	—131	.673	71.1
Finland	.602	10.4	.103	5.41
Japan	.850	—136	.258	41.1
Lebanon	.947	9.1	.919	6.78
Peru	.630	3.3*	.610	5.46
Venezuela	.832	216	.412	61.9
Group IV				
Austria	.775	— 82	.454	42.9
Indonesia	.534	— 76	.653	61.0
Norway	.670	66.7	— .123	3.78
Philippines	.174	17	.034	5.2
Group V				
Australia	.198	173	— .041	21.0
Belgium	.960	—180	1.095**	43.9
Canada	.665	—836	.982**	109.2
France	.814	172	.599	149.8
Germany	.926	—496	.658	287.5
Italy	.958	—446	.766	139.6
Mexico	.368	70	.212	29.6
Netherlands	.960	— 62	.891	51.9
Portugal	.942	—467	1.249**	17.1
Switzerland	.979	19*	.921	30.7
United Kingdom	.937	—180*	.948**	131.8

[a] Entries carried out to an extra decimal place relate to countries that publish reserve-asset data worked out to the nearest $100,000; the same procedure will be followed in later tables without further comment. To identify the non-significant cases in this and later tabulations, compare the list of countries in the regression table with the list in Table 2.1. For the number of observations and standard errors of the coefficients, *see* Appendix B (Table G).

* Not significantly different from zero at the 0.05 level.

** Not significantly different from unity at the 0.05 level.

finally, Portugal and Canada actually belong to category (A), B_o should approximate /F*/, but is far too large to be a working balance.[3]

These anomalies urge a certain skepticism toward the regression estimates in Table 3.1, and their other properties foster still more doubt: First, the gold and reserve data are both highly autocorrelated,[4] so that some of the correlations in Table 3.1 may be the spurious consequence of common trends. Second, almost every set of residuals, e, shows autocorrelation, so that the standard errors of B_R may be much too small and the statistical significance of B_R may be exaggerated.[5] Third, gold is itself a major reserve-asset, so that the reserve statistics may reflect errors of measurement in the gold-stock estimates, and G may seem to be linked with R even when there is no functional connection.

These three flaws in the coefficients of Table 3.1 would not bar straightforward forecasting. But one could not appraise forecasts made with those coefficients, nor can one use those coefficients to classify central-bank asset preferences.

First-difference regressions. To cope with the defects in the coefficients derived from equation (1), I have made a second set of regression estimates, using:

$$\Delta G = {}_{\Delta}B_t + {}_{\Delta}B_R \cdot \Delta R + {}_{\Delta}e \qquad (2)$$

This is a transformation of equation (1), after adding a trend term.[6]

[3] The German and Italian values for B_o are also suspicious; if these countries do belong in category (B), B_o should be smaller than /F*/. These two coefficients, however, may be biased by powerful trends toward gold; Germany and Italy both display positive trend terms in the computations laid out below.

[4] For von Neumann's ratio, *see* Appendix B (Table B).

[5] *See* Appendix B (Table F). I have computed von Neumann's ratio for 19 sets of regression residuals (the 19 being countries that also gave significant first-difference regressions in Tables 3.2 and 3.4 below); 18 of the 19 were autocorrelated at the 0.01 level of significance.

[6] Rewrite equation (1) with a trend term, B_t, denoting two adjacent quarters by Q and Q-1 and by the subscripts $_q$ and $_{q-1}$:

$$G_q = B_o + B_t \cdot Q + B_R \cdot R_q + e_q$$
$$G_{q-1} = B_o + B_t \cdot Q\text{-}1 + B_R \cdot R_{q-1} + e_{q-1}$$

Subtracting the second equation from the first:

$$G_q - G_{q-1} = B_t + B_R(R_q - R_{q-1}) + (e_q - e_{q-1})$$

Or:

$$\Delta G = {}_{\Delta}B_t + {}_{\Delta}B_R \cdot \Delta R + {}_{\Delta}e$$

First-difference equations cannot be used to make extended extrapolations. One could forecast ΔG_{q+1} and add it to the last-known level of gold holdings, G_q, to estimate G_{q+1}, then add a forecast of ΔG_{q+2} to estimate G_{q+2}. But this kind of cumulative forecasting sheds reliability as the chain grows longer; the forecast of G_{q+n} has a variance ns^2_p, where s^2_p is the variance of the first forecast, ΔG_{q+1}. (*See* R. Stone and S. J. Prais, "Forecasting from Econometric Equations: A Further

It explains the quarterly change in gold holdings, ΔG, by an autonomous trend ${}_{\Delta}B_t$ (denominated in millions of dollars), and by the quarterly change in total reserves, ΔR.

This procedure is quite crude by comparison with some of the transformations the experts recommend. But first-differencing has often proved its worth in similar situations. It can remove a good part of the trend or cycle in the basic data and thereby impose a stiffer test on behavioral connections.[7] In addition, it will often serve to randomize residuals. In short, the first-difference transformation works to give a true "marginal propensity" and an unbiased estimate of its standard error.[8] Finally, first-differencing can sometimes combat bias in regression estimates due to the shared errors of measurement—those that are transmitted from the gold-stock data to the reserve data because gold is a reserve-asset. It can do so when these errors are themselves autocorrelated.[9] Errors of measurement in the gold-stock statistics, moreover, are apt to be autocorrelated, as an erroneous valuation of one gold-stock change will be carried over to the later data.

I correlated ΔG and ΔR for the countries in Groups II through V and computed ${}_{\Delta}B_t$ and ${}_{\Delta}B_R$ for the 23 that gave significant correlations at the 0.05 level (Table 3.2).[1] The correlation coefficients were lower than

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Note on Derationing," *Economic Journal*, March 1953). But this defect of equation (2) is not especially serious here. I shall only use the first-difference coefficients to identify asset preferences and to study asset choices in the first quarter after those used to estimate the parameters.

[7] The inclusion of a linear trend term, ${}_{\Delta}B_t$, also helps in this regard, and it can be estimated very economically. I have found, however, that first-differencing itself accounts for the bulk of the change in the "marginal propensities" as between Table 3.1 and Table 3.2; in Appendix B (Table H) I compare the B_R and ${}_{\Delta}B_R$ with an intermediate parameter, ${}_{h}B_R$, which is computed from a homogeneous version of equation (2). Most of the change in each coefficient occurs between B_R and ${}_{h}B_R$, rather than between ${}_{h}B_R$ and ${}_{\Delta}B_R$.

[8] On these points, *see* D. Cochrane and G. H. Orcutt, "Application of Least Squares Regression to Relations Containing Autocorrelated Error Terms," *Journal of the American Statistical Association*, March 1949.

[9] And, it should be added, when the basic data has a stationary mean. If the basic data is itself autocorrelated, the impact of first-differencing on the spurious correlation introduced by systematic errors of measurement will depend on the strength of the autocorrelation in the basic data as compared with the strength of the autocorrelation in the errors of measurement.

[1] Six of the 23 countries in Table 3.2 did not appear in Table 3.1, and 14 that appeared in the first table do not appear in the second. Nine of the 14 deletions, however, are in Groups II and III (Denmark, the Dominican Republic, Ethiopia, Haiti, Iraq, Pakistan, Finland, Japan, and Lebanon), reducing the turnout in these Groups to nine for 27 countries, a more plausible proportion than 17 for 27, given the rarity of gold-stock changes in Groups II and III. Two more of the deletions occur in Group IV (Norway and the Philippines), the first being one of the anomalies $B_R < 0$; but two new Group IV countries show up in Table 3.2

TABLE 3.2

Correlation and Regression Results: First-differences on Gold and First-differences on Reserve-assets.[a]

Country	Δr^2	ΔB_t	ΔB_R	ΔB_o[b]	ΔS_e
Group II					
Egypt	.163	4.0	.109	103	7.1
Iran	.133	— 0.2*	.038	130	1.4
Nicaragua	.098	— 0.1*	.013	1.9	0.26
Turkey	.180	— 0.3*	.144	121	1.7
Group III					
Bolivia	.180	— 0.4*	.365	4.2	2.08
Cuba	.182	— 7.0	.191	89	16.4
Peru	.213	— 0.1*	.230	20.7	3.14
Spain	.398	— 7.0*	.201	44	13.1
Venezuela	.171	1.0*	.171	414	40.7
Group IV					
Argentina	.495	—18.0	.340	68	19.3
Austria	.144	4.0*	.184	39*	13.9
Indonesia	.192	— 4.0*	.170	62	15.3
Sweden	.211	— 2.1*	.329	92	14.7
Group V					
Belgium	.787	4.1*	.803	95*	22.5
Canada	.101	8.0*	.108	755	31.7
Chile	.180	0.1*	.053	40.9	1.37
Germany	.129	65.0	.131	1132	90.3
Mexico	.358	— 2.0*	.344	70	20.8
Netherlands	.434	10.1*	.608	—62*	43.8
Portugal	.185	6.1	.365	178*	8.6
Switzerland	.864	0.1*	.874	98*	20.3
Un. S. Africa	.284	2.3*	.201	129	12.7
United Kingdom	.793	8.9*	.862**	46*	142.1

[a] For the number of observations and standard errors of the coefficients, *see* Appendix B (Table J).

[b] Inferred from the first-difference coefficients for the mean value of reserve-assets; tested indirectly. For details, *see* the text.

* Not significantly different from zero at the 0.05 level.

** Not significantly different from unity at the 0.05 level.

(Argentina and Sweden), to sustain the turnout of significant relationships. There are three more deletions in Group V; two (France and Italy) have very short time-series, and the other (Australia) may have fallen victim to divergent trends in the private and official foreign-exchange holdings that are combined in the reserve-assets data. But the turnout in Group V remains high (10 for 13 countries), as two new countries (Chile and the Union of South Africa) appear in the table. This high turnout is what one would hope to find for countries with "continuous" gold-stock changes.

those for G and R, and the $_{\Delta}B_R$ were lower than the B_R for all the countries that appear in both tabulations. But these pairs of coefficients $_{\Delta}B_R$ and B_R are positively correlated. Finally, few of the first-difference residuals, $_{\Delta}e$, show any autocorrelation at the 0.05 or 0.01 levels.[2]

The trend terms $_{\Delta}B_t$ do not show a widespread drift toward gold. Only five of the trend terms are significant and two of these are actually negative.[3] Furthermore, just one of the three positive trend terms (Germany) is at all large. The 23-country mean value for $_{\Delta}B_t$ is \$3.4 million (\$0.6 million excluding Germany), which is not significant at the 0.05 level.[4]

Consider, next, the column marked $_{\Delta}B_o$ in Table 3.2. It contains a set of estimates of the constant term B_o for equation (1), derived by replacing B_R with $_{\Delta}B_R$ and B_t with $_{\Delta}B_t$ in the definition:

$$B_o = \overline{G} - B_t \cdot \overline{Q} - B_R \cdot \overline{R} \qquad (3)$$

which is, in turn, developed from equation (1) after adding a trend term. If the index Q is numbered so that the mid-date of each country's data takes $Q = 0$, then $\bar{Q} = 0$ and equation (3) becomes:

$$_{\Delta}B_o = \bar{G} - {}_{\Delta}B_R \cdot \bar{R} \qquad (3a)$$

Therefore, the $_{\Delta}B_o$ refer to the mid-date of each country's time-series; they would be higher later if $_{\Delta}B_t$ were positive, and lower later if $_{\Delta}B_t$ were negative.

One cannot directly test the significance of the inferred constant terms, $_{\Delta}B_o$. The first-difference standard error, $_{\Delta}s_e$, cannot be made to yield a variance for $_{\Delta}B_o$, as it relates to gold-stock *changes*. One cannot

[2] Whereas 18 out of 19 countries studied had autocorrelated e's, a mere eight of the 23 in Table 3.2 have autocorrelated $_{\Delta}e$'s at the 0.05 level. Austria, Canada, Cuba, Egypt, Germany, and Portugal show positive autocorrelation; Chile and Switzerland show negative. Only four of these, moreover, show autocorrelation at the 0.01 level. In the subsample of 17 countries common to Tables 3.1 and 3.2, the mean value for von Neumann's ratio rises from 0.54 to 1.77. *See* Appendix B (Table F).

[3] These two may signal special situations. The Cuban trend term may reflect the rapid depletion of usable foreign exchange ahead of total foreign exchange; Cuba had pledged some of its foreign exchange as collateral for foreign loans. The Argentine trend term may reflect a lag in the rebuilding of Argentina's gold stock after the recent increase in Argentine reserves.

[4] For this test I computed a sample standard deviation for $_{\Delta}\overline{B}_t$ directly from the 23 estimates of $_{\Delta}B_t$, then formed the normal deviate $_{\Delta}\overline{B}_t/{}_{\Delta}s_{\overline{B}_t}$.

use s_e (Table 3.1) because it is biased.[5] But if B_o were different from zero, the "marginal propensity" to hold gold would differ from the "average propensity" or gold ratio. More precisely, $({}_pG_q/R_q - {}_\Delta B_R)$ should differ from zero for all quarters, where R_q refers to total reserves at the end of the Qth quarter and ${}_pG_q$ refers to the corresponding estimate of gold holdings made by using ${}_\Delta B_o$, ${}_\Delta B_t$, ${}_\Delta B_R$, and R_q. If, moreover, ${}_pG_q/R_q$ were exact, not stochastic, $({}_pG_q/R_q - {}_\Delta B_R)/{}_\Delta s_{B_R}$ would be distributed as t, and for the mid-date ($Q = 0$), this expression would reduce to $({}_\Delta B_o/R_{q=o})/{}_\Delta s_{B_R}$.[6]

Treating ${}_pG_q/R_q$ as exact and looking at the mid-date, 18 of the 23 constant terms in Table 3.2 turn out to be significant at the 0.05 level; Austria, Belgium, the Netherlands, Portugal, Switzerland, and the United Kingdom are the only countries with ${}_\Delta B_o = 0$.

The paired parameters ${}_\Delta B_o$ and ${}_\Delta B_R$ consequently allocate the countries in Table 3.2 to my categories (C) and (D), with the vast majority going into (D). This would suggest that pattern (3), a "basic" gold reserve, is the prevailing asset-preference scheme. This is the one asset pattern included in (D),[7] and the six countries that fall into category (C) might also partake of asset pattern (3), because countries that partake of pattern (3) may appear in category (C) if they belong to (3.c), or if F^* is rising.[8]

But the parameters in Table 3.2 may still have grave defects and my comments on the incidence of rival asset patterns may be quite wrong. The classification depends on ${}_\Delta B_o$, which in turn depends on ${}_\Delta B_R$, and my values for ${}_\Delta B_R$ may be far too low. The "conditional frequencies" of gold-stock change presented in Chapter 2 suggest that gold and reserve

[5] One can construct a variance for ${}_\Delta B_o$ using ${}_\Delta s_e$ and the standard deviation of $\overline{R}$. This procedure gives a very similar result to the one described below. But this technique is not too reliable because R is also autocorrelated, so that $s_{\overline{R}}$ is probably too small.

[6] This procedure overstates t, as the ratio ${}_pG_q/R_q$ *is* stochastic with a standard deviation of its own that should figure into the denominator. But most of the significant variates are so large that they would probably survive a more precise test; the smallest significant t works out at 2.73, and the majority are larger than 5.00.

[7] A pervasive trend away from gold synchronized with rising R (or a pervasive trend toward gold synchronized with falling R) could displace the countries that belong in (B) or (C) toward category (D). But from what we already know, these are the least likely trends. Furthermore, a trend toward gold with rising reserves or an increase in F^* could shift countries that belong in category (D) toward categories (A), (B), or (C), and those that belong in category (C) toward (A) or (B). Hence, Table 3.2 may actually understate the prevalence of asset pattern (3).

[8] The United Kingdom, however, gives a value for ${}_\Delta B_R$ that is not significantly different from unity, and may therefore partake of asset pattern (1).

changes are more closely linked when reserves are rising than when they are falling. This suggests that the true $_{\Delta}B_R$ may be higher for $\Delta R > 0$ than for $\Delta R < 0$, and reserve-asset growth is the more important case for the future of the gold-exchange standard. Furthermore, lags in asset adjustment could reduce the computed "marginal propensities" for all reserve-asset changes. Central banks may let their foreign-exchange holdings grow as they gain reserves, buying gold only after a large increase; they may let their holdings fall as they lose reserves, selling gold only after a large decrease. In either case, the "marginal propensities" to buy gold defined anent current reserve changes would be lower than the "marginal propensities" defined anent cumulative movements.

To study the first of these possibilities, I computed separate regressions for the quarters in which reserves rose and for those in which they fell, then compared the separate estimates of $_{\Delta}B_R$. To study the second, I used multiple regressions.

Pooled Regressions. Belgium, the Netherlands, Switzerland, and the United Kingdom give $_{\Delta}B_R > .600$ and $_{\Delta}B_o = 0$. They are the countries that could conceivably partake of asset pattern (1). Pooling the gold and reserve data for these countries, but separating quarters with $\Delta R > 0$ from those with $\Delta R \leq 0$,[9] I have computed new parameters for equation (2):

	$_{\Delta}r^2$	$_{\Delta}B_R$	$_{\Delta}s_{B_R}$	$_{\Delta}B_t$	$_{\Delta}s_{B_t}$
$\Delta R > 0$ (100 quarters)	.581	.922	.079	— 7.1	8.5
$\Delta R < 0$ (60 quarters)	.893	.859	.039	12.6	7.1

In this case, ΔG and ΔR were more closely correlated when reserves were falling; this was probably because the four countries under study had so little foreign exchange that they had to disgorge gold when they lost reserves.[1] And though $_{\Delta}B_R$ was higher when reserves were rising, the two "marginal propensities" were not significantly different.

I repeated this procedure for six other countries having $.200 < {}_{\Delta}B_R < .500$ (Bolivia, Peru, Argentina, Sweden, Mexico, Portugal, and the Union of South Africa):

	$_{\Delta}r^2$	$_{\Delta}B_R$	$_{\Delta}s_{B_R}$	$_{\Delta}B_t$	$_{\Delta}s_{B_t}$
$\Delta R > 0$ (77 quarters)	.174	.270	.068	—0.2	1.2
$\Delta R < 0$ (81 quarters)	.081	.139	.053	—1.6	1.0

[9] There were only three quarters in which reserves did not change for one or another of the four countries.

[1] All four showed one or more "forced breaks" in their gold data.

This time, r^2 and ${}_{\Delta}B_R$ were both higher when reserves were rising, and the difference between the "marginal propensities" was more substantial. But the difference was not yet significant.

In short, the ${}_{\Delta}B_R$ may be biased by an asymmetry in central-bank gold policies, but not by enough to disguise asset preferences or seriously to understate the demand for gold.

MULTIPLE REGRESSIONS AND LAGGED ADJUSTMENT

Multiple regressions. To look for lags in portfolio adjustment and to test for asset-pattern (1) more incisively, I computed one more set of regression coefficients. These pertain to the equation:

$$\Delta G = {}_{m}B_t + {}_{m}B_R \cdot \Delta R + {}_{m}B_F(F_{-1} - F^*) + {}_{m}e \qquad (4)$$

where F_{-1} is the foreign-exchange balance held at the start of the quarter. This equation says that the change in gold stocks has three components: A linear trend term ${}_{m}B_t$, the "marginal propensity" to buy (sell) gold out of the current increase (decrease) in total reserves, and an adjustment for the discrepancy between desired and actual foreign-exchange holdings at the start of the current quarter.[2]

I did not try to estimate F^* directly or to calculate ${}_{m}B_t$ in equation (4). Instead, I defined a new coefficient, ${}_{m}B_k$, such that:

$$ {}_{m}B_k = {}_{m}B_t - {}_{m}B_F \cdot F^* \qquad (5)$$

then written:

$$\Delta G = {}_{m}B_k + {}_{m}B_R \cdot \Delta R + {}_{m}B_F \cdot F_{-1} + {}_{m}e \qquad (4a)$$

I then computed coefficients for equation (4a) for all the countries in Groups III through V and for the four countries in Group II that gave ${}_{\Delta}B_R > 0$. First, I ran the correlations listed in Table 3.3: ${}_{\Delta}r$, the simple correlation between ΔG and ΔR; ${}_{m}r$, the multiple correlation between ΔG and ΔR *cum* F_{-1}; $r_{\Delta G F \cdot \Delta R}$, the *partial* correlation between ΔG and F_{-1}; and if this last correlation was significant, $r_{\Delta G \Delta R \cdot F}$, the *partial* correlation between ΔG and ΔR.[3]

Fifteen out of 38 countries gave a significant partial correlation be-

[2] Note that the third term serves to substitute for a sum of lagged "marginal propensities," ${}_{m}B_{R-1} \cdot \Delta R_{-1}$, ${}_{m}B_{R-2} \cdot \Delta R_{-2}$, etc. This is because an increase in reserves that is not invested currently in gold will turn up in the end-of-quarter foreign-exchange balance. Note, too, that F^* may include desired foreign-currency investments, in addition to a working balance.

[3] I also computed simple correlations between ΔR and F_{-1}, needed for the standard errors of the regression coefficients. Surprisingly few of these correlations turned out to be significant (a mere three of the 11 in Table 3.4—Egypt, Italy, and the United Kingdom). Hence multicollinearity may not be a major problem.

tween ΔG and F_{-1}. Twelve of these were countries that gave $_{\Delta}r$ significant, and three of them (Lebanon, France, and Italy) were countries that had disappeared in the transformation to first-differences (from Table 3.1 to Table 3.2). Then 11 of the 12 and Italy gave a significant partial correlation between ΔG and ΔR. The regression coefficients for these countries are arrayed in Table 3.4. Six of the coefficients $_{m}B_{R}$ are larger than the corresponding simple "marginal propensities," $_{\Delta}B_{R}$,

TABLE 3.3

Correlation Results: First-differences on Gold with First-differences on Reserve-assets and Lagged Foreign Exchange

Country	$_{\Delta}r^2$	$_{m}r^2$	$r^2_{\Delta G F \cdot \Delta R}$	$r^2_{\Delta G \Delta R \cdot F}$
Group II				
Egypt	.163	.439	.311	.268
Iran	.133	.154	*	–
Nicaragua	.098	*	*	–
Turkey	.180	.187	*	–
Group III				
Bolivia	.180	.300	.122	.205
Cuba	.182	.260	*	–
Lebanon	*	.159	.125	*
Peru	.213	.493	.339	.335
Spain	.398	.403	*	–
Venezuela	.171	.263	.187	.193
Group IV				
Argentina	.495	.498	*	–
Austria	.144	.517	.415	.269
Indonesia	.192	.446	.294	.227
Sweden	.211	.240	*	–
Group V				
Belgium	.787	.809	*	–
Canada	.101	.267	.166	.188
Chile	.180	.239	*	–
France	*	.457	.383	*
Germany	.129	.202	*	–
Italy	*	.744	.686	.285
Mexico	.358	.423	*	–
Netherlands	.434	.639	.343	.461
Portugal	.185	.342	.164	*
Switzerland	.864	.888	.156	.888
Un. S. Africa	.284	.371	.099	.327
United Kingdom	.793	.932	.664	.884

* Not computed unless the partial correlation between ΔG and F_{-1} was significant at the 0.05 level.

* Not significantly different from zero at the 0.05 level.

but only one (Bolivia) is very much larger; five are smaller than the corresponding $_{\Delta}B_R$, but only two (the Netherlands and United Kingdom) are very much smaller. As one might expect, the three largest differences between $_mB_R$ and $_{\Delta}B_R$ belong to countries with the largest $_mB_F$; for Britain, in fact, $_mB_F$ does not differ significantly from unity.

TABLE 3.4

Regression Results: First-differences on Gold with First-differences on Reserve-assets and Lagged Foreign Exchange[a]

Country	$_mB_k$	$_mB_R$	$_mB_F$	$_mB_t$[b]	$_mS_e$
Group II					
Egypt	— 4.7	.112	.018	4.0	5.9
Group III					
Bolivia	— 1.5	.534	.388	0.3*	1.95
Peru	— 4.5	.263	.276	—0.1*	2.55
Venezuela	— 11.0	.187	.065	1.1*	39.0
Group IV					
Austria	— 24.0	.219	.087	4.1*	10.6
Indonesia	— 26.1	.165	.128	—4.0*	12.8
Group V					
Canada	—108.0	.158	.132	7.0*	29.0
Italy	—152.0	.158	.283	104.1	48.2
Netherlands	— 61.9	.537	.439	12.1*	35.5
Switzerland	— 27.3	.851	.242	0.1*	18.6
Un. S. Africa	— 10.0	.220	.076	2.2*	12.1
United Kingdom	—274.1	.744	.910	10.8*	82.6

[a] For the number of observations and standard errors of the coefficients, *see* Appendix B (Table J).

[b] Inferred using $\bar{F}$ as an approximation to F^*. For details, *see* the text.

* Not significantly different from zero at the 0.05 level.

Two of the 12 sets of residuals, $_me$, are autocorrelated at the 0.01 level (Austria and Canada), and one more is autocorrelated at the 0.05 level (the United Kingdom).[4] But the two that show the strongest autocorrelation give higher values for von Neumann's ratio than they did for $_{\Delta}e$.

The trend terms $_mB_t$ in the penultimate column of Table 3.4 were derived by assuming $F^* = \bar{F}$ and solving equation (5) for $_mB_t$. This

[4] *See* Appendix B (Table F).

procedure gives a set of trend terms which are conceptually comparable and similar in size to the corresponding ${}_{\Delta}B_t$ of equation (2).[5]

One could now infer values for ${}_{m}B_o$ from the current "marginal propensities," ${}_{m}B_R$, as with the simple first-difference equations. But the current "marginal propensities" understate the demand for gold when there are lags in portfolio adjustment. Consider a country that starts a quarter with $F = F^*$ and acquires ΔR_1 of reserves during the quarter. At the end of the quarter, it will have bought ${}_{m}B_R \cdot \Delta R_1$ of gold and added $(1 - {}_{m}B_R)\Delta R_1$ to its foreign-exchange balance. But because it started with $F = F^*$, it will buy ${}_{m}B_F(1 - {}_{m}B_R)\Delta R_1$ more of gold during the next quarter to reduce its foreign-exchange balance toward F^*. And unless ${}_{m}B_F = 1$, it will still hold excess foreign exchange at the close of the second quarter and will buy another tranche of gold in the third quarter, this one equal to ${}_{m}B_F(1 - {}_{m}B_R)(1 - {}_{m}B_F)\Delta R_1$. To generalize, the increase in reserves, ΔR_1, will bring about a cumulative n-quarter total of gold purchases that can be written as:

$$\Delta G_{T(q=n)} = [{}_{m}B_R + (1 - {}_{m}B_R){}_{m}B_F \cdot \sum_{j=o}^{n-1} (1 - {}_{m}B_F)^j] \, \Delta R_1 \qquad (6)$$

But because the ${}_{m}B_F$ are smaller than unity, the summation in equation (6) converges toward $[1 - (1 - {}_{m}B_F)^j]/{}_{m}B_F$. Therefore:

$$\Delta G_{T(q=n)} = [1 - (1 - {}_{m}B_R)(1 - {}_{m}B_F)^{n-1}] \, \Delta R_1 \qquad (6a)$$

Now define the cumulative "marginal propensity" to hold gold as ${}_{m}B_{T(q=n)} = \Delta G_{T(q=n)}/\Delta R_1$. This is the "marginal propensity" that should be used to infer the constant term, ${}_{m}B_o$. It should take the place of ${}_{\Delta}B_R$ in equation (3a) to give:

$${}_{m}B_{o(q=n)} = \overline{G} - {}_{m}B_{T(q=n)} \cdot \overline{R} \qquad (7)$$

[5] This result is built into the analysis. As:

$${}_{m}B_k = \overline{\Delta G} - {}_{m}B_R \cdot \overline{\Delta R} - {}_{m}B_F \cdot \overline{F}_{-1}$$

and when $F^* = \overline{F}$:

$${}_{m}B_t = {}_{m}B_k + {}_{m}B_F \cdot \overline{F}$$

so that

$${}_{m}B_t = \overline{\Delta G} - {}_{m}B_R \cdot \overline{\Delta R} - {}_{m}B_F \cdot (\overline{F}_{-1} - \overline{F})$$

But $\overline{F}_{-1}$ and $\overline{F}$ are approximately equal, as are ${}_{m}B_R$ and ${}_{\Delta}B_R$. Therefore, the ${}_{m}B_t$ and ${}_{\Delta}B_t$ are quite similar. My procedure, then, does not prove that $\overline{F}$ is a good approximation to F^*. It merely says that ${}_{m}B_k + {}_{m}B_F \cdot \overline{F}$ would be a good approximation to the true trend term *if* $\overline{F}$ were a good approximation to F^*. The computed ${}_{m}B_t$ were tested for significance using ${}_{m}s_{B_k}$ in Appendix B (Table J), as it can be shown that this would be the standard error of ${}_{m}B_t$ had the ${}_{m}B_t$ been directly calculated from equation (4), using $\overline{F}$ as F^*.

But as $n \to \infty$, $(1 - {}_mB_F)^{n-1}$ tends toward zero, so that (6a) tends toward ΔR_1, and ${}_mB_{T(q=n)}$ toward unity. Equation (7) then gives ${}_mB_{o(q=n)} = /\overline{F}/$, which is a reason for regarding $\overline{F}$ as the proper proxy for F^*.

This set of manipulations gives a new *full-series* test for the working-balance asset-preference pattern. It says that all the countries in Table 3.4 must partake of asset pattern (1), for in a sufficiently long period each one would put all its reserves into gold, save for a working balance, F^*, of foreign exchange.

But the *full-series* test may be somewhat implausible, although quite logical. It assumes that central banks make point-estimates of F^* and that, if undisturbed, they would run down their foreign-exchange holdings until $F = F^*$. It implies an attenuated process of adjustment, as some countries give ${}_mB_R < .2$ and ${}_mB_F < .2$, leaving more than 40 per cent of the adjustment to be made a full year after reserves change. Finally, it is hard to reconcile asset pattern (1) with positive trend terms, as with Egypt and Italy. These trend terms might indicate a decline in working-balance needs. But can one view a $104 million quarterly trend (Italy) in this way?[6]

I shall therefore substitute a *truncated* test for asset pattern (1): Arbitrarily fixing $q = 2$ to calculate ${}_mB_T$ and infer ${}_mB_o$, I shall require that ${}_mB_{T(q=2)} = 1$ and that ${}_mB_{o(q=2)} \leq 0$ before inferring a working-balance rule from the parameters in Table 3.4.[7]

[6] Strictly speaking, moreover, the trend toward lower F^* would be larger than $104 million. If ${}_mB_t$ is to be treated as a trend toward lower working balances, it must be differently derived. Rewrite equation (5) as:

$$ {}_mB_k = - {}_mB_F(F^* - {}_mB_t^*) \qquad (5a) $$

Solving (5a) and (5) for ${}_mB_t^*$ and ${}_mB_t$, ${}_mB_t^* - {}_mB_t = {}_mB_k(1 - {}_mB_F)/{}_mB_F$. This argument is positive because ${}_mB_F < 1$. At the same time, the trend terms in Table 3.4 were computed on the premise that $\overline{F} = F^*$. With Egypt, this would mean that $F^* = $463 million; and with Italy that $F^* = $802 million. These holdings are too large to be working balances. One might therefore infer that $F^* < \overline{F}$ (in which case, the ${}_mB_t$ in Table 3.4 overstate true trends). Alternatively, one might infer that F^* includes foreign currency held to earn income (in which case, the ${}_mB_t$ would not be too large, but one would have to reinterpret the working-balance rule to encompass instances in which central banks hold a fixed total of foreign exchange as a working balance *cum* source-of-income.

[7] I have used a proxy for the standard deviation of ${}_mB_{T(q=n)}$:

$$ {}_mS_{B_{T(q=n)}} = \sqrt{{}_mS_{B_R}^2 + (n-1)\,{}_mS_{B_F}^2} $$

This is probably too small, but the bias runs in the right direction, overstating $[1 - {}_mB_{T(q=n)}]/{}_mS_{B_{T(q=n)}}$. To test ${}_mB_{o(q=n)}$, I have used the same procedure as for

Calculated values for ${}_{m}B_{T}$ and for ${}_{m}B_{o}$ at $q = 2$ are given in Table 3.5 along with ${}_{m}B_{T}$ at $q = 3$ and $q = 4$. Four countries pass the *truncated* test for the working-balance asset-preference pattern (Bolivia, the Netherlands, Switzerland, and the United Kingdom), giving values for ${}_{m}B_{T}$ which approach unity in half a year and values for ${}_{m}B_{o(q=2)}$ quite close to zero.[8] One other country would pass the same test for $q = 4$ (Peru), but the other values for ${}_{m}B_{T(q=4)}$ are still far from unity.[9]

Simple lagged regressions. Two of the countries in Table 3.3 (France and Lebanon) gave a significant partial correlation between ΔG and F_{-1}, but not between ΔG and ΔR. This result suggests one more relationship as an explanation of gold-stock changes:

$$\Delta G = {}_{f}B_{t} + {}_{f}B_{F}(F_{-1} - F^{*}) + {}_{f}e \tag{8}$$

or:

$$\Delta G = {}_{f}B_{k} + {}_{f}B_{F} \cdot F_{-1} + {}_{f}e \tag{8a}$$

where ${}_{f}B_{k}$ is defined as ${}_{f}B_{t} - {}_{f}B_{F} \cdot F^{*}$. Equation (8) argues that gold purchases are fully lagged, depending wholly on the gap between desired and actual foreign-exchange holdings.

I tried equation (8a) on the 15 countries that gave significant partial correlations between ΔG and F_{-1}, with 10 successes.[1] But only four of the results were at all interesting: France and Lebanon gave their first significant first-difference coefficients; Portugal evinced a better fit than with equations (2) or (4); and the residuals for Austria were

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${}_{\Delta}B_{o}$, forming $({}_{m}B_{o}/R)/{}_{m}s_{B_{T}}$ for R at the mid-date of each time-series and treating it as having a t-distribution. This approximation gives a biased t, as ${}_{m}s_{B_{T}}$ is itself too small. Note, in passing, that the *full-series* test of this same ratio should give a significant negative t (because ${}_{m}B_{o}$ tends toward $-\overline{F}$ as $n \to \infty$), but most of the *full-series* tests do not give significant negative values for ${}_{m}B_{o}$, as the gap between G/R and ${}_{m}B_{T}$ on which the test of ${}_{m}B_{o}$ is based narrows for large R.

[8] In these cases, moreover, the *full-series* counterpart of ${}_{m}B_{o}$, $/\overline{F}/$, is not implausibly different from a working balance. For Bolivia, $\overline{F} = \$3.0$ million; for the Netherlands, $\overline{F} = \$170$ million; for Switzerland, $\overline{F} = \$114$ million; and for the United Kingdom, $\overline{F} = \$317$ million. These numbers are not out of line with typical quarterly changes in total reserves. Note, too, that the deviations $(F - \overline{F})$ are more nearly random for Bolivia and the United Kingdom than for any other countries; *see* Appendix B (Table B).

[9] For $q = 2$, five other countries (Egypt, Venezuela, Canada, Italy, and the Union of South Africa) may be regarded as holding "basic" gold reserves. The remaining three (Peru, Austria, and Indonesia) may be regarded as partaking of "proportionality."

[1] Egypt, Lebanon, Peru, Austria, Indonesia, France, Italy, the Netherlands, Portugal, and the United Kingdom.

not autocorrelated.[2] The six other countries gave fits for equation (8) which were far inferior to the corresponding equation (4); the standard error of estimate was larger and, in two cases, the residuals were more markedly autocorrelated.

TABLE 3.5

Calculated Values for the Truncated $_mB_T$ and Inferred $_mB_o$

Country	$_mB_T$[a]			$_mB_{o(q=2)}$[b]
	$q=2$	$q=3$	$q=4$	
Group II				
Egypt	.128	.144	.160	91
Group III				
Bolivia	.715**	.826**	.894**	0.2*
Peru	.466	.613	.719**	10.6*
Venezuela	.240	.290	.337	335
Group IV				
Austria	.287	.349	.406	— 7*
Indonesia	.272	.365	.446	33*
Group V				
Canada	.268	.365	.448	462
Italy	.396	.567	.690	338
Netherlands	.740**	.854**	.918**	88*
Switzerland	.887**	.914**	.934**	76*
Un. S. Africa	.279	.333	.383	102
United Kingdom	.977**	.998**	1.000**	—256*

[a] For the appropriate formula and test of significance, *see* the text.

[b] Inferred from $_mB_{t(q=2)}$; for the appropriate formula and test of significance, *see* the text.

* Not significantly different from zero at the 0.05 level.

** Not significantly different from unity at the 0.05 level.

The regression coefficients for the four interesting cases are listed in Table 3.6. Three of the trend terms are significant; the fourth is also positive and large, but not significant at the 0.05 level.[3]

The asset-preference scheme implied by equation (8) is quite similar

[2] In fact, all four of these countries gave random residuals. *See* Appendix B (Table F).

[3] These trend terms were calculated from the definition of $_rB_k$, assuming that $F^* = \overline{F}$. They were tested for significance using $_rs_{B_k}$ in Appendix B (Table J). In this case, my procedure comes close to assuming that $_rB_t$ equals $\overline{\Delta G}$. As $_rB_k = \overline{\Delta G} - {}_rB_F \cdot \overline{F}_{-1}$ and $_rB_t = {}_rB_k + {}_rB_F \cdot \overline{F}$, it follows that $_rB_t = \overline{\Delta G} - {}_rB_F(\overline{F}_{-1} - \overline{F})$.

TABLE 3.6

Correlation and Regression Results: First-differences on Gold and Lagged Foreign Exchange, Selected Countries[a]

Country	${}_fr^2$	${}_fB_k$	${}_fB_F$	${}_fB_t$[b]	${}_fs_e$
Austria	.315	−18.0	.080	7.9	12.4
France	.446	−27.8	.363	47.0*	107.1
Lebanon	.145	− 1.3	.227	2.1	3.58
Portugal	.253	−60.8	.243	8.7	8.3

[a] Significant results were also obtained for Egypt, Indonesia, Italy, the Netherlands, Peru, and the United Kingdom, but the standard errors were larger in these cases than in Tables 3.2 or 3.4. For the number of observations and standard errors of the coefficients, *see* Appendix B (Table J).

[b] Inferred using $\overline{F}$ as an approximation to F^*. For details, *see* the text.

* Not significantly different from zero at the 0.05 level.

to the one implied by equation (4): Every change in reserves sets off a train of gold-stock changes, so that:

$$\Delta G_{T(q=n)} = \sum_{j=0}^{n-2} (1 - {}_fB_F)^j \cdot {}_fB_F \cdot \Delta R_1 \qquad (9)$$

$$= [1 - (1 - {}_fB_F)^{n-2}]\, \Delta R_1 \qquad (9a)$$

And equation (9) gives a cumulative "marginal propensity" to hold gold, ${}_fB_{T(q=n)}$, that tends toward unity as $n \to \infty$, so that ${}_fB_{o(q=n)}$ tends toward $/\overline{F}/$. By the *full-series* test, the four countries in Table 3.6 should be regarded as adhering to the simple working-balance pattern. Yet the usual objections may be adduced against this *full-series* test: It implies a point-estimate of F^* and an attenuated process of adjustment. I shall therefore use a *truncated* test by setting $q = 2$.[4]

The ${}_fB_{T(q=2)}$ (or ${}_fB_F$) and values for ${}_fB_{o(q=2)}$ are arrayed in Table 3.7, along with ${}_fB_{T(q=n)}$ for $q = 3$ and $q = 4$. None of the countries passes the *truncated* test, although France comes close after a full year ($q = 4$). And all the ${}_fB_{o(q=2)}$ are distinctly positive, suggesting that these countries hold "basic" gold reserves, partaking of asset pattern (3).

[4] This time, I approximated the standard deviation of the cumulative "marginal propensity" by

$${}_fS_{B_{T(q=n)}} = \sqrt{(n-1)\,{}_fS^2_{B_F}}$$

and used the ratio $({}_fB_o/R)/{}_fS_{B_T}$ for R at the mid-date to test the significance of ${}_fB_{o(q=n)}$.

TABLE 3.7

Calculated Values for the Truncated ${}_fB_T$ and Inferred ${}_fB_o$

Country	${}_fB_T$[a] $q=2$	$q=3$	$q=4$	${}_fB_{o(q=2)}$[b]
Austria	.080	.156	.223	85
France	.363	.594	.738**	473
Lebanon	.227	.402	.538	47.1
Portugal	.243	.427	.566	267

[a] For the appropriate formula and test of significance, *see* the text.

[b] Inferred from ${}_fB_{T(q=2)}$; for the appropriate formula and test of significance, *see* the text.

** Not significantly different from unity at the 0.05 level.

A COLLATION OF THE REGRESSION RESULTS AND THE FOURTH QUARTER ONCE AGAIN

A composite picture. I collated my regression results in Table 3.8, selecting for each country the regression model with the smallest standard error of estimate (${}_\Delta S_e$, ${}_m S_e$, or ${}_f S_e$). The table lists the corresponding correlation coefficient, notes whether the constant term (${}_\Delta B_o$, ${}_m B_{o(q=2)}$, or ${}_f B_{o(q=2)}$) differs from zero at the 0.05 level, and gives the cumulative "marginal propensity" when this coefficient is relevant.

Three points deserve mention at the outset:

1. *The distribution of significant results*: The total number of countries in each Group and the corresponding number appearing in Table 3.8 turn out very much as one would forecast:

Group	*In Group*	*In Table 3.8*
II	15	4
III	12	6
IV	9	4
V	13	12

The number of significant regression results seems to increase with the frequency of gold-stock changes.[5]

2. *The residuals*: A mere three of the 26 countries in Table 3.8 give residuals that show positive autocorrelation at the 0.01 level of significance (Austria, Canada, and Germany), and one of these (Austria) has an alternative estimator that does not give any auto-

[5] There is a drop in the proportion for Group IV, the Group giving the largest standard deviations for the "conditional frequencies" in Chapter 2. Group IV may therefore include a heterogeneous collection of central banks.

TABLE 3.8

Best Regression Estimators by the Criterion of Least Standard Error

Country	r[a]	s_e[b]	B_o[c]	*Equation*[d]	$B_{T(q=2)}$[e]
Group II					
Egypt	.66	5.9	sig.	$4.0 + .112\Delta R + .018(F_{-1} - \bar{F})$	.128
Iran	.36	1.4	sig.	$* + .038\Delta R$	–
Nicaragua	.31	0.26	sig.	$* + .013\Delta R$	–
Turkey	.42	1.7	sig.	$* + .144\Delta R$	–
Group III					
Bolivia	.56	1.95	*	$* + .534\Delta R + .388(F_{-1} - \bar{F})$	.715**
Cuba	.43	16.4	sig.	$-7.0 + .191\Delta R$	–
Lebanon	.38	3.58	sig.	$2.1 + .227(F_{-1} - \bar{F})$	.227
Peru	.70	2.55	*	$* + .263\Delta R + .276(F_{-1} - \bar{F})$	.466
Spain	.63	13.1	sig.	$* + .201\Delta R$	–
Venezuela	.51	39.0	sig.	$* + .187\Delta R + .065(F_{-1} - \bar{F})$	.240
Group IV					
Argentina	.74	19.3	sig.	$-18.0 + .340\Delta R$	–
Austria[f]	.72	10.6	*	$* + .219\Delta R + .087(F_{-1} - \bar{F})$	.287
Indonesia	.67	12.8	*	$* + .165\Delta R + .128(F_{-1} - \bar{F})$	.272
Sweden	.46	14.7	sig.	$* + .329\Delta R$	–
Group V					
Belgium	.89	22.5	*	$* + .803\Delta R$	–
Canada	.52	29.0	sig.	$* + .158\Delta R + .132(F_{-1} - \bar{F})$	.268
Chile	.42	1.37	sig.	$* + .053\Delta R$	–
France	.67	107.1	sig.	$* + .363(F_{-1} - \bar{F})$	.363
Germany	.36	90.3	sig.	$65.0 + .131\Delta R$	–
Italy	.86	48.2	sig.	$104.0 + .158\Delta R + .283(F_{-1} - \bar{F})$	.396
Mexico	.60	20.8	sig.	$* + .344\Delta R$	–
Netherlands	.80	35.5	*	$* + .547\Delta R + .439(F_{-1} - \bar{F})$	.740**
Portugal	.50	8.3	sig.	$8.7 + .243(F_{-1} - \bar{F})$	.243
Switzerland	.94	18.6	*	$* + .851\Delta R + .242(F_{-1} - \bar{F})$	.887**
Un. S. Africa	.69	12.1	sig.	$* + .220\Delta R + .076(F_{-1} - \bar{F})$	.279
United Kingdom[g]	.97	82.6	*	$* + .744\Delta R + .910(F_{-1} - \bar{F})$	.977**

[a] The relevant correlation coefficient, $_{\Delta}r$, $_{m}r$, or $_{f}r$.

[b] The relevant standard error of estimate, $_{\Delta}Se$, $_{m}Se$, or $_{f}Se$.

[c] The abbreviation 'sig.' indicates that the corresponding constant term, $_{\Delta}B_o$, $_{m}B_{o(q=2)}$, or $_{f}B_{o(q=2)}$, was significantly different from zero at the 0.05 level (in every instance, positive); an asterisk indicates that it was not.

[d] The equation given here "explains" ΔG. The first term gives the quarterly trend ($ million); an asterisk indicates there was no significant trend at the 0.05 level. The second term gives the impact of the current change in reserves. The third gives the impact of "excess" foreign-

correlation. Two more countries (Cuba and the United Kingdom) give residuals that show autocorrelation at the 0.05 level, and one of these (the United Kingdom) also has a second estimator that does not give any autocorrelation. One more country (Chile) gives residuals that are negatively autocorrelated at the 0.05 level, but not at the 0.01. These results are far more satisfactory than those that I obtained with equation (1).

3. *The trend terms*: There are several significant trend terms in Table 3.8, more than in any other table. Two of these are negative, but may be linked to special situations. Five more are positive, and two are quite large.[6] The large ones, moreover, pertain to strategic countries in the international monetary system; Germany and Italy together held some $3.4 billion of foreign exchange on September 30, 1960. Furthermore, the probability that eight of the other nine countries in Group V would show $B_t \geqq 0$ if all the nine trend terms were truly zero works out to a mere 0.0195. This suggests that the lopsided distribution of B_t is not due to chance. In brief, several countries with large foreign-exchange holdings would seem to have been moving markedly toward gold, and several others showed a weaker drift, but in the same direction.

I should like to be able to employ my coefficients taxonomically—

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exchange holdings at the start of the quarter with $\overline{F} = F^*$. For the number of observations and standard errors of the coefficients, *see* Appendix B (Table J).

[e] These are ${}_mB_{T(q=2)} = 1 - (1 - {}_mB_R)(1 - {}_mB_F)$, or ${}_fB_{T(q=2)} = {}_fB_F$. They represent the cumulative "marginal propensities" on the supposition that an adjustment must be completed in half a year. A double asterisk indicates that ${}_mB_T$ is not significantly different from unity at the 0.05 level.

[f] Von Neumann's ratio for the simple-lag estimator does not show any autocorrelation in the regression residuals, whereas, for the equation used here it shows positive autocorrelation, even at the 0.01 level. One may therefore wish to substitute the simple-lag equation and this row of data for Austria:

.56	12.4	sig.	7.9 +	$.080(F_{-1} - \overline{F})$	.080

[g] Von Neumann's ratio for the simple first-difference estimator does not show any autocorrelation in the residuals, whereas, for the equation used here, it shows a positive autocorrelation at the 0.05 level. One may therefore wish to substitute the simple first-difference equation and this row of data for the United Kingdom:

.89	142.1	*	*	$.862\Delta R$

* Not significantly different from zero at the 0.05 level.
** Not significantly different from unity at the 0.05 level.

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[6] Remember, however, that three of these (Lebanon, Italy, and Portugal) were derived on the assumption that $F^* = \overline{F}$. If this assumption does not hold (and the marked autocorrelation in the foreign-exchange data suggests it may not), the trend estimates will be biased.

to classify each central bank by asset-preference pattern.[7] But there are too many anomalies in the coefficients to allow a decisive classification. Four countries in Group II changed their gold holdings in fewer than one-fifth of the quarters, yet produced significant regression equations.[8] Five countries in Group IV changed their gold holdings in more than half the quarters, yet did not produce significant relationships. I shall therefore confine myself to these weaker inferences:

By all the criteria I have proposed, "proportionality" seems to be the least frequent asset-preference pattern. A mere four countries in Table 3.8 give $B_o = 0$ and $B_R > 0$ (or $0 < B_{T\,(q=2)} < 1$), and three of these satisfy the *full-series* test for the working-balance pattern. The working-balance pattern is likewise rare; four countries give $B_o \leq 0$ and $B_{T(q=2)} = 1$. But the *full-series* test gives this pattern much more prominence; eleven other countries give $B_F > 0$ and, therefore, $B_{T(q\to\infty)} = 1$.

The most common reserve-asset pattern is the "basic" gold reserve. As many as 18 countries in Table 3.8 partake of this pattern, using the *truncated* test. And most of the 25 countries that did not yield regression relationships also belong in this class.[9] Even if the *full-series* test is used, this pattern appears frequently; ten of the 26 countries in Table 3.8 remain in this class (among them Argentina, Germany, and Spain). This asset-pattern seems to include three groups of countries—those that have kept their gold stocks absolutely constant, those that have raised their "basic" gold reserves discontinuously (or have had to dip into them when losing reserves), and those that have built onto a "basic" gold reserve with $B_R > 0$. The Group I countries belong to the first subclass; most of the Group II and Group III countries belong to the second; the Group IV and Group V countries belong to the third.

The prevalence of pattern (3) augurs well for the future of the gold-exchange standard. The "marginal propensities" to buy gold of countries that hold "basic" gold reserves are smaller than their "average propensities," and this gap implies a lower rate of growth in the demand for gold than in total reserve-assets. But several of the countries

[7] For a trial classification, *see* Appendix B (Tables K and L).

[8] These, perhaps, partake of pattern (3.c); they may have a true $B_R = 0$ but straddle segments like bc_2 and c_2d_2 in Figure 3.1.

[9] Four of the 12 in Group I have constant gold holdings; ten in Group II, six in Group III, and five in Group IV did not give significant regression equations. All these should be classified as having $B_o > 0$ and $B_R = 0$. I exclude Israel (as having no gold at the end of the 1950's) and Australia (whose asset pattern is obscured by the inclusion of private foreign-exchange holdings in the reserve data).

that partake of this asset pattern also show striking trends toward gold. All of the positive trend terms in Table 3.8 belong to countries with $B_0 > 0$, and several of the countries that do not appear in Table 3.8 were also shifting into gold.[1] If these trends continue into the 1960's, they could vitiate the salutary impact of an assets-inelastic demand for gold.[2]

The fourth quarter of 1960. As a final application of my equations, I made forecasts of fourth-quarter gold-stock changes for 1960 and compared my forecasts with actual events.[3] This exercise provides a check on my procedure in Chapter 2; it looks at the *size* of gold-stock changes, as well as the *sign*. This analysis of the fourth quarter cannot have the same broad coverage as the one in Chapter 2; I do not have regression coefficients for 23 of the 49 countries in Groups II through V. But the 26 that are in Table 3.8 accounted for 22 of the 30 gold-stock changes arrayed in Table 2.4. They made about $800 million of the $900 million of gross gold acquisitions and about $100 million of the $115 million of gross gold disposals.

First, I made forecasts of the fourth-quarter gold-stock changes, ${}_{\Delta}G_p$, using the equations in Table 3.8.[4] These are arrayed in the second column of Table 3.9. Next, I computed the standard errors of forecast, ${}_pS_{\Delta G}$, arrayed in the third column.[5] Finally, I took the difference between each gold-stock change and the corresponding forecast and formed the ratios $(\Delta G_a - \Delta G_p)/{}_pS_{\Delta G}$, which are distributed as t.

There is only one significant negative variate in the final column of Table 3.9; Belgium bought less gold than forecast.[6] There are five

[1] Iraq and Japan are the best examples. Note, too, that some of the countries in Table 3.8 give positive trend terms that were not separately significant; France ($47 million) is in this group.

[2] At some point, of course, a trend toward gold will have to stop, as the central bank will have run out of foreign exchange. But from that time, it will evince a working-balance pattern with a high "marginal propensity."

[3] Recall, in this connection, that the parameters in Table 3.8 were computed using data that stopped with September 1960; the fourth-quarter forecasts go one period further.

[4] Actually, I used the equations (4a) and (8a) with ${}_mB_k$ and ${}_fB_k$, rather than equations (4) and (8) given in Table 3.8. This means that an error in the computed trend terms, resulting from a difference between F^* and $\overline{F}$, will not bias my fourth-quarter estimates.

[5] These were computed using the appropriate variants of:

$$ {}_pS^2_{\Delta G} = s^2_{B_t} + (\Delta R - \overline{\Delta R})^2 s^2_{B_R} + (F_{-1} - \overline{F}_{-1})^2 s^2_{B_F} + s^2_e $$

[6] I used a one-tailed test of significance here and below, as this is what I did in the corresponding section of Chapter 2. When, therefore, I refer to a significant result, I mean an instance in which the probability of obtaining a difference as

TABLE 3.9

Forecasts of Gold-stock Changes using the "Best Estimators," Fourth Quarter of 1960

Country	Change in Gold Stock ($ million)		$p_{S_{\Delta G}}$	$\frac{(\Delta G_a - \Delta G_p)}{p_{S_{\Delta G}}}$ [a]
	Actual (ΔG_a)	Predicted (ΔG_p)		
Group II				
Egypt	0	− 1.7	6.31	0.27
Iran	− 1	0	1.44	−0.69
Nicaragua	0	− 0.1	0.26	0.38
Turkey	+ 1	+ 5	2.50	−1.42
Group III				
Bolivia	0	+ 1.1	2.01	−0.55
Cuba[b]	− 2	− 34	18.80	1.70*
Lebanon	+ 17.5	+ 6.8	4.09	2.61*
Peru	+ 15.1	+ 6.9	3.32	2.45*
Spain	+ 80	+ 5	13.81	5.38*
Venezuela	− 64	− 6	39.61	−1.46
Group IV				
Argentina	+ 20	− 21	19.91	2.08*
Austria[c, e]	0	+ 11	11.01	−0.99
Indonesia	+ 24	+ 12	13.89	0.86
Sweden	− 1	− 6	15.07	0.35
Group V				
Belgium	+ 76	+167	26.07	−3.48*
Canada[c]	− 9	+ 16	29.38	−0.84
Chile[d]	+ 2.6	− 0.4	1.37	2.21*
France	+ 14	+102	112.01	−0.78
Germany[c]	+ 82	+117	92.69	−0.38
Italy	+ 17	+101	79.69	−1.05
Mexico	+ 15	+ 12	21.30	0.14
Netherlands	+105	+131	39.59	−0.66
Portugal	+ 2	− 5	9.48	0.74
Switzerland	+205	+185	21.41	0.93
Un. S. Africa[c]	− 26	− 12	12.57	−1.11
United Kingdom[c, e]	+125	+211	84.63	−1.02

[a] An asterisk in this column means that the variate is statistically significant at the 0.05 level *in respect of the appropriate one-tailed test.* An asterisk next to a positive entry denotes an actual gold purchase larger than the corresponding forecast (or a sale smaller than the forecast). An asterisk next to a negative entry denotes an actual gold purchase smaller than the corresponding forecast (or a sale larger than the forecast).

[b] The residuals are positively autocorrelated at the 0.05 level (but not at the 0.01 level).

[c] The residuals are positively autocorrelated at the 0.05 and 0.01 levels.

[d] The residuals are negatively autocorrelated at the 0.05 level (but not at the 0.01 level).

[e] The alternative estimators suggested in the footnotes to Table 3.8 to eliminate autocorrelation give these results:

Austria	0	+ 15	12.8	−1.17
United Kingdom	+125	+115	144.5	0.07

significant positive differences.[7] As the probability of a *single* chance outcome this large or larger is smaller than 0.05, the probability of obtaining five or more by pure chance is smaller than:

$$\sum_{x=5}^{26} \frac{26!}{(26-x)!x!} (.05)^x(.95)^{26-x} = 0.036$$

and 0.036 may be much too high, as some of the variates have probabilities smaller than 0.05.

Look next at the mean values of $(\Delta G_a - \Delta G_p)/_p s_{\Delta G}$ in each Group:

II	−0.36
III	1.69
IV	0.58
V	−0.44

None of these is significantly different from zero at the 0.05 level,[8] but the signs are interesting. They suggest that the 1960 shift toward gold occurred at the periphery of the international monetary system. The key-currency countries in Group V behaved normally, and may even have shown a special restraint to sustain the gold-exchange standard at a time of crisis.

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large as or *larger* than the actual result is smaller than 0.05 if the true difference is zero.

[7] Actually six, but the $34 million reduction forecast for Cuba was larger than Cuba's gold stock on September 30, 1960.

[8] Neither by an ordinary application of the t-distribution, nor by computing a sample s_t^2 to form $\bar{t}s_{\bar{t}}$.

4. CONCLUSIONS AND PROSPECTS

THE FINDINGS

These three compound statements summarize my findings:

(1) *The role of gold.* Official foreign-exchange holdings are larger today than ever before, absolutely and in relation to total reserves. All the central banks hold working balances of foreign exchange and some hold foreign currencies and foreign securities as a store of value or to pay their way. But the gold tradition retains much of its vitality and may be growing stronger rather than waning. Central banks are more willing to disgorge foreign exchange when they lose reserves than to give up gold. As manifest in high gold ratios, the gold tradition seems to be the luxury of high-reserve countries; even those that keep a "basic" gold reserve have marked "marginal propensities" to hold gold. But the low-reserve, low-income countries also hold gold, and some of them have also added to their gold stocks.

(2) *The long-run demand for gold.* The gold ratio is not an efficient measure of the demand for gold, as few central banks partake of pure "proportionality." But it is quite hard to say whether the gold ratio overstates or understates the demand for gold. Many central banks hold "basic" gold reserves and consequently have "marginal propensities" to hold gold that are much lower than their gold ratios. Yet several of these countries also show separate trends toward gold (including those that hold the largest foreign-exchange balances); they may be moving toward a working-balance pattern and high "marginal propensities." Several other central banks already evince a working-balance pattern and have "marginal propensities" at or near to unity. This pattern does not seem to be too common when one examines the "marginal propensities" to buy gold out of current reserve gains, but appears to be more common when one allows for lags in portfolio adjustment and cumulative "marginal propensities."

(3) *Recent instability.* Central-bank reserve-asset preferences would seem to have been stable in the 1950's.[1] But there were abrupt changes in 1960. Several central banks that had not changed their gold stocks for some time bought large quantities in the fourth quarter; others bought much more than one would have forecast, or bought in circumstances when they would more normally have sold. Yet the major central banks, mainly in Europe, displayed a striking self-restraint during the fourth-quarter flurry; the 1960 shift toward gold was chiefly manifest at the periphery of the international monetary system.

[1] But bear in mind the *caveat* at the end of footnote 4, p. 34.

These three generalizations have mixed implications for the future of the international monetary system. They imply that the major central banks recognize their special obligations. But they also confirm the familiar forecast that new gold supplies may not satisfy the prospective demand, and pose major problems for those who would reform financial arrangements.

Most of the "marginal propensities" set out in Chapter 3 are much smaller than the corresponding gold ratios, but are quite high enough to warrant concern. If the 26 countries listed in Table 3.8 were to increase their reserves by three per cent *per annum* and to buy the gold indicated by their "marginal propensities," they would absorb $470 million *per annum* at the start and somewhat more in later years.[2] This sum is two-thirds of the average annual increase in monetary gold stocks for 1956 through 1959.[3] It leaves only $220 million to feed the trends toward gold and to satisfy all other countries.[4] This calculation does not say that reserves *should* increase at three per cent each year, but it does confirm the common *conditional* forecast: If such an increase were required, there would be a shortage of gold, and such a shortage would be dangerous to the monetary system.

The advocates of monetary reform must also consider these findings. My results imply a firm adherence to the gold tradition which may make it very difficult to change the present system. They also call for a more radical reform than most architects have yet dared to propose.[5] Professor Triffin has acknowledged that an expanded International Monetary Fund could suffer large gold losses as reserves grow, but is inclined to discount this possibility. "The danger of a gold or currency scarcity in the Fund," he writes, "would . . . appear extremely remote, especially as most countries could be expected to hold Fund

[2] This estimate is obtained by taking three per cent of total reserves on September 30, 1960 (Table 2.4) and multiplying by the appropriate "marginal propensity." For countries with significant B_F, I used the corresponding $B_{T(Q=4)}$ (Tables 3.5 and 3.7).

[3] Computed from the global gold tabulation in *International Financial Statistics* (January 1962, p. 24); I did not use 1960 or 1961 in this computation because of the extraordinary private demand in the autumn and winter of 1960-1961.

[4] The five significant positive quarterly trends in Table 3.8 sum to more than $700 million *per annum*, and this is *additional* to the $470 million annual demand that would be caused by an increase in total reserves. The 23 countries in Groups II through V that did not give significant regression equations bought $146 million of gold in 1959, the last "normal" year for which all the data are available.

[5] On this point, however, *see* James W. Angell, "The Reorganization of the International Monetary System," *Economic Journal*, December 1961, p. 699.

deposits well in excess of their minimum requirements."[6] But a change in institutional arrangements is not apt to bring quick change in long-established habits. And as they are manifest in my parameters, these habits forecast a demand for gold that could quickly bleed an expanded IMF of its own gold holdings (or force it to turn to the U.S. Treasury and cash its dollars to obtain sufficient gold). The international monetary system might still experience serious strains, and any reform may have to deal drastically with the gold tradition if it is to grant us a long respite from alarms and crises.

My conclusions are somewhat more gloomy than those of others who have looked at reserve-asset preferences. The 1958 IMF study of international liquidity predicted a steady growth in the demand for foreign exchange. "[It] seems certain," the Fund said, "that exchange holdings, as a more readily usable form of asset than gold holdings, will continue to form an important part of any *accumulation* of reserves."[7] And Klopstock put the same point much more strongly. "Central banks," he wrote, "are finding dollar assets increasingly attractive relative to gold as an *international store of value.*"[8] But these judgments were made before the recent trends had been fully articulated. The European drift toward gold seems to date from 1958-1959. Then too, Klopstock's study may have been influenced by some special situations; Britain held a large amount of foreign exchange at the end of 1956, but this was newly-borrowed from the IMF.[9] In brief, the monetary system was not as stable as it seemed in the mid-1950's, and may have become much more vulnerable since.

THE PROSPECTS

The events of 1961 push my assessment several ways at once. Some recent tendencies are cause for more pessimism. Others invite brighter hopes for the present system.

On the one hand, the drift toward gold appears to have continued.

[6] Robert Triffin, *Gold and the Dollar Crisis*, Yale University Press, 1960, p. 113. Triffin does provide for an increase in minimum requirements to forestall a scarcity should it occur (p. 114). But I doubt that the central banks causing the scarcity would themselves vote to increase requirements at a time of crisis or prospectively.

[7] International Monetary Fund, *International Reserves and Liquidity*, 1958, p. 39 (italics added).

[8] Fred H. Klopstock, *The International Status of the Dollar*, Essays in International Finance, No. 28, Princeton University, 1957, p. 3 (italics in original).

[9] Klopstock's dollar data, moreover, include that part of the increase in demand for dollars that was a shift from sterling rather than from gold.

The gold content of the U.S. deficit reached its peak in the first quarter of 1961, then declined a bit; but it was higher in the final quarter of 1961 than at any time before the fourth quarter of 1960 (Table 1.3). A number of key central banks bought large amounts of gold in 1961.[1] The Italian trend toward gold tapered off quite markedly, but Germany acquired $673 million of gold, although German reserves fell by $303 million.

On the other hand, the central banks took important steps to strengthen the monetary system: In the aftermath of the German and Dutch revaluations, several central banks went to the support of the pound, under a series of *ad hoc* arrangements (the Basle agreements); at one point, their commitments totalled about $900 million, an impressive measure of cooperation.[2] At about the same time, the U.S. authorities intervened in the foreign-exchange market to whittle away a forward discount on the dollar *vis-à-vis* the deutsche mark and the Swiss franc. These were the first major U.S. operations in more than two decades, and presaged regular activity. The major central banks would seem to have worked out a common policy toward the private gold markets which should forestall another crisis like the one in 1960.[3] Finally, the key-currency countries have at last hammered out arrangements to provide the IMF with convertible foreign exchange should its own resources be too small to aid a key-currency country.[4]

None of these new arrangements is perfect. But each can make a major contribution to the vitality of the present system. One wonders, indeed, whether it is still the same system the critics were condemning a year or so ago. The recent innovations involve a sort of burden-sharing. The task of defending the international monetary standard is no longer the exclusive responsibility of the United States and the United Kingdom. Furthermore, the Basle agreements and U.S. intervention in the foreign-exchange markets may increase the official de-

[1] Four of the 12 Group V countries in Table 3.8 added to their holdings in the first quarter, though seven were gaining reserves. But in the second quarter, after the "gold rush" had ended, all but one that gained reserves (and two more that lost reserves) acquired gold. The third quarter saw nine net gold purchases, including three by countries that were losing reserves and one by a country whose net purchase was far larger than its reserve increase.

[2] Bank of England, *Quarterly Bulletin*, September 1961, p. 10.

[3] They have, of course, declined to divulge the volume of official operations in the London market. But the continuing net physical export of gold from the United States, even in the autumn of 1961, suggests large-scale sales.

[4] *See* International Monetary Fund, *International Financial News Survey*, January 12, 1962, pp. 1-2 and supplement.

mand for foreign exchange and extend that demand to several of the European currencies.[5] This will be true even if official operations are confined to the forward markets; central banks that enter into forward foreign-exchange contracts are apt to cover their commitments with spot holdings in the appropriate currency, rather than with gold.[6]

This is not to say that every key currency can become a reserve currency. A reserve currency must be a key currency—one that is widely used in international trade and fully convertible, at least for nonresidents. But it must have additional attributes. A reserve-currency country should be a long-term foreign investor so that it can run a continuing payments deficit without becoming a net debtor.[7] It should also have a large short-term public debt and a well-developed money market so as to afford an adequate supply of the cash assets central banks prefer to hold. But there is still room for an increase in official holdings of the major European currencies or for more extensive credit arrangements that could substitute for further growth in national reserves.

OBITER DICTA ON REFORM

Yet the central banks and governments should not wait for another crisis to test the devices they have fashioned during the last year or so. They should continue to improve the monetary system.

Standby agreements. The 1961 Basle agreements should be made the model for a system of standby credits. Each of the major central banks should be pledged to take up predetermined quantities of foreign exchange at the request of a sister institution and to defer conversions into gold for three, six, or nine months.[8]

[5] United States holdings of foreign currencies ran as high as $550 million in 1962. These funds were acquired under swap arrangements or by outright purchases and loans. Triffin has warned against this tendency as a new source of instability (*see* his *Europe and the Money Muddle*, Yale University Press, 1957, p. 284), but it may well be the least of evils, especially if buttressed by some of the arrangements listed below. For a more complete statement of my views on this point and those below, *see* "International Liquidity, the Next Steps," *American Economic Review*, May 1963.

[6] This would seem to have been U.S. practice in 1961-1962.

[7] I owe this point to Henry C. Aubrey, but he should not be held responsible for this abbreviated formulation of his more subtle argument.

[8] There are many ways in which these principles could be implemented. The central banks could conclude a series of formal protocols reciting the amounts to which each participant would be committed, the terms on which the credits would be liquidated, and the necessary maintenance-of-value arrangements. For this approach, *see* Frank M. Tamagna, "Central Banks and International Monetary Arrangements," *Banca Nazionale del Lavoro Quarterly Review*, June 1961, pp. 124-130. The same purpose could also be served by spot transfers of foreign exchange against forward sales of gold or by swap transactions like those recently arranged by the United States.

The recent agreement to supply additional foreign exchange to the International Monetary Fund may not be an adequate substitute for such a network of standby arrangements linking the key central banks. Transactions with the IMF are too conspicuous and may take too much time. The Fund's resources, cash and credit, should be used to consolidate intergovernmental debts created when the standby network is brought into play, much as they were used in 1961 to liquidate Britain's short-term indebtedness under the Basle agreements.

Exchange-rate guarantees. A network of standby arrangements would have to include exchange-rate guarantees. The central banks' willingness to hold a foreign currency under sharp attack would surely be much enhanced if they were protected against a devaluation. But similar guarantees should also be formulated to shelter the existing reserve-assets. The reserve-currency countries are unduly constrained by their banking obligations; they are not free to change their exchange rates. As the number of reserve currencies increases, these inhibitions will also spread, freezing the exchange-rate structure into a pattern that could become altogether ludicrous.

There are, of course, objections to exchange-rate guarantees, as well as formidable obstacles athwart the process of negotiation.[9] But these could be overcome with half the effort and ingenuity that has been expended attacking guarantees. Sterie Beza and Gardner Patterson have rightly warned against a guarantee of payment in gold, for the total of guaranteed claims could come to exceed the value of the guarantor's gold stock, and the guarantee would not then be credible.[1] But they have gone on to oppose *any* guarantee or maintenance-of-value clause because it would "reduce the usefulness of our gold reserves in maintaining the dollar rate should we run into balance-of-payments troubles," and would give the foreign governments a windfall gain

[9] I know of no one who has worked out the problems attendant upon a future breach of convertibility. Faced with a major payments crisis, the United States might not devalue the dollar; it might merely suspend gold payments, as it did in 1933 and as Britain did in 1931. Guarantees against such a suspension of convertibility would not be fully credible. Yet guarantees against losses due to a devaluation could not necessarily be invoked to cover losses due to a suspension and depreciation. Effective exchange-rate guarantees would have to encompass *de facto* depreciation as well as *de jure* devaluation. This, however, would require a complex formula for indemnification. Should a foreign government be compensated (in inconvertible dollars) at the exchange rate ruling in the market a week, a month, or a year after the suspension, or for the (larger) losses it would suffer when it came to sell off its dollar holdings on the free foreign-exchange market?

[1] Sterie T. Beza and Gardner Patterson, "Foreign Exchange Guarantees and the Dollar," *American Economic Review*, June 1961, p. 382.

that might be used to make large claims on American resources.[2] The first of these two statements is perfectly true, but trivial. The U.S. gold stock could not be used to defend the dollar if foreign central banks preferred dollars to gold. But if they did, the United States would not have to defend the dollar in the foreign-exchange markets.[3] The second Beza-Patterson argument confuses the cost of a guarantee with the cost of devaluation. If foreign governments and central banks were to buy gold with their dollars prior to a U.S. devaluation, they would secure the same gains and claims on the United States that a guarantee would give them; the dollar value of their newly-purchased gold would increase by as much as the face value of a guaranteed dollar asset. The true cost of a guarantee is a mere fraction of the cost of devaluation. It is the windfall gain that would accrue to foreign central banks if, in the absence of a guarantee, they would not have bought gold before a devaluation.[4]

My elaborate computations have not made a case for standby arrangements or for guarantees. These last paragraphs are *obiter dicta.* But the trends and tendencies exposed in this monograph are cause for concern, and the two reforms I have urged may be the simplest ways to cope with those tendencies.

[2] *Ibid.*, pp. 382-384.

[3] This argument would only make sense if no other country were willing to accept dollars *or* gold.

[4] To pursue this theme, the cost of a guarantee decreases as other countries' forecasts of U.S. policy become more accurate. If every foreign central bank were correctly to anticipate a devaluation of the U.S. dollar, devaluation without guarantees could be just as costly of U.S. resources as devaluation with guarantees.

APPENDIX A

Notes on the Data

GENERAL

The data used in this analysis of national gold and foreign-exchange holdings were drawn from the following issues of *International Financial Statistics* (IFS):

Data for 1950	July 1951
" " 1951	" 1952
" " 1952	August 1953
" " 1953	October 1955
" " 1954	" 1956
" " 1955	" 1957
" " 1956	" 1958
" " 1957	" 1959
" " 1958	" 1960
" " 1959-1960	April 1961

To secure maximum continuity, the year-end data for 1950-1957 reported in the October 1960 and April 1961 issues were compared with the corresponding entries in each of the earlier issues. Small discrepancies were frequent but were ignored. Larger discrepancies required the revision of some of the data. (The method of revision used in each case is described in the appropriate country note.) The reserve-asset series were reconstructed from the gold and foreign-exchange series so as to be fully comparable with their components.

All the data span the period 3.31.50 through 9.30.60 and refer to the holdings of central banks (national banks or reserve banks), unless otherwise indicated in the country notes.

COUNTRY NOTES

The following symbols are used below:

NG No gold listed.
C The foreign-exchange data are convertible currencies.
$ " " " " " mainly U.S. dollars.
£ " " " " " " sterling.
LT " " " " include long-term securities (a suffixed $ or £ indicating that the securities are chiefly denominated in U.S. dollars or pounds sterling).

Argentina: Gold from 12.31.53; entries for March-September 1954 and March-September 1955 interpolated. Foreign exchange from 12.31.55; dollars through September 1957, convertible currencies thereafter (but convertible currencies were mainly dollars before 1958).

Australia (Reserve Bank, government, and check-paying banks): LT(£). Foreign-exchange data net of check-paying banks' foreign-exchange liabilities. IFS data for 1950-1952 include gross holdings of check-paying banks; these figures were reduced by $30 million to render them more closely comparable to the later statistics.

Austria: All data from 12.31.52. Gold entries for March-September 1953 interpolated. Foreign-exchange data exclude net claims on the European Payments Union (included in IFS series).

Belgium: All data for 1950-1957 last Thursday in month. Foreign-exchange data exclude net claims on the European Payments Union (included in IFS series). Discrepancy in foreign-exchange series at 12.31.60 treated by subtracting from the 1960 entries the excess of the new series over the old at 12.31.59. No adjustment made for earlier discrepancies.

Bolivia: Foreign exchange from 12.31.50; entry for September 1957 interpolated. Foreign-exchange data are dollars through September 1957, convertible currencies thereafter.

Brazil (Bank of Brazil through December 1957, monetary authorities thereafter): Year-end gold data for 1950-1952 in the recent issues of IFS imply small gold-stock fluctuations during 1950-1952; these were ignored. Foreign exchange from 12.31.55; dollars through 1958, convertible currencies thereafter (but convertible currencies were mainly dollars before 1958); discrepancy at 12.31.57 treated by adding $16 million to the earlier data.

Burma: NG; £.

Canada (monetary authorities and government): $ (small sterling balances have been excluded to avoid frequent discontinuities).

Ceylon: NG; £; LT(£).

Chile: Data include gold and foreign exchange held for others. Foreign-exchange data for December 1952 through 1960 exclude net payments-agreement balances (included in IFS series as "other foreign exchange"); earlier data include small payments-agreement balances.

China (Bank of Taiwan, Central Bank of China, and state-owned commercial bank): All data from 12.31.55.

Colombia: All data from 12.31.54. $. Foreign-exchange data include

small payments-agreement balances and International Bank for Reconstruction and Development bonds.

Costa Rica: All data rounded to nearest $0.1 million. $.

Cuba: $; LT($). Foreign-exchange data include assets pledged as collateral for foreign loans.

Denmark: Foreign-exchange data include sizeable bilateral balances currently usable (but exclude the European Payments Union position); also include gold not separately reported.

Dominican Republic: $.

Ecuador: $.

Egypt (and Egyptian Region of the United Arab Republic): All data from 12.31.50. LT(£).

El Salvador: LT.

Ethiopia: All data from 12.31.55. Gold entries for December 1955 and December 1956 carried at $4.2 million (as reported in the April 1961 IFS); entries for March-September 1955 interpolated. LT. Foreign-exchange entry for March 1956 interpolated.

Finland: LT. Discrepancy in foreign-exchange series at 9.30.53 treated by adding to the earlier entries an interpolation of the difference between the year-end figures in the October 1960 IFS and earlier issues; thus, the 1953 data were constructed as follows:

	10.60 IFS	*Earlier Issue*	*Interpolated Correction*	*New Estimate*
12.31.52	$106.4	$136.9	—30.5	$106.4
3.31.53	—	148.3	—31.7	116.6
6.30.53	—	140.9	—32.9	108.0
9.30.53	—	147.4	—34.1	113.3
12.31.53	118.9	154.2	—35.3	118.9

France (monetary authorities): All data from 12.31.56. C.

Germany (Federal Republic): Gold from 12.31.52. Foreign exchange from 12.31.53. Foreign-exchange data are convertible currencies from December 1956; earlier data are U.S. and Canadian dollars and European Payments Union currencies *plus* an interpolation of the difference between the year-end convertible-currencies figure in the October 1960 IFS and the dollars-plus-European Payments Union-currencies figure in the earlier IFS; thus, the 1956 data were constructed as follows:

	Convertible Currencies	*Dollars & EPU Currencies*	*Interpolated Correction*	*New Estimate*
12.31.55	$1484	$1478	6	$1484
3.31.56	—	1513	—20	1493
6.30.56	—	1755	—46	1709
9.30.56	—	1969	—72	1897
12.31.56	1908	2007	—99	1908

Ghana: NG. Foreign exchange from 12.31.55. £; LT(£). Early data are the sterling-equivalents of the domestic currency issue.

Greece: Gold from 12.31.50. Foreign exchange from 12.31.54. Discrepancy in foreign-exchange series at 9.30.57 treated by adjusting the earlier data as in the case of Finland.

Guatemala: $.

Haiti: All data from 12.31.54. Gold entries for March-September 1954 interpolated. C.

Honduras: All data rounded to nearest $0.1 million. $; LT($).

Iceland: As described in the General Note.

India: £; LT(£).

Indonesia: Foreign exchange from 12.31.50.

Iran: Data relate to the 20th of the last month in the quarter; include National Bank holdings for the government.

Iraq: LT.

Ireland: £; LT(£).

Israel: All data from 6.30.53; gold entries (zero) for 1953 through September 1955 interpolated. C.

Italy (monetary authorities): Foreign exchange from 12.31.56. C.

Japan (monetary authorities): Gold from 12.31.52; entries through 1959 exclude amounts whose ownership was in dispute. Foreign exchange from 12.31.56.

Jordan (Currency Board): NG; £; LT(£). Foreign-exchange data are the sterling-equivalents of the domestic currency issue.

Korea: All data from 12.31.54. Foreign-exchange data include assets held for others.

Lebanon (Bank of Syria and Lebanon, Office of Exchange Control, and Exchange Stabilization Fund): All data from 12.31.50. Continuity of the foreign-exchange data disturbed by devaluations of the French franc.

Malaya (monetary authorities): NG. Foreign exchange from 12.31.55.

£; LT(£); data include assets held as cover for the domestic currencies of Singapore, Brunei, etc.

Mexico: Foreign exchange from 12.31.52; include assets held for others.

Netherlands: Foreign exchange from 12.31.51. C.

New Zealand: Foreign exchange from 12.31.50. £; LT(£).

Nicaragua: All data rounded to nearest $0.1 million. C. Foreign-exchange data include (small) holdings by commercial banks.

Norway: LT.

Pakistan: All data from 12.31.52. Discrepancy in foreign-exchange series at 9.30.57 treated by adjusting the earlier entries as in the case of Finland.

Panama: NG; $. Foreign-exchange data are holdings of commercial banks.

Peru: $.

Philippines: $.

Portugal: Foreign exchange from 12.31.52. Discrepancy in foreign-exchange data at 9.30.56 (due to a change in valuation) treated by adjusting the earlier entries as in the case of Finland.

Spain (monetary authorities): All data from 12.31.57. C.

Sudan: NG. Foreign exchange from 12.31.55.

Sweden: Foreign exchange from 12.31.51; dollars through 1958, convertible currencies thereafter.

Switzerland: Data adjusted to exclude Treasury holdings (included in IFS series).

Thailand (monetary authorities).

Turkey: Foreign exchange from 12.31.52. C.

Union of South Africa: Foreign-exchange data adjusted to exclude Treasury holdings (included in IFS series).

United Kingdom (Exchange Equalisation Account): All data from 6.30.50. Gold data are Federal Reserve estimates. Foreign-exchange data are U.S. and Canadian dollars through September 1958, convertible currencies thereafter.

Venezuela: All data from 12.31.50. Gold data include Treasury holdings; entry for December 1950 carried at $273 (as in the October 1960 IFS) and entry for March 1951 interpolated. $.

APPENDIX B

Supplementary Tables

TABLE A

Selected Gold and Reserve-asset Characteristics, 48 Countries[a]

Country	$\overline{G}$	$\overline{R}$	$s_R/\overline{R}$	$\dot{d}_R/\overline{R}$[b]	$\dot{s}_G/\dot{s}_R$	$\dot{d}_G/\dot{d}_R$[c]
	($ millions)					
Argentina	154	253	.401	.212	.702	.310
Australia	126	1158	.022	.181	.008	.007
Austria	121	446	.387	.079	.266	.221
Belgium	870	959	.202	.055	1.249	.838
Bolivia	8.4	11.5	.906	.231	.790	.756
Brazil	319	381	.107	.087	.103	.055
Canada	952	1821	.085	.053	1.448	.122
Chile	42.2	68.3	.374	.178	.006	.014
China	12	94	.197	.096	.056	.045
Colombia	72	160	.249	.255	.070	.023
Cuba	176	456	.167	.086	1.297	.231
Denmark	31.2	156	.369	.099	(d)	(d)
Dominican Rep.	10.7	34	.232	.097	.097	.060
Ecuador	21.7	35.6	.117	.081	.083	.045
Egypt	172	635	.338	.052	.006	.055
El Salvador	28.4	47.5	.175	.192	.149	.014
Ethiopia	4.1	60.6	.099	.086	.001	(d)
Finland	29.6	185.6	.343	.141	.018	.005
France	936	1277	.369	.138	.440	.642
Germany	1538	3093	.478	.114	.467	.169
Greece	15.9	194.7	.105	.703	.106	.017
Guatemala	26.7	51	.260	.156	.008	.003
Haiti	1.3	5.9	.581	.375	.039	.016
Indonesia	111	286	.346	.149	.797	.162
Iran	138	212	.133	.067	.006	.011
Iraq	16.4	221.6	.372	.073	.106	.253
Ireland	18	234	.082	.049	(d)	(d)
Italy	1147	1949	.430	.119	.612	.420
Japan	110	951	.385	.132	.078	.055
Korea	1.6	121.1	.167	.063	(d)	.001
Lebanon	64.0	79.5	.388	.054	.891	.996
Mexico	142	339	.310	.129	.122	.328
Netherlands	822	992	.281	.070	.828	.923
New Zealand	32.9	231	.232	.181	(d)	.001
Nicaragua	2.1	16.8	.322	.383	.016	.037
Norway	45.5	172.9	.250	.111	.023	.031
Pakistan	45	270	.120	.079	.007	.039
Peru	33.9	50.1	.230	.138	.592	.247
Philippines	11	181	.390	.094	.006	.031
Portugal	444	729	.074	.017	1.658	1.036
Spain	80	178	.795	.329	.020	.068
Sweden	219	387	.224	.061	.147	.460
Switzerland	1567	1681	.132	.035	.867	.879
Thailand	113	309	.094	.046	.014	.010
Turkey	143	152	.043	.039	.313	.117
Un. S. Africa	199	348	.171	.112	.171	.142
United Kingdom	2310	2627	.201	.120	.959	.940
Venezuela	499	686	.482	.154	.204	.171

[a] Countries used in the rank correlations (Chapter 2).

[b] Denoting $\frac{\sqrt{\Sigma\Delta R^2/n}}{\overline{R}}$.

[c] Denoting $(\Sigma\Delta G^2)/(\Sigma\Delta R^2)$.

[d] Less than .0005.

TABLE B

Von Neumann's Ratio for Gold, Foreign Exchange, and Reserve-assets, 48 Countries[a]

Country	*Gold*	*Foreign Exchange*	*Reserve-assets*
Argentina	.0752	.1074	.1704
Australia	.2587	.2799	.2994
Austria	.0343	.0834	.0413
Belgium	.0502	.2666	.0748
Bolivia	.0549	1.2938	.0574
Brazil	.3450	.7486	.6630
Canada	.0331	.7168	.3942
Chile	.5635	.2077	.2273
China	.1897	.2102	.2373
Colombia	.3388	.9450	1.0418
Cuba	.0477	.2354	.2682
Denmark	.0307	.0731	.0734
Dominican Rep.	.1083	.2436	.1759
Ecuador	.2604	.5136	.4787
Egypt	.2236	.0213	.0239
El Salvador	.1106	.9320	1.1984
Ethiopia	.2660	.7817	.7487
Finland	.0443	.2013	.1694
France	.1785	.4922	.1224
Germany	.0163	.1980	.0450
Greece	.0725	.4841	.4463
Guatemala	.1207	.3669	.3618
Haiti	.1646	.5251	.4175
Indonesia	.0378	.3110	.1864
Iran	.4948	.2578	.2583
Iraq	.0914	.0522	.0384
Ireland	.2500	.3673	.3624
Italy	.0522	.6070	.0761
Japan	.0827	.1760	.1179
Korea	.5432	.1424	.1434
Lebanon	.0219	.5805	.0196
Mexico	.4674	.1607	.1732
Netherlands	.0630	.6791	.0618
New Zealand	.1364	.6152	.6123
Nicaragua	.0883	.8252	.8199
Norway	.1604	.1567	.1972
Pakistan	.4843	.4924	.4406
Peru	.1516	.7209	.3627
Philippines	.2788	.0514	.0577
Portugal	.0329	.2736	.0527
Spain	.5874	.1448	.1715
Sweden	.2327	.0663	.0744
Switzerland	.0705	.3642	.0695
Thailand	.1743	.2292	.2386
Turkey	.3029	.9579	.8116
Un. S. Africa	.3588	.3226	.4311
United Kingdom	.3502	1.2008	.3574
Venezuela	.0856	.2228	.1023

[a] Countries used in the comparison of mean values for von Neumann's ratio and in the rank correlations (Chapter 2).

TABLE C

Quarters in which Gold Stocks were Constant, 37 Countries[a]

Country	*1950-1951*[b]	*1952-1953*	*1954-1955*	*1956-1957*	*1958-1960*[c]	*1950-1960*
Australia	2	1	0	1	0	4
Belgium	0	0	0	0	0	0
Bolivia	7	2	3	4	0	16
Brazil	7	7	6	7	5	32
Canada	0	0	0	0	1	1
Chile	0	2	0	1	4	7
Cuba	3	2	7	8	4	24
Denmark	6	6	6	8	11	37
Dominican Rep.	5	8	8	6	8	35
Ecuador	2	5	7	4	9	27
Egypt	2	8	8	7	10	35
El Salvador	1	1	1	3	8	14
Finland	2	8	2	8	8	28
Greece	0	2	6	3	4	15
Guatemala	7	8	8	7	8	38
Indonesia	3	2	6	1	7	19
Iran	5	7	7	8	8	35
Iraq	7	8	7	6	8	36
Ireland	6	8	8	8	11	41
Italy	5	7	7	6	0	25
Lebanon	2	2	3	5	10	22
Mexico	0	0	0	1	2	3
Netherlands	5	0	2	0	1	8
New Zealand	2	7	8	8	9	34
Nicaragua	7	8	8	7	10	40
Norway	4	3	1	1	8	17
Pakistan	7	7	7	7	6	34
Peru	4	5	5	3	6	23
Philippines	2	6	4	0	0	12
Portugal	2	1	0	0	1	4
Sweden	0	1	3	0	6	10
Switzerland	0	0	1	0	0	1
Thailand	5	7	6	8	10	36
Turkey	3	3	5	8	10	29
Un. S. Africa	1	1	0	1	0	3
United Kingdom	0	0	2	2	0	4
Venezuela	7	8	7	4	6	32

[a] All countries for which gold data were available (whether or not foreign-exchange data were also available); used in the test for uniformity (Chapter 2).

[b] Based on seven quarters and, in some cases, on fewer than seven (in which instances, the count has been blown up to its seven-quarter equivalent).

[c] Based on eleven quarters (excluding the fourth quarter of 1960).

TABLE D

Quarters in which Gold Stocks and Reserve-assets Moved in the Same Direction, 28 Countries[a]

Country	*1950-1951*[b]	*1952-1953*	*1954-1955*	*1956-1957*	*1958-1960*[c]	*1950-1960*
Australia	3	4	4	6	4	21
Belgium	7	7	5	5	11	35
Bolivia	0	2	5	1	1	9
Canada	4	5	6	6	5	26
Chile	2	1	6	4	4	17
Cuba	4	4	1	0	5	14
Denmark	0	1	1	0	0	2
Dominican Rep.	3	0	1	0	2	6
Ecuador	1	3	0	2	1	7
Egypt	4	0	0	0	1	5
El Salvador	4	3	5	3	3	18
Finland	4	0	3	0	1	8
Guatemala	0	0	0	0	2	2
Indonesia	6	5	2	5	1	19
Iran	1	1	1	0	2	5
Iraq	0	0	1	1	2	4
Ireland	0	0	0	0	0	0
Lebanon	4	5	4	2	1	16
New Zealand	4	0	0	0	1	5
Nicaragua	0	0	0	1	1	2
Norway	0	1	4	2	2	9
Peru	3	2	4	4	2	13
Philippines	2	2	3	3	6	14
Switzerland	6	7	7	7	7	32
Thailand	0	0	0	0	1	2
Un. S. Africa	3	4	4	4	9	24
United Kingdom	6	7	5	5	8	32
Venezuela	6	1	3	3	5	16

[a] All countries for which gold and foreign-exchange data were available; used in the test for uniformity (Chapter 2).

[b] Based on seven quarters and, in some cases, on fewer than seven (in which instances, the count has been blown up to its seven-quarter equivalent).

[c] Based on eleven quarters (excluding the fourth quarter of 1960).

TABLE E

The Frequency of Quarterly Increases in Gold Holdings[a]

Country	*Frequency*	*Country*	*Frequency*
Group II		*Group IV*	
Denmark	.000	Argentina	.053
Dominican Rep.	.143	Austria	.516
Egypt	.103	Colombia	.522
Ethiopia	.000	El Salvador	.119
Guatemala	.024	Greece	.522
Haiti	.037	Indonesia	.154
Iran	.048	Norway	.256
Iraq	.143	Philippines	.571
Ireland	.024	Sweden	.343
Israel	.103		
New Zealand	.154	*Group V*	
Nicaragua	.000	Australia	.667
Pakistan	.161	Belgium	.571
Thailand	.024	Canada	.619
Turkey	.097	Chile	.442
		France	.667
Group III		Germany	.935
Bolivia	.205	Italy	.933
Brazil	.263	Mexico	.516
China	.105	Netherlands	.686
Cuba	.071	Portugal	.806
Ecuador	.191	Switzerland	.595
Finland	.238	Un. S. Africa	.628
Japan	.400	United Kingdom	.512
Korea	.304		
Lebanon	.462		
Peru	.238		
Spain	.273		
Venezuela	.154		

[a] Based on the count of gold-stock changes in Table 2.1.

TABLE F

Von Neumann's Ratio for the Regression Residuals, 26 Countries[a]

Country	*Von Neumann's Ratio*			
	G on R (e)	ΔG *on* ΔR ($_{\Delta}e$)	ΔG *on* ΔR *and* F_{-1} ($_{m}e$)	ΔG *on* F_{-1} ($_{f}e$)
Argentina	—	1.84	—	—
Austria	.13[b]	.85[b]	1.23[b]	1.52
Belgium	.36[b]	2.31	—	—
Bolivia	1.67	2.51	1.90	—
Canada	.66[b]	.99[b]	1.10[b]	—
Chile	—	2.61[d]	—	—
Cuba	.13[b]	1.36[c]	—	—
Egypt	.29[b]	1.27[b]	1.74	—
France	.78[b]	—	—	2.03
Germany	.33[b]	.79[b]	—	—
Indonesia	.17[b]	1.58	1.79	—
Iran	.58[b]	2.16	—	—
Italy	.73[b]	—	1.99	—
Lebanon	—	—	—	2.00
Mexico	.48[b]	1.96	—	—
Netherlands	.76[b]	2.36	1.56	—
Nicaragua	—	2.10	—	—
Peru	.58[b]	1.91	1.89	—
Portugal	.55[b]	1.44[c]	—	2.29
Spain	—	2.28	—	—
Sweden	—	1.70	—	—
Switzerland	.42[b]	2.79[d]	2.43	—
Turkey	.42[b]	1.91	—	—
Un. S. Africa	—	1.70	1.69	—
United Kingdom	1.13[b]	2.18	1.37[b]	—
Venezuela	.53[b]	1.78	1.76	—

[a] Countries giving r^2 significant at the 0.05 level for ΔG on ΔR or ΔG on F_{-1}.

[b] Indicative of significant positive autocorrelation at the 0.05 and 0.01 levels.

[c] Indicative of significant positive autocorrelation at the 0.05 level but not at the 0.01 level.

[d] Indicative of significant negative autocorrelation at the 0.05 level, but not at the 0.01 level.

TABLE G

Standard Errors of the Basic Regression Coefficients[a]

Country	*Number of Observations*	s_{B_R}	s_{B_O}
Group II			
Denmark	43	b	0.03
Dominican Rep.	43	.037	1.33
Egypt	40	.011	7.43
Ethiopia	20	.008	0.10
Haiti	24	.028	0.17
Iran	43	.011	2.43
Iraq	43	.043	10.33
Pakistan	32	.014	3.77
Turkey	32	.087	83.74
Group III			
Bolivia	40	.027	0.45
Cuba	43	.143	31.38
Finland	43	.013	2.62
Japan	16	.029	30.55
Lebanon	40	.035	3.04
Peru	43	.073	3.79
Venezuela	40	.030	23.11
Group IV			
Austria	32	.045	21.69
Indonesia	40	.099	30.29
Norway	43	.014	2.43
Philippines	43	.011	3.38
Group V			
Australia	43	.013	8.82
Belgium	43	.035	34.64
Canada	43	.109	201.65
France	16	.076	70.52
Germany	32	.034	117.97
Italy	16	.043	94.36
Mexico	32	.051	12.82
Netherlands	36	.031	28.54
Portugal	36	.057	42.18
Switzerland	43	.021	36.64
United Kingdom	42	.039	105.65

[a] Standard errors of the coefficients in Table 3.1.
[b] Less than .0005.

TABLE H

An Intermediate First-difference Transformation[a]

Country	B_R[b]	${}_hB_R$[c]	${}_\Delta B_R$[d]
Group II			
Denmark	—.002	*	*
Dominican Rep.	.205	*	*
Egypt	—.037	*	.109
Ethiopia	.017	*	*
Haiti	.152	*	*
Iran	.036	.039	.038
Iraq	.173	*	*
Nicaragua	*	*	.013
Pakistan	.040	*	*
Turkey	.308	.184	.144
Group III			
Bolivia	.873	.393	.365
Cuba	.673	.199	.191
Finland	.103	*	*
Japan	.258	*	*
Lebanon	.919	*	*
Peru	.610	.230	.230
Spain	*	*	.201
Venezuela	.412	.171	.171
Group IV			
Argentina	*	.297	.340
Austria	.454	.249	.184
Indonesia	.653	.171	.170
Norway	—.123	*	*
Philippines	.034	*	*
Sweden	*	.302	.329
Group V			
Australia	—.041	*	*
Belgium	1.095	.814	.803
Canada	.982	.120	.108
Chile	*	.053	.053
France	.599	*	*
Germany	.658	.251	.131
Italy	.766	.388	*
Mexico	.212	.340	.344
Netherlands	.891	.673	.608
Portugal	1.249	.605	.365
Switzerland	.921	.895	.874
Un. S. Africa	*	.198	.201
United Kingdom	.948	.863	.862

[a] This table compares the regression coefficients obtained directly from equation (1) in the text, those obtained from a first-difference transformation of equation (1) without the addition of a trend term, and those obtained from equation (2) in the text, which includes a trend term.

[b] Coefficients for equation (1), reproduced from Table 3.1.

[c] Coefficients computed from a homogeneous first-difference transformation of equation (1): $\Delta G = {}_hB_R \cdot \Delta R + {}_he$; these compare to the B_R more closely than the ${}_\Delta B_R$.

[d] Coefficients for equation (2), reproduced from Table 3.2.

* Not significantly different from zero at the 0.05 level.

TABLE J

Standard Errors of the First-difference Regression Coefficients[a]

Country	Number of Observations	Coefficients for ΔR		Coefficients for F_{-1}		Trend Terms		
		ΔS_{B_R}	$_mS_{B_R}$	$_mS_{B_F}$	$_fS_{B_F}$	ΔS_t	$_mS_k$[b]	$_fS_k$[b]
Group II								
Egypt	39	.040	.034	.004	—	1.4	1.1	—
Iraq	42	.015	—	—	—	0.22	—	—
Nicaragua	42	.006	—	—	—	0.09	—	—
Turkey	31	.053	—	—	—	0.63	—	—
Group III								
Bolivia	39	.128	.183	.156	—	0.45	0.41	—
Cuba	42	.064	—	—	—	2.7	—	—
Lebanon	39	—	—	—	.091	—	—	0.61
Peru	42	.070	.057	.060	—	0.58	0.46	—
Spain	11	.083	—	—	—	4.5	—	—
Venezuela	39	.062	.060	.031	—	7.3	6.7	—
Group IV								
Argentina	19	.083	—	—	—	4.8	—	—
Austria	31	.083	.064	.019	.022	2.7	7.3	2.7
Indonesia	39	.057	.048	.031	—	3.1	2.8	—
Sweden	35	.111	—	—	—	2.6	—	—

TABLE J (continued)

Country	Number of Observations	Coefficients for ΔR		Coefficients for F_{-1}		Trend Terms		
		ΔS_{B_R}	$_mS_{B_R}$	$_mS_{B_F}$	$_fS_{B_F}$	ΔS_t	$_mS_k$[b]	$_fS_k$[b]
Group V								
Belgium	42	.066	—	—	—	5.6	—	—
Canada	42	.051	.049	.044	—	7.1	6.8	—
Chile	42	.017	—	—	—	0.45	—	—
France	15	—	—	—	.112	—	—	51.5
Germany	31	.063	—	—	—	19.6	—	—
Italy	15	—	.063	.052	—	—	35.1	—
Mexico	31	.086	—	—	—	3.8	—	—
Netherlands	35	.121	.099	.103	—	15.2	13.1	—
Portugal	31	.142	—	—	.078	1.7	—	3.1
Switzerland	42	.055	.051	.079	—	3.8	3.6	—
Un. S. Africa	42	.051	.049	.033	—	2.1	2.0	—
United Kingdom	41	.071	.043	.103	—	29.8	22.9	—

[a] Standard errors of the coefficients in Tables 3.2, 3.4, and 3.6.

[b] These are the same as $_mS_{B_t}$ and $_fS_{B_t}$, respectively, if $F^* = \overline{F}$.

TABLE K

A Trial Classification of Countries by Reserve-asset-preference Pattern

No Gold	*"Basic" Gold Reserve*[a] $B_R = 0$	*"Basic" Gold Reserve*[a] $B_R > 0$	*Proportionality*[a]	*Working Balance*[b]
Group I (no gold or no change in gold):[c]				
Burma	Costa Rica			
Ceylon	Honduras			
Ghana	Iceland			
Jordan	India			
Malaya				
Sudan				
Vietnam				
Group II ("rare" changes):[d]				
Israel*	Denmark			(Egypt)
	Dominican Rep.			
	Egypt*			
	Ethiopia			
	Guatemala			
	Haiti			
	Iran			
	Iraq			
	Ireland			
	New Zealand			
	Nicaragua			
	Pakistan			
	Thailand			
	Turkey			
Group III ("infrequent" changes):				
	Brazil	Cuba	Peru*	Bolivia[f]
	China	Lebanon*		(Lebanon)
	Ecuador	Spain		(Peru)
	Finland	Venezuela		(Venezuela)
	Japan			
	Korea			
Group IV ("frequent" changes):				
	Colombia	Argentina	Austria*	(Austria)
	El Salvador	Sweden	Indonesia*	(Indonesia)
	Greece			
	Norway			
	Philippines			

TABLE K (continued)

No Gold	*"Basic" Gold Reserve*[a] $B_R = 0$	*"Basic" Gold Reserve*[a] $B_R > 0$	*Proportionality*[a]	*Working Balance*[b]
Group V ("continuous" changes):[g]				
		Canada*	Belgium	(Canada)
		Chile		(France)
		France*		(Italy)
		Germany		Netherlands
		Italy*		(Portugal)
		Mexico		Switzerland
		Portugal*		(Un. S. Africa)
		Un. S. Africa*		United Kingdom

[a] Countries listed in these columns with an asterisk also met the *full-series* test for the working-balance pattern and are listed in parentheses in the working-balance column.

[b] Countries listed in this column without parentheses met the *truncated* test (for $q = 2$) for the working-balance pattern; those that are listed in parentheses passed the *full-series* test and are also listed (without parentheses) in the appropriate columns to the left.

[c] Panama is not classified because all its foreign-exchange holdings belong to the commercial banks.

[d] The four countries in this Group that give significant regression results (Egypt, Iran, Nicaragua, and Turkey) are listed as having $B_R = 0$ because they most probably partake of the broken pattern (3.c) with true $B_R = 0$.

[e] Israel held no gold at the end of the 1950's.

[f] Bolivia might also be classified as holding a "basic" gold reserve but lying on the 45° segment of the demand function; Bolivian reserves fell sharply during the period under study.

[g] Australia is not classified because its foreign-exchange holdings include the net foreign-exchange assets of check-paying banks.

TABLE L

A Summary Tabulation of Asset-preference Patterns on Alternative Criteria[a]

Criterion and Group	*No Gold*	*"Basic" Gold Reserve*	*Proportionality*	*Working Balance*
A. Using the Truncated Test ($q = 2$):				
I	7	4	0	0
II	1	14	0	0
III	0	10	1	1
IV	0	7	2	0
V	0	8	1	3
All 59 Countries[b]	8	43	4	4
All 26 in Table 3.8	0	18	4	4
B. Using the Full-series Test:				
I	7	4	0	0
II	1	13	0	1
III	0	8	0	4
IV	0	7	0	2
V	0	3	1	8
All 59 Countries[b]	8	35	1	15
All 26 in Table 3.8	0	10	1	15

[a] Based on Table K.

[b] Panama (Group I) and Australia (Group V) not classified; *see* notes c and g to Table H.

APPENDIX C

Cross-sectional Regressions and the Global Demand for Gold

In an essay on the theory of the gold-exchange standard, I hypothesized a global demand function for foreign exchange, and as its complement, a global demand function for gold.[1] The national parameters presented in Chapter 3 challenge this procedure; they are too heterogeneous and, perhaps, too volatile to be "averaged" into a global function. This appendix tries directly to estimate a global demand function, with similarly dismal results.

To begin, I constructed three subsets of countries:[2]

A. The 14 countries giving $_{\Delta}B_R > 0$ and having gold and foreign-exchange data that span 1950-1960: Belgium, Bolivia, Canada, Chile, Cuba, Egypt, Indonesia, Iran, Peru, Nicaragua, Switzerland, Union of South Africa, United Kingdom, and Venezuela.

B. The 7 countries giving $_{\Delta}B_R > 0$ and having data that span 1953-1960: Austria, Germany, Mexico, the Netherlands, Portugal, Sweden, and Turkey.

C. The 15 countries giving $_{\Delta}B_R = 0$ and having data that span 1953-1960: Australia, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, Guatemala, Ireland, Iraq, Lebanon, New Zealand, Norway, Pakistan, Philippines, and Thailand.

Then I separated these subsets into three cross-sectional samples:

1. A 14-country sample spanning 1951-1960 (A).
2. A 21-country sample spanning 1953-1960 (A + B).
3. A 36-country sample spanning 1953-1960 (A + B + C).

I also constructed larger samples spanning shorter periods, so as to include some of the other countries that held large amounts of gold and changed their gold stocks frequently:

4. A 25-country sample spanning 1958-1960 (A + B *plus* France, Italy, Japan and Spain).
5. A 40-country sample spanning 1958-1960 (A + B + C *plus* France, Italy, Japan and Spain).

[1] Peter B. Kenen, "International Liquidity and the Balance of Payments of a Reserve-currency Country," *Quarterly Journal of Economics*, November 1960; I used a similar assumption in some of the notes to Chapter 1, above.

[2] The countries excluded from this assortment are the ones that did not have complete data for 1953-1960: Argentina, Brazil, China, Colombia, Ethiopia, France, Greece, Haiti, Israel, Italy, Japan, Korea, and Spain.

I used the 14-country sample (1) to make three trial computations, searching for the best demand relationship:

First, I computed separate regression equations for each of 40 quarters using:

$$_{i}\Delta G = {}_{i}C_t + {}_{i}C_R\Delta R + {}_{i}e \qquad (C.1)$$

This equation gave quite poor results, as the large gold transactions of two or three countries tended to dominate, and the irregularities in their transactions (especially in those of the United Kingdom) gave huge standard errors. A full 33 of the 40 coefficients ${}_{i}C_R$ were not significantly different from zero at the 0.05 level.

Second, I computed separate equations for each of 40 quarters using R as a deflator, to remove the influence of country size:

$$(\Delta G/R) = {}_{ii}C_t + {}_{ii}C_R\,(\Delta R/R) + {}_{ii}e \qquad (C.2)$$

This model gave somewhat better results. It produced significant ${}_{ii}C_R$ for 10 of the 40 quarters.

Third, I computed separate equations for each of 40 quarters using:

$$(\Delta G/G) = {}_{iii}C_t + {}_{iii}C_R\,(\Delta R/R) + {}_{iii}e \qquad (C.3)$$

These straightforward percentage changes gave the best results; 11 of the 40 coefficients ${}_{iii}C_R$ were significant at the 0.05 level.

I therefore used equation (C.3) to compute regression coefficients for each of the five samples listed above. The coefficients ${}_{iii}C_R$ are given in Table M. The 21-country and 25-country samples came out best; they furnished more significant relationships and the smallest average standard error. In other words, the addition of the 15 countries in subset (C) did not strengthen the relationship; it was strongest when based on the countries that gave significant time-series regressions.

But not much can be gleaned from the best cross-sectional estimates: The 21-country sample gave a mere 15 significant coefficients out of a possible 32; the 25-country sample gave a mere 3 out of a possible 12. Three of the 21-country results, moreover, gave ${}_{iii}C_R < 0$. The mean value for ${}_{iii}C_R$ is significantly greater than zero for both samples,[3] but is not very large:

	21 countries	*25 countries*
${}_{iii}\overline{C}_R$	.3391	.2872
$s_{\overline{c}_R}$	.1313	.0829

[3] This test of significance is based on a sample standard deviation for $\overline{C}_R$ computed directly from the separate quarterly estimates, then upon the ratio $\overline{C}_R/s_{\overline{c}_R}$

TABLE M

Cross-sectional Regression Coefficients: Percentage Change in Gold on Percentage Change in Reserve-assets ($_{111}c_r$), Various Samples, 1951-1960

Year and Quarter		Number of Countries				
		14	*21*	*25*	*36*	*40*
1951	I	.001*				
	II	— .014*				
	III	.269*				
	IV	.771				
1952	I	.282*				
	II	.269*				
	III	.199*				
	IV	.452				
1953	I	.130*	.264*		.099*	
	II	.007*	.082*		.072*	
	III	.496	.437		.314	
	IV	.110*	.358*		.270	
1954	I	.446*	.488		.346	
	II	.611	.935		.750	
	III	.020*	.172*		.137*	
	IV	.099*	.101*		.064*	
1955	I	.727	.653		.462	
	II	.980	.996		.759	
	III	.078*	.833		.571	
	IV	— .050*	.002*		— .004*	
1956	I	— .747	— .720		— .590	
	II	4.138	3.832		.253	
	III	— .080*	— .012*		.014*	
	IV	.641	.637		.523	
1957	I	.007*	.009*		.046*	
	II	— .403*	— .317*		— .233*	
	III	.120*	.213		.166	
	IV	— .544	— .507		.058*	
1958	I	.127*	.164*	.154*	.167*	.149*
	II	.522*	.479*	.472*	— .044*	.021*
	III	.159*	.263	.415	.188	.297
	IV	.208*	.287*	.865	.088*	.417*
1959	I	.002*	.003*	.074*	.039*	.131*
	II	— .055	— .060	.056*	— .067*	— .058*
	III	.347*	.339	.169*	.262*	.134*
	IV	.091*	.084*	.096*	.085*	.097*
1960	I	— .235*	— .185*	.015*	— .036*	.045*
	II	.114*	.136*	.129*	.275	.235
	III	.179*	.193*	.226*	.139*	.149*
	IV	.758*	.694	.779	.384	.454

* Not significantly different from zero at the 0.05 level.

And the poverty of my calculations is the more striking because the method I used has a built-in bias toward high correlations; the denominator of $(\Delta G/G)$ correlates with the denominator of $(\Delta R/R)$.

The mean of the trend terms ${}_{iii}C_t$ is also positive in the two best samples, but is not significantly different from zero:

	21 countries	*25 countries*
${}_{iii}\overline{C}_t$	0.53%	2.91%
$s_{\bar{c}_t}$	0.50	1.75

The larger trend term for the 25-country sample would seem chiefly to reflect the impact of Italy, which has separately evinced a strong trend toward gold.[4]

I tried to strengthen the cross-sectional relationships by adding extra variables. I used $F_{-1}/\overline{F}$, as the analogue of $(F_{-1} - \overline{F})$ in my time-series regressions, and worked with several of the measures of volatility studied in Chapter 2. But these attempts did not enlarge the number of significant relationships, nor much improve those results that were already significant.

The fourth quarter of 1960 gave a large significant value for ${}_{iii}C_R$ and a positive value for ${}_{iii}C_t$ in each of the two best samples, (2) and (4). But the values for ${}_{iii}C_R$ were not significantly different from the mean values for ${}_{iii}C_R$, and the trend terms were not significantly different from zero.

The mean values for ${}_{iii}C_R$ do confirm one basic hypothesis—that the demand for gold is inelastic with respect to reserve-assets; the ${}_{iii}C_R$ are direct estimates of this elasticity and are much lower than unity.[5] But the principal inference to be drawn from this analysis is, I think, the agnostic assertion with which I began: One cannot talk about a global demand function for gold, for it must be a weighted average of separate national demands in which the weights and national propensities would both change through time.

[4] There is no evidence of trend, incidentally, in the sequence of quarterly values of ${}_{111}C_R$.

[5] Stretching credibility a bit, write the "typical" 21-country demand function as:

$$(\Delta G/G) = 0.5 + .3391(\Delta R/R)$$

This gives an autonomous annual increase in gold stocks of roughly 2.0 per cent (4 x 0.5). If, then, total reserve-assets are rising by 3.0 per cent per year, the demand for gold will actually grow by about 3.0 per cent (2.0 + .3391 x 3.0). With a 3.0 per cent increase in reserves, therefore, the global gold ratio, G/R, will stay put. But this stability would seem to be an historical fluke due to the coincidence of an average annual 2.0 per cent drift toward gold and a 3.0 per cent increase in reserves. It does not imply (as some have inferred) that the global demand for gold has a unitary reserve-elasticity.

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