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4 Dollarization in Mexico: Causes and Consequences

Guillermo Ortiz

4.1 Introduction

The term "dollarization" will be interpreted in this paper as the degree to which real and financial transactions are actually performed in dollars relative to those performed in domestic currency. Since this is an unobservable variable, an obvious choice for measuring the extent of dollarization in the economy is the proportion of dollars to domestic currency circulating at any time.

This concept of dollarization is closely related to the literature on "currency substitution." This literature explains the conditions under which diversified portfolios of domestic and foreign money balances will be held and adapted in response to expected changes in relative risks and returns among the various currencies. The general idea of several recent papers (Miles 1978; Brillenbourg and Schadler 1980; Girton and Roper 1981) is that monetary policy will be ineffective in a country where foreign currencies are regarded as good substitutes for domestic currency. An important implication of this hypothesis is that the elasticity of substitution between domestic and foreign currency is likely to increase in periods when the exchange rate is floating and, consequently, the perceived risks of changes in the value of domestic currency are greater. This implies, of course, that the ability of the monetary authorities to pursue independent monetary policies is severely restricted—even in a world of floating rates. Hence, if the issue of currency substitution turns out to be

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empirically relevant, one of the stronger arguments for floating rates—greater national monetary independence—is seriously weakened.

The relevance of the dollarization problem for Mexico and other Latin American countries is not so much related to fixed versus floating exchange rates—since most countries in the area are not feasible floaters anyway—but to the potential problems of short-run monetary instability that currency substitution can create. If the demand for domestic currency is strongly influenced by "foreign" variables, a substantial degree of instability may be imported from abroad (from volatile interest rates, for example) even if the monetary authorities follow consistent monetary and exchange rate policies.

A fluctuating foreign-domestic composition of bank deposits is likely to be reflected on the asset side of the portfolios of financial institutions and, consequently, on the availability of the credit in domestic currency extended to firms and individuals. Also, in the absence of adequate protection mechanisms, firms may be reluctant to accept foreign currency denominated loans (or may engage in speculative inventory activities if highly leveraged in foreign currency). These effects may be more important if dollarization extends to time and savings deposits, especially in countries, such as Mexico, where the banking system provides most of the external financing to firms.

This paper focuses mainly on the dollarization of demand deposits, since most of the discussion on the effects of currency substitution has been concerned with narrow definitions of money. Section 4.2 contains a historical account of the dollarization process from 1933 to date. In section 4.3 an attempt is made to explain and quantify the main forces determining the behavior of the dollar/peso deposit ratio. Section 4.4 deals with the problem of monetary instability caused by currency substitution, and section 4.5 is a brief summary of the results and conclusions.

4.2 Dollarization: A Historical Perspective

The earliest regulations on exchange rate policy and monetary control in Mexico were implemented during the long (and politically stable) administration of General Porfirio Díaz. The Comisión de Cambios y Moneda (Council on Money and Exchange Rate) was created in 1905 with the intention of administering a fund of "monetary regulation" that would control the flows of gold, foreign exchange, and trade credit resulting from international transactions. The circulation of foreign currency in Mexico was explicitly prohibited by the Comisión; this constitutes one of the first—and last—attempts at establishing any form of exchange controls in Mexico.

The incipient financial system of General Díaz was completely dismantled by the Mexican Revolution of 1910–1917. The breakdown of the system began around 1913 and was reflected in a rapid depreciation of paper money, extreme inflation and falsification of bank notes, defaults in payments by the government and other debtors, and a general dislocation of economic activity.

In 1916, monetary circulation consisted of gold and silver coins and twenty-one types of paper money issued by different institutions and revolutionary factions; these notes were mostly inconvertible into metallic coins and were heavily discounted with respect to gold and silver. In an effort to unify fiduciary circulation, the Carranza government authorized the issue of 500 million pesos of "unforgeable" bank notes with a 20 percent gold guarantee in April 1916. However, these notes were not well received by the public, and by November they had depreciated to less than 1 percent of their face value in terms of gold. The following year, the "unforgeable" was finally demonetized and became "inconvertible;" as a result of this experience and other previous unsuccessful efforts, from 1917 to 1932 the Mexican monetary system consisted almost exclusively of gold and siver coins. Evidence also exists that during that period a substantial amount of foreign currency (mostly U.S. gold and silver coins) circulated alongside Mexican currency.[1]

The most important step toward the reorganization of the financial system after the Revolution, was the creation of Banco de México in 1925. Although the official charter granted the bank monopoly over the issuance of paper money, it was not until the early thirties that the *billetes* of Banco de México began to circulate effectively. The original idea was to establish a central bank in the British tradition; however, Banco de México began operating as an ordinary commercial bank, lending and receiving deposits directly from the public.

Although a gold standard was formally adopted with the creation of Banco de México, the importance of the country as a silver producer determined the existence of a de facto bimetallic standard.[2] The newly created central bank attempted to stabilize the price of silver with respect to gold to avoid excessive fluctuations of the real money stock. The price of this metal remained stable during 1925 and 1926, but dipped about 10 percent in 1927 in response to the slowdown of the economic activity in the United States. Banco de México stopped minting silver coins during that year, and the price of silver made some gains in 1928. However, the crash of 1929 and the Great Depression that followed had a very strong impact on the price of the metal; from 1929 to 1932 the price of silver declined by more than 50 percent (see table 4.1).

1. Martínez-Ostos (1946) and Cavazos (1976) provide an interesting discussion of monetary events of the epoch.

2. Martínez-Ostos (1946). Although only gold coins had legal tender, both gold and silver coins circulated widely. Fluctuations in the price of silver with respect to gold were reflected in the discount of silver pesos with respect to gold pesos.

Table 4.1 **Economic and Financial Indicators, 1925–1932**

Average (year)	GDP	GDP Deflator	Money Supply	Intl. Reserves Banco de México (million dollars)	Price of Silver (dollars per troy ounce)	Exchange Rate (peso/dollar)
	(nominal growth rates)					
1926–1928	−1.3	−2.0	10.8	17.9	.59	2.09
1929	−3.1	0.8	4.5	25.0	.52	2.15
1930	−4.0	2.4	4.3	13.6	.38	2.26
1931	−9.6	−12.5	−60.2	9.7	.27	2.65
1932	−24.0	−10.7	31.1	31.2	.34	3.16

Source: Medio Siglo de Estadísticas Económicas Seleccionadas. Subdirección de Investigación Económica y Financiera, Banco de México, S.A., in Fernández-Hurtado (1976).

The decline in the price of silver had a clear contractionary effect on the money supply (measured in terms of gold) since an important proportion of the money stock consisted of silver coins. In 1929 this decline was compensated with an increase of Banco de México's international reserves; however, in 1930 and 1931 the trade surplus was more than offset with a capital (gold) outflow, and the central bank's reserves actually declined. The combination of these price and reserve movements, compounded with the decision of the monetary authorities to stop minting silver coins to avoid a further erosion of the price of silver (derived from the Ley Calles of 1931), resulted in a drastic reduction of the money stock in 1931.[3]

The contraction of the money stock in 1931 apparently had a severe deflationary effect on economic activity. Prices fell by more than 10 percent per year in 1931 and 1932, while real output dropped nearly 15 percent in 1932, the greatest decline registered in Mexican economic history in a single year.

While it remains true that the deflationary spirit of the 1931 legislation was responsible at least for part of the decline of the money stock, it is not clear that effective countercyclical measures could have been taken by Banco de México even if the government had deliberately embarked on an expansionary monetary policy. Given the public's reluctance to accept bank notes as part of their money holdings, the only means available to the monetary authorities for expanding the quantity of money in circulation was the minting of silver coins. However, an increase in the supply of silver relative to gold would have put additional downward pressure on the gold price of the newly minted coints, frustrating, at least partially, the efforts to increase the (gold) money supply.

The deflationary policy was abandoned in 1932 when a new legislation changing the statutory provisions governing the activities of Banco de México was enacted. The new law strengthened Banco de México's control over the issuance of bank notes, limited the amount of transactions that the bank could undertake with the public and subjected monetary reserves to direct control by the central bank. Also, the law required all commercial banks to associate with Banco de México, purchasing stock and maintaining reserve deposits there. The minting of silver coins was then resumed, the exchange rate was allowed to float, and the first successful issues of bank notes were made. The scarcity of means of payment was so acute in that year that a national campaign promoting the

3. In view of the substantial loss of metallic reserves and foreign currency that occurred in the late 1920s, the Ley Calles of 1931 suspended convertibility of silver coins and retired gold out of circulation; gold was to be used exclusively for international transactions. The minting of silver coins was also stopped in an effort to prevent a decline of the silver peso exchange rate.

Table 4.2 Composition of the (Narrowly Defined) Money Supply (in percentages)

Average (years)	Coins	Bank Notes	Checking Deposits
1925–1931	73.99	0.3	25.73
1932–1940	34.41	29.02	36.58
1941–1950	9.69	43.82	46.51
1951–1960	4.16	45.34	50.48
1961–1970	3.05	39.65	57.29
1971–1975	3.26	39.44	57.30

Source: Banco de México, S.A.

acceptance of the central bank's notes was endorsed by trade unions, chambers of commerce, and various local associations.[4]

As a result of the new silver mintings and note issues, and the favorable impact on the trade balance of the peso's downward float, the money supply increased 31 percent in 1932 and 15.4 percent in 1933. Also the proportion of bank notes to the money supply increased from 0.4 percent in 1931 to 10.5 percent in 1932 and 16.5 percent in 1933. (The structure of the domestic money supply has evolved, as shown in table 4.2.) In November 1933, Banco de México fixed the exchange rate for the first time at 3.60 pesos per dollar, this rate would prevail until 1938.

Figure 4.1 shows the ratios of foreign to domestic currency demand deposits and total deposits held by households and firms in Mexican private financial institutions from 1933 to 1979.[5]

During the first fixed exchange rate period (from November 1933 until March 1938) the demand deposits ratio fell consistently; by the end of 1937 less than 6 percent of checking deposits were denominated in foreign currency. The years 1933–1936 were relatively stable and prosperous. GDP grew at an average real rate of 8.3 percent, prices increased by less than 5 percent on the average, and a continued trade surplus—sustained by a hefty increase in the price of silver from 1933 to 1935—resulted in a net increase of Banco de México's international reserves of nearly 60 million dollars.

The ambitious social and economic development program launched by President Cárdenas in the mid-1930s required greater financial flexibility

4. See Cavazos (1976) and Carrillo-Flores (1976).

5. Consistent figures on total dollar deposits were obtained only after 1938. The institutional distinction between private and official banking institutions in Mexico is important for the purposes of this paper. Official banking institutions (such as Nacional Financiera) have traditionally handled external foreign currency denominated borrowing by Mexican public sector agencies, and their holdings of foreign currency liabilities reflect this borrowing pattern. It is therefore more convenient to consider exclusively the liabilities of private financial institutions (which held an average of 88 percent of total liabilities to the public from 1960 to 1980).

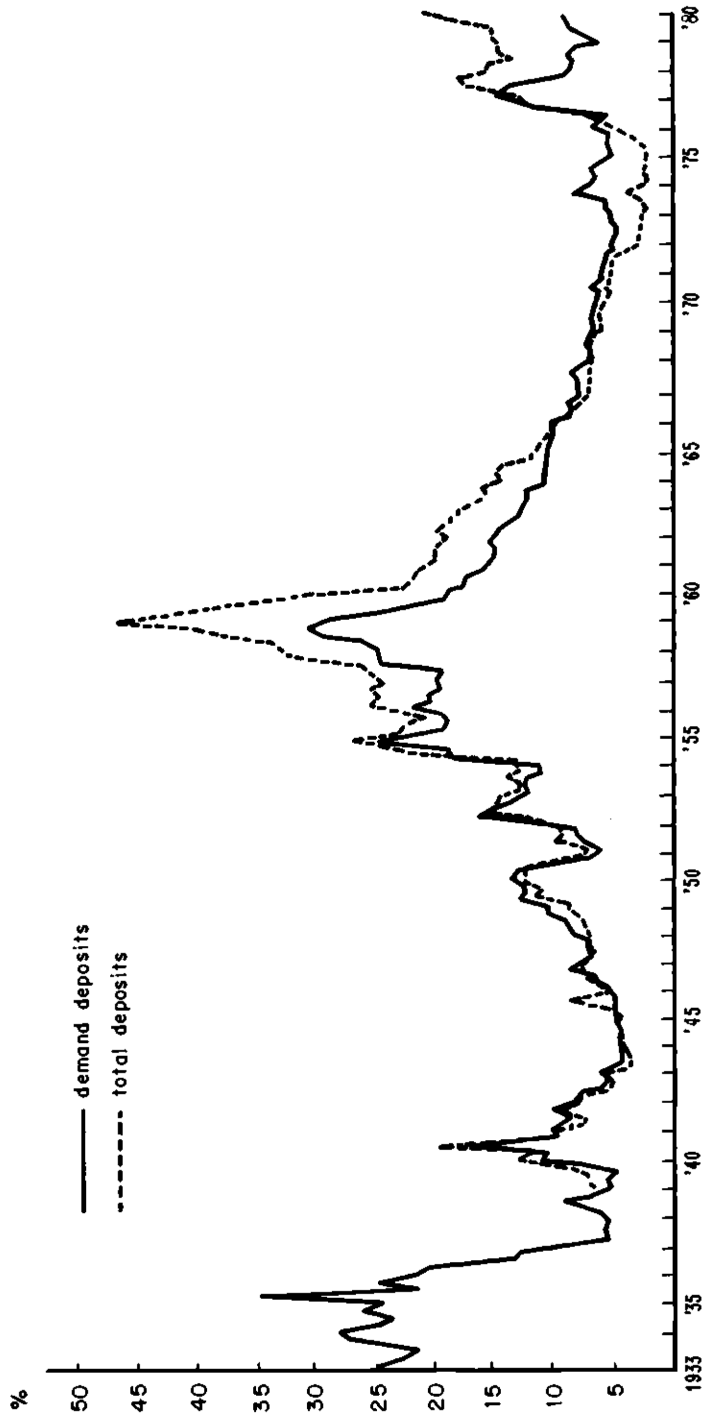

Fig. 4.1 Dollar/peso deposit ratios in the Mexican banking system (1933–1980).

from Banco de México. In 1936, the statutory law of the bank was revised one more time, further strengthening its position as a central bank. Two important innovations were introduced then: first, the flexible reserve requirement system that would serve as the instrument for the selective credit control policies followed later; and, second, the authorization granted to Banco de México to issue fixed-yield securities on behalf of the federal government. Taking advantage of expanded financial facilities, the government deficit increased substantially in 1936 and 1937.

Although the upsurge in government expenditures had only a moderate impact on the trade surplus, the U.S. recession and the capital outflow caused by the populist policies followed by the Mexican government resulted in a strong decline of international reserves in 1937. It was in this climate of international recession and domestic troubles in the balance of payments that President Cárdenas signed the decree of nationalization of the oil industry on March 18, 1938. That same day Banco de México withdrew from the foreign exchange market and the peso was allowed to float again.[6] The year 1938 turned out to be extremely difficult for Mexico; foreign retaliation in response to the oil takeover was felt immediately (for example, oil exports declined 60 percent from 1937 to 1938), aggravating the already depressed economic situation. GDP increased only 1.6 percent in real terms during that year.

The peso floated for thirty-one months. After two failed attempts at fixing the exchange rate, in October 1940 Banco de México announced a new parity: 4.85 pesos to a dollar. The depreciation of the peso with respect to its previous fixed value (in 1938) amounted to 34 percent. It is apparent from figure 4.1 that a new process of dollarization began with the floating of the peso; the dollar/peso deposit ratio reached its highest point in September 1940 and declined substantially following the establishment of a fixed, peso-dollar exchange rate.

The outbreak of World War II provided Mexico some relief from international pressures. Foreign demand for Mexican goods and services stimulated economic activity (GDP increased at an average rate of 6.07 percent from 1941 to 1945), and a consistent trade surplus was registered throughout the war years, reinforced by important inflows of capital seeking refuge from war-ravaged Europe; Banco de México's reserves increased by more than 250 million dollars from 1941 to 1945. Again, the dollarization coefficients showed an initial decline, stabilizing around a value of 5 percent in 1944 and 1945.

6. The possibility of implementing exchange controls at the time of the expropriation was apparently given serious consideration. However, President Cárdenas himself, in his 1938 State of the Union address, declared that "exchange controls can only function in highly disciplined countries where customs regulations are well organized and borders can be effectively patrolled; exchange controls (in Mexico) would surely be overridden by a black market" (Cavazos 1976, p. 83).

The fast pace of economic activity sustained during the war years was also accompanied by a relatively high rate of inflation. The wholesale price index increased 60.4 percent more in Mexico than in the United States from 1941 to 1945; by the end of the war the peso was probably overvalued. The following years, in 1946 and 1947, the largest historical trade balance deficits were recorded, probably as a result of deferred consumption during the war, and Banco de México lost practically all the reserves accumulated during the war years. In view of the continued loss of reserves, the monetary authorities decided to float the peso in July 1948. This new experiment with a floating exchange rate lasted only eleven months; in June 1949, the exchange rate was fixed at 8.65 pesos per dollar (a devaluation of 76 percent). The dollarization coefficient increased from 7.5 percent to 11.5 percent during the float, and there is also evidence that substantial capital outflows occurred during these months.

The 8.65 parity lasted from 1949 to 1954. Once more, the Korean War stimulated export growth in 1950 and 1951; the favorable trade balance of 1950 was reinforced with new capital inflows (mostly returning capital now that the float was over), and international reserves more than doubled. In contrast, the economic activity was negatively affected in 1952 and 1953 by the new U.S. recession, causing a rapid deterioration of the trade balance. In April 1954 the peso was devalued approximately 45 percent. This time the monetary authorities did not experiment with a floating period, and the new parity was announced outright to the surprise of many. This devaluation had a very strong psychological impact on the public. In only two months following the announcement, capital outflows reduced the central bank's reserves to one-half of their April level, and the dollarization ratios jumped dramatically.[7]

The exchange rate was maintained at 12.5 pesos to a dollar from April 1954 until September 1976. This period, the longest recorded with a fixed exchange rate, includes two distinct subperiods. The first, known in the literature as "stabilizing development" began after the adjustments to the 1954 devaluation had been completed and lasted until the early 1970s. A rapid rate of economic growth and low rates of inflation (averaging 6.5 and 2.95 percent from 1956 to 1971) were sustained through the combination of favorable international economic conditions and consistent domestic monetary and fiscal policies. Foreign borrowing was used to finance the persistent, but mostly moderate, trade deficits, preventing a direct impact from the short-run behavior of international reserves on the exchange rate as was experienced in the past.[8]

7. The dollar/peso demand deposit ratio increased from 11.5 to 25 percent from March to December; the total deposit ratio increased by a similar proportion. See figure 4.1.

8. This period of Mexican economic and financial development has been thoroughly surveyed in recent literature. See, for example, Nassef (1972) and Solís (1981).

The stable period ended with the upsurge of world inflation in 1973 and the government's decision to spare Mexico from the parallel effects of international recession by means of higher government expenditures. Although a liberal use of foreign credits was utilized for this purpose (the foreign long-term public debt jumped from 4 to 16 billion dollars from 1972 to 1976), the average growth rate of GDP in 1972–1976 (5.4 percent) was lower than in the stable period, while the inflation rate turned out to be significantly higher (14.76).[9]

The dollarization ratios, which increased substantially after the 1954 devaluation and then stabilized around a 20–25 percent level in 1955 and 1956, began to climb again in the second quarter of 1957 and reached an all time high at the end of 1958: the dollar/peso demand deposit ratio exceeded 30 percent, while the total deposit dollar/peso ratio went over 46 percent. Both ratios commenced a steady decline again in 1959 that continued through the 1960s and the first half of the 1970s; in the fourth quarter of 1975, the value of the checking deposits ratio was only 6.2 percent, and the total deposit ratio was even lower.

The 1957–1958 dollarization was motivated both for economic and political reasons. First, the downturn of economic activity in industrialized countries during those years put strong pressure on the balance of payments. The trade deficit almost trebled in 1957 (with respect to 1954) and continued at very high levels in 1958; in that year, the reserves of Banco de México declined almost 20 percent. Second, 1958 was the last year of President Ruiz-Cortinez's administration, and the private sector felt queasy about the seemingly leftist overtones of Mr. López-Mateos's rhetoric (the official presidential candidate). However, in 1959 the trade balance improved and the private sector was temporarily appeased, ending the speculative burst against the peso.

On August 31, 1976, the monetary authorities decided to float the peso once more and "let the market determine its equilibrium level" instead of devaluing outright as in 1954. The exchange rate rose quickly, reaching levels of around 20–21 pesos to a dollar; two weeks later a temporary rate was tried (19.5–19.7 pesos/dollar), but it had to be abandoned after five weeks because of strong speculative activity. Since then, the peso has been formally on a float, although the exchange rate has fluctuated within very narrow margins since the second quarter of 1977. The magnitude of the depreciation (about 45.50 percent in terms of dollars) was probably greater than what was generally anticipated and, not surprisingly, had a profound impact on economic activity.[10]

9. For a more detailed account of events that led to the 1976 devaluation, see Ortiz and Solís (1979).

10. For instance, the three-month forward rate for the Mexican peso quoted in the Chicago Mercantile Exchange Market in June 1976 was about 13 pesos, implying a premium of only 4 percent. For a discussion on the effects of the devaluation, see Córdoba and Ortiz (1979).

Table 4.3 Dollarization Coefficients, 1976–1980

Ratios	1976 (I–III)	1976 (IV)	1977	1978	1979	1980
Checking deposits (dollars/pesos)	6.6	12.5	13.3	8.7	8.7	11.2
Total deposits (dollars/pesos)	6.5	11.8	16.4	14.5	17.0	18.7

Source: Banco de México, S.A.

The behavior of the dollarization coefficients after the 1976 devaluation has been different from that observed in the previous periods with floating exchange rates. While the checking deposit peso/dollar ratio declined after the third quarter of 1977, the total deposit ratio has remained at substantially higher levels (see table 4.3). The explanation seems to be the liberalization of the Mex-dollar deposit rate in 1977.

Although private financial institutions were traditionally authorized to receive deposits denominated in foreign currencies from the public, the interest rate payable in these types of deposits was regulated by Banco de México and moved at infrequent intervals. In the more volatile world of the 1970s, the authorities attempted to keep the Mex-dollar deposit rate more in line with those prevailing abroad for similar types of deposits; however, large and persistent differentials between Mex-dollar and international rates often developed. Finally, in view of the large capital outflows that occurred after the peso was allowed to float, the monetary authorities decided to peg the Mex-dollar deposit rates for different maturities to the corresponding Eurodollar rates (March 1977). This measure had the effect of slowing considerably the outflow of capital since Mex-dollar deposits became perfect substitutes, except for political risk factors, for dollar deposits held abroad.[11]

4.3 Fixed versus Flexible Exchange Rates and Devaluation Expectations: Effects on the Dollarization of Demand Deposits

The literature on currency substitution outlined in section 4.2 has pointed out that, in the context of the existing international environment, domestic residents have strong incentives to diversify the composition of their currency holdings.[12] The same motives that exist for holding domestic money apply to the demand for foreign currency. Individuals and firms engaged in international exchange have similar transaction and portfolio incentives for holding foreign currencies as they do for maintaining

11. The implication of this measure for domestic monetary policy has been explored recently by Ortiz and Solís (1982).

12. Miles (1978) and Alexander (1980).

domestic money balances. It is clear, for example, that people who travel abroad for business or pleasure, residents of border areas, and importers or exporters have incentives to hold foreign currency balances. Also, large firms with liabilities denominated in foreign currencies will probably want to diversify their financial portfolios, particularly their holdings of liquid assets.

The case of border transactions is particularly important in the Mexican case. Given the length of the Mexican-U.S. border and its economic importance, it can almost be considered a different currency area from the rest of the country. Prices are usually quoted in dollars and payments are mostly made in dollars; pesos, although accepted as a means of payment on both sides of the border, are in less demand. The structure of financial intermediation clearly reflects this pattern of transactions. The average checking deposit dollar/peso ratio in the six more important border cities from 1977 to 1980 was 51 percent, compared with a national average of 12 percent.

Among the diverse reasons for holding foreign currency balances, the currency substitution hypothesis emphasizes the importance of foreign exchange risk effects. According to this hypothesis, the perceived risk of holding exclusively domestic currency increases when the exchange rate is floating. Consequently, there is a greater incentive to diversify the portfolio of liquid money assets under floating rates than when the exchange rate is fixed, and one would expect the dollarization of demand and time deposits to behave accordingly.[13] Table 4.4 summarizes the behavior of the demand deposit ratio during periods of fixed and floating exchange rates.

The figures presented in table 4.4 seem to indicate precisely the opposite behavior of the dollarization coefficient: the dollar/peso demand deposit ratio has been lower and more stable, on the average, during the periods when the exchange rate has been floating. This is true even if the first fixed exchange rate period (highly dollarized and unstable, 1933–

13. It is not obvious why greater variability of the exchange rate should increase the degree of risk of domestic currency holdings, since it could just as easily be interpreted as increasing the risk of holding foreign currency. However, a number of arguments have been advanced in favor of interpreting the variability of exchange rates as an incentive to diversify currency holdings. Akhtar and Putnam (1980) argue that domestic currency provides less information concerning international transactions when the exchange rate is floating and may not serve as an optimal store of value for a given level of transactions, creating incentives for diversification. Also, if fluctuations of the exchange rate between third currencies are uncorrelated with movements of the domestic/foreign currency exchange rate, some portfolio holders will find incentives to diversify, reducing the share of domestic currency in their portfolios. Miles and Stewart (1980) also investigate the effects of exchange rate risk (measured again by the variability of the exchange rate) using a "production function of money services." Both papers find a statistically significant negative effect of movements in the deutsche mark/dollar exchange rate, both in the demand for dollars and in the demand for marks.

Table 4.4 **Demand Deposit Dollar/Peso Ratio (percentages)**

Period	Exchange Rate Regime	Mean		Standard Deviation	
1933(I)–1937(IV)	fixed	20.6		8.4	
1938(I)–1940(IV)	floating	9.1		4.2	
1941(I)–1948(I)	fixed	6.4		1.9	
1948(II)–1949(II)	floating	10.5		1.8	
1949(III)–1954(I)	fixed	11.4		2.9	
1954(II)–1976(II)	fixed	12.9		6.8	
1976(III)–1980(IV)	floating	10.7		2.4	
Average	fixed[a]	12.5	11.3[b]	5.63	5.22[b]
Average	floating[a]	10.0		3.1	

Source: Banco de México, S.A.

[a]Weighted by relative length of the period.

[b]Excluding the 1933(I)–1937(IV) period.

1937) is not taken into account. It should be kept in mind, however, that the floating exchange rate periods have been relatively short (about thirty quarters from 1933 to 1980), and also that Banco de México has intervened constantly in the foreign exchange market when the peso has been "floating." Hence, the fixed/floating exchange rate distinction does not seem to shed much light on the dollarization process.

Going back to figure 4.1, it can be observed that the largest jumps of the dollarization ratio (after 1937) occurred in 1940, 1952, 1954, 1957–1958, and 1976; of these dates, 1940, 1952, 1958, and 1976 correspond to the last year of the incumbent administrations, while a devaluation also occurred in 1954 and in 1976. It seems, then, that both political variables and devaluation expectations must play a crucial role in explaining the historical record of Mexican dollarization; this proposition deserves a closer examination.

Consider the following simple money demand formulations:

$$\frac{M^d}{P} = L^d(\pi^d, \pi^f, r, \theta, \xi, w), \tag{1}$$

$$\frac{M^f}{P} = L^f(\pi^d, \pi^f, r, \theta, \xi, w), \tag{2}$$

where M^d/P and M^f/P are real domestic and foreign desired money balances; π^d, π^f, and r are the real returns on domestic currency, foreign currency, and an alternative asset; θ is a measure of foreign exchange risk; ξ is a proxy for political risk factors, and w is real wealth. Assuming that (1) and (2) can be expressed as exponential functions, and writing the relative returns in differential form, the money demand functions can be written:

$$\text{(3)} \quad \frac{M^d}{P} = \underset{+}{\alpha_0}(w) \exp\,[\underset{+}{\alpha_1}(\pi^d - \pi^f) + \underset{+}{\alpha_2}(\pi^d - r) + \underset{-}{\alpha_3}\theta + \underset{-}{\alpha_4}\xi],$$

$$\text{(4)} \quad \frac{M^f}{P} = \underset{+}{\beta_0}(w) \exp\,[\underset{+}{\beta_1}(\pi^f - \pi^d) + \underset{+}{\beta_2}(\pi^f - r) + \underset{+}{\beta_3}\theta + \underset{+}{\beta_4}\xi],$$

where the signs under the coefficients indicate partial derivatives. Subtracting (3) from (4), taking logarithms and rearranging terms, the following equation is obtained:

$$\text{(5)} \quad \ln\left(\frac{M^f}{M^d}\right) = \ln\left(\frac{\alpha_0(w)}{\beta_0(w)}\right) + \alpha_1(\pi^d - \pi^f) - \beta_1(\pi^f - \pi^d) - \beta_2(\pi^f - r) + (\alpha_3 - \beta_3)\theta + (\alpha_4 - \beta_4)\xi.$$

Imposing the following symmetry condition to equation (5): $\alpha_i = \beta_i$ for $i = 0, 1, \ldots 4$, and adding a random term u_t, the following expression is obtained:

$$\text{(6)} \quad \ln\left(\frac{M^f}{M^d}\right) = a_1(\pi^f - \pi^d) + a_2\theta + a_3\xi + u_t,$$

where $a_1 = (2\alpha_1 + \alpha_2)$, $a_2 = 2\alpha_1$, and $a_3 = 2\alpha_4$.[14] Equation (6) was incorporated in a partial adjustment model to obtain a final estimating equation,

$$\text{(7)} \quad \ln\left(\frac{M^f}{M^d}\right) = b_1(\pi^f - \pi^d) + b_2\theta + b_3\xi + b_4 \ln\left(\frac{M^f}{M^d}\right)_{t-1} + \epsilon_t,$$

where $b_1 = \lambda a_1$, $b_2 = \lambda a_2$, $b_3 = \lambda a_3$, $b_4 = (1 - \lambda)$, and $\epsilon_t = \lambda u_t$.

M^d and M^f are peso and dollar demand deposits held by the public in Mexican private financial institutions.[15] For a Mexican resident, the real return of the holdings of domestic currency, π^d, can be approximated by the rate of inflation. The real return on foreign money is simply $\pi^f = \pi^d$ plus the expected percentage rise in the peso price of dollars. Hence, the differential $(\pi^f - \pi^d)$ is just the expected depreciation of the exchange rate. Since a futures market for Mexican pesos did not exist during most of the period under consideration, an obvious proxy for the expected rate

14. The restrictions imposed on equation (5) prevent the identification of the substitution coefficients α_1 and α_2 in equation (6). However, this is not important for the purpose of this exercise. Note also that $\beta_3, \beta_4 < 0$.

15. Since no data on dollar currency circulation in Mexico are available, only demand deposits were included in the definition of M^d.

of devaluation of the exchange rate is the difference between the official and the real exchange rate.

As mentioned above, previous studies have used some measure of variability of the exchange rate as a proxy for foreign exchange risk. However, given the length of the period in which the exchange rate was fixed, the deviations of the real exchange rate from the trend rate were used here as a measure of foreign exchange risk. Finally, a dummy variable was included in the years when administration changes occurred to take into account the "political risk" factor mentioned earlier. Equation (7) was estimated using quarterly data from 1933(I) to 1980(IV), and the results are shown in equation (8). ED stands for the expected devaluation proxy, ER for the foreign exchange risk measure, and PRD for the political risk dummy.[16] After some experimentation, a simple two-period lag structure for the independent variables was found to perform adequately.

$$(8) \quad \left(\frac{M^f}{M^d}\right) = \underset{(1.70)}{0.059\,\mathrm{ED}_{t-1}} + \underset{(1.83)}{0.053\,\mathrm{ED}_{t-2}} + \underset{(2.23)}{0.066\,\mathrm{ER}_{t-1}}$$

$$+ \underset{(1.32)}{0.045\,\mathrm{ER}_{t-2}} + \underset{(2.75)}{0.079\,\mathrm{PRD}} + \underset{(17.3)}{0.932}\left(\frac{M^f}{M^d}\right)_{t-1};$$

$$R^2 = 0.907,\ \mathrm{DW} = 2.20,\ \mathrm{SE} = 0.157.$$

Figures in parenthesis correspond to t-statistics.

The regression results are satisfactory in spite of the somewhat crude measures of differential returns and of the risk of exchange rate variations. All the coefficients estimated have the correct sign and are significantly different from zero at the 5 percent level of confidence, except for the second lagged term of the risk variable which is insignificant. It should also be kept in mind that only part of the monetary aggregates (namely demand deposits) were included in M^f and M^d, and consequently, the variations of the currency/deposit ratio that affect the dollarization coefficient were not taken into account.

The difficulties of obtaining good measures of devaluation expectations for such a long period of time in the absence of a forward market are quite obvious. However, the effects of the devaluations of 1954 and 1976, as well as the impact of the devaluation expectations prevailing in 1976, on the dollarization of demand deposits can also be studied using intervention analysis directly from the time series.

Intervention analysis is a statistical method developed by Box and Tiao (1975) for the purpose of detecting and quantifying the effect of an

16. ER was generated from the residuals of a regression between the real exchange rate and a trend variable.

exogenous event on the behavior of time series.[17] However, this procedure requires the series to be stationary (that is, to have constant mean and variance), so the original dollar/peso demand deposit ratio could not be studied directly. The analysis was performed on the growth rate of the original series, and the results show that the growth rate of the dollarization ratio increased 45.6 percent in the second quarter of 1954, returning immediately (the following quarter) to its original level. The 1976 devaluation's effect on the growth of the dollarization coefficient was also concentrated in one quarter: the fourth of 1976, when the ratio jumped 63 percent.

4.4 Effects of Dollarization

The monetary and real effects of dollarization on economic activity will obviously depend on the degree to which domestic currency is being displaced by dollars. If the substitution process goes to the extreme of eliminating or substantially reducing the circulation of domestic coins and currency, the monetary habitat of the country will be changed. This implies, of course, handing to the United States (or the country issuing the substitute currency) the seigniorage of money creation and seriously eroding the base of the inflation tax.[18] Even in less drastic situations, it has been pointed out in the currency substitution literature that substantial monetary instability might arise as a result of diversified currency holdings by domestic residents. The relevance of this substitution problem for monetary policy can only be evaluated empirically, and the evidence to date is scarce.[19]

One method of estimating the potential monetary instability problems of currency substitution is to simply examine the properties of alternative definitions of monetary aggregates. If dollar deposits are effectively regarded by the public as money, they should be included as part of the money stock for policy making purposes. Alternatively, if the currency substitution problem is important, domestic money demand estimations that fail to account for the foreign currency component should be unstable. To explore the relevance of this question for the case of Mexico, a

17. See Appendix A for details.

18. See the chapter by Stanley Fischer in this volume (chapter 3).

19. Miles (1978) used Canadian data to estimate a "production function of monetary services" obtaining direct measures of elasticities of substitution between U.S. and Canadian dollars. He finds that both currencies are close portfolios substitutes, especially during period of floating rates. Also utilizing Canadian data, Alexander (1980) included several "foreign influence" variables on the demand for money (such as expected returns on foreign currency holdings and exchange rate risk), obtaining low elasticities of substitution. In contrast to Miles, this author concludes that the currency substitution phenomenon has not posed important problems for the achievement of monetary policy objectives in Canada.

conventional money demand equation based on a partial adjustment model was estimated using quarterly data from 1960 to 1979, using two definitions of the monetary aggregate: M^j = currency (pesos) + peso demand deposits, and M^k = currency (pesos) + peso demand deposits + dollar demand deposits. The estimated equation was:

$$(9) \qquad \ln\left(\frac{M^{j,k}}{P}\right) = \alpha_0 + \alpha_1 \ln Y_t^c + \alpha_2 \mathrm{RL}_t + \alpha_3 \mathrm{FR}_t + \alpha_4 \mathrm{IR} + \alpha_5 \ln\left(\frac{M^{j,k}}{P}\right)_{t-1} + d_1 + d_2 + d_3 + \epsilon_t .$$

where $(M^{j,k}/P)$ is the real monetary aggregate; Y_t^c is current real income; RL_t is the interest rate payable on short-term Mexican peso deposits; FR_t is the three-month Eurodollar deposit rate; IR is the expected rate of inflation; d_1, d_2, and d_3 are dummies included to correct for seasonal variations, and ϵ_t is a random error term.[20] Since the monetary authorities in Mexico fix the normal deposit rate, this variable does not always capture expected inflation. This is why both variables are included in equation (9).

Estimates of equation (9) from 1960 to 1979 are reported in table 4.5. The regression results for both definitions of money are very similar; perhaps the most striking difference is the income elasticity term which turns out to be not significantly different from zero for the M^k aggregate. Note also that the foreign interest rate coefficient is not significantly different from zero for either equation. Static and dynamic simulations were performed to examine the question of stability. Equation (9) was estimated from 1960 to 1972, and simulated from 1973 to 1979; a summary of the simulation results is included in table 4.6.

The simulation results are very similar for both aggregates and only slightly better for M^k. The truly remarkable outcome of the simulations is the smallness of the errors both in the static and in the dynamic exercises. The largest dynamic errors obtained correspond to the last observations of 1979 and represent less than 2 percent of the dependent variable. The magnitude of average errors for the postdevaluation period, 1976(IV)–1977(IV), is less than 0.5 percent for both equations. On the basis of this performance, the demand for domestic currency appears to be highly stable, and either definition M^j or M^k seems appropriate for purposes of policy making.

20. The estimation of equation (9) was taken from Ortiz (1982). The expected rate of inflation was calculated simply as a weighted average of current and lagged values. Several measures of expected inflation (including instrumental variables and a Box-Jenkins generated series consistent with the rational expectations approach) were tried in Ortiz (1982), but the results did not differ substantially from those reported here. See Appendix B for data sources.

Table 4.5 Regression Results of Equation (9), 1960–1979

Dependent Variables	$\ln Y_t^c$	RL_t	IR	FR_t	$\ln(M^{j,k}/P)_{t-1}$	R^2	Durbin-h	ρ	SE
M^j	.100	−.122	−.034	.010	.937	.9952	1.59	−.50	.0262
	(1.69)	(−3.34)	(−5.65)	(.94)	(15.69)				
M^k	.045	−.118	−.051	.004	.968	.9952	1.53	−.59	.0253
	(.81)	(−3.60)	(−5.84)	(.46)	(16.80)				

Note: Figures in parentheses correspond to t-statistics. The Cochrane-Orcutt procedure is used to correct for first order serial correlation. The estimated coefficients of constants and dummies are not reported for convenience.

Table 4.6 **Simulation Results (1973[I]–1979[IV])**

Simulations	Root-Mean-Square Percent Error	Mean Percent Error	Theil's Inequality Coefficient
Static:			
M^j	.4508	.2263	.00227
M^k	.4210	.2030	.00230
Dynamic:			
M^j	.5201	.4017	.00261
M^k	.5144	.4072	.00259

4.5 Concluding Remarks

The discussion of the previous sections suggests that the difficulties associated with the presence of currency substitution have not been empirically significant for Mexico. The dollarization of demand deposits has not been more pronounced during periods of floating exchange rates and, apparently, no instability has been introduced in the demand for domestic currency by the fact that both pesos and dollars are held by the public in the form of monetary assets. This conclusion is reinforced by the good performance of the money demand simulations in the difficult months following the 1976 devaluation.

The behavior of the dollar/peso demand deposit ratio has been influenced by economic as well as political considerations; among the former, devaluation expectations seem to be the most important factor. An interesting observation is that the last two devaluations seem to have fostered exchange rate risk expectations, at least temporarily, instead of appeasing them.

Although the empirical analysis was restricted to the behavior of demand deposits, the dollarization of time deposits has followed closely the movements of the dollar/peso demand deposit ratio until recent times. It was mentioned that the liberalization of Mex-dollar deposit rates had the effect of making Mex-dollar deposits near perfect substitutes for dollar deposits held abroad, and this explains the relative increase of the dollarization of time deposits. However, this need not concern the monetary authorities. Now that the Mexican banking system offers a competitive menu of foreign currency denominated financial assets, domestic investors will find little incentive to maintain deposits abroad, and consequently, short-run speculative capital flows should be reduced.[21] To the extent that the dollarization consists of locally produced

21. A recent theoretical paper by Alain Ize (1981) lends support to this view. Ize also concludes that the existence of Mex-dollar deposits has resulted in a more efficient allocation of financial resources.

dollars, the negative effects on economic activity can probably be minimized with appropriate exchange rate insurance mechanisms on the credit side.

4.6 An Addendum

On 18 August 1982 (almost a year and a half after the first draft of this paper was completed), the monetary authorities decreed that mexdollar deposits could no longer be transferred out of the country. Henceforth, mexdollar deposits would be paid in domestic currency at the rate of 70 pesos to a dollar. A few days later, on 1 September, a system of full exchange controls was imposed in Mexico for the first time in several decades. These decisions marked the end of the mexdollar market.

It is clear that the effectiveness of the mexdollar market to absorb short-term capital flows depended on the public's perception of close substitution between mexdollars and dollars held abroad. Hence, the commitment of the monetary authorities to maintain full convertibility of the peso and unrestricted capital flows was a key element of the public's trust of the system. As the Mexican economy's financial troubles deepened during the first months of 1982 and the public's confidence that the authorities would undertake the necessary macroeconomic adjustments faltered, the mexdollar market ceased functioning as a shock absorber. Large capital outflows occurred, and the authorities decided to cancel the potential threat of a run on mexdollars that could not possibly have been met with the available foreign exchange reserves.

Appendix A: Intervention Analysis

This procedure involves the following steps: First, the series to be analyzed is represented as a stochastic model of the Box-Jenkins (1976) type, such as an ARIMA model. Second, a dynamic intervention function, constructed a priori to represent the type of exogenous event under consideration, is constructed. Third, the iterative Box-Jenkins technique is used again to represent the complete model, including the intervention function. The effect of the exogenous event can then be quantified by the magnitude of the intervention function coefficients.[22]

The exogenous events (or interventions) considered here are: (a) the 1954 devaluation that occurred during the second quarter of 1954; and (b) the devaluation expectations of 1976 and the devaluation itself that occurred in September of that year. The objective, then, is to explore the effects of these events on the demand deposit dollar/peso ratio DDR_t

22. See Box and Tiao (1975).

(taken quarterly from 1939[I] to 1980[IV]). As a first step, the transformation $(1 - B)$ ln (DDR_t), where B is a lag operator, such that $BZ = Z_{t-1}$ for any variable Z, was applied to DDR_t to obtain a stationary series with constant mean and variance. Note that the transformed series

$$(1 - B) \ln (\text{DDR}_t) = \ln \left(\frac{\text{DDR}_t}{\text{DDR}_{t-1}} \right) \simeq \gamma_t ,$$

where γ_t is the growth rate of the dollarization coefficient. A Box-Jenkins type model was estimated for each of the following periods: 1939(I)–1954(I), 1939(I)–1976(I), and 1939(I)–1980(IV); the results are shown in table 4.7.

The θ coefficients in the above models represent moving average parameters and the sequence $\{a_t\}$ is a white noise Gaussian process with mean zero and constant variance σ_a^2. The ω's are parameters of the intevention functions.

$$P_t^i = \begin{cases} 1 \text{ for } t = i \\ 0 \text{ otherwise}, \; i = \text{I}, \text{II}, \end{cases}$$

where P^i is a pulse indicator designed to detect an instantaneous jump of the series at the time when the "interventions" seem to have occurred, namely, I = 1954(II) and II = 1976(II). This particular form of intervention function $\epsilon_{\text{I}} = \omega_0 P_t^{\text{II}}$ (chosen after testing other functional forms) seems appropriate to model the effects of the first depreciation because of the surprising character of the 1954 devaluation. In contrast, devaluation

Table 4.7 **Box-Jenkins Models Estimated for the Period 1939(I)–1980(IV)**

Period	Model	Estimated Parameters and Standard Deviations	$\hat{\sigma}_a$	Q Statistic[a] (h) Degree of Freedom
1939(I)–1954(I)	$(1-B) \ln (\text{DDR}_t) = (1-\theta B^6)a_t$	$\hat{\theta} = 0.246$ (± 0.126)	0.1933	10.70, (23)
1939(I)–1976(I)	$(1-B) \ln (\text{DDR}_t) = \omega_0 P_t^{\text{I}} + (1-\theta B^6)$	$\hat{\omega}_0 = 0.456$ (± 0.139) $\hat{\theta} = 0.201$ (± 0.082)	0.1419	13.17, (22)
1939(I)–1980(IV)	$(1-B) \ln (\text{DDR}_t) = \omega_0 P_t^{\text{I}} + \omega_1 P_t^{\text{II}} B^2 + (1-\theta B^6)$	$\hat{\omega}_0 = 0.456$ (± 0.137) $\hat{\omega}_1 = 0.630$ (± 0.139) $\theta = 0.207$ (± 0.081)	0.1403	14.23, (21)

[a]The Q statistic should be compared with the value of X^2 with (k) degrees of freedom (see Box and Jenkins 1976).

expectations seem to have been widespread in the months prior to the devaluation of 1976; substantial capital outflows were registered in the first half of the year, particularly during the second quarter. A dynamic intervention function designed to pick up the effects of devaluation expectations of 1976(II) was constructed and incorporated into the model; however, preliminary estimation failed to show any significant effects during the second and third quarters.[23] Finally, the model for the whole period was estimated incorporating a simple intervention function $\epsilon_{II}(t) = \omega_1 B^2 P_t^{II}$ to capture the effects of the 1976 devaluation. Figure 4.2 depicts graphically the effects of the estimations presented in table 4.7.

As mentioned in the text, the growth rate of the dollarization ratio increased 45.6 percent in the second quarter of 1954, then returned to its original level. The 1976 devaluation's effect on the series was concentrated in the fourth quarter of that year (increasing 63 percent). Also, the devaluation expectations of the preceding months did not significantly affect the dollarization ratio.

Appendix B: Data Sources

Demand deposits in pesos and dollars are regularly published in the *Informes Anuales* and *Indicadores Económicos* of Banco de México. Data on earlier years (since 1925) will soon be published by the *Oficina de Cuentas Financieras*, Subdirección de Investigación Económica, Banco de México, S.A.

Interest rates on Mexican time deposits have been published regularly only since 1972. However, a statistical appendix in Ortiz (1982) provides a previously unpublished series, weighted by the relative participation of the different financial instruments.

The Mexican consumer price index was utilized to deflate income and monetary variables. Quarterly data on prices before 1968 were constructed by applying seasonal variations observed in the consumer price index to the GDP deflator. Quarterly income data were also obtained by applying seasonal movements of the Mexican index of industrial production to real GDP. These series are also available in the statistical appendix of Ortiz (1982).

23. The intervention function postulated for the 1976 devaluation was of the form:

$$\epsilon_{II}(t) = \left\{\frac{\omega_1 - \omega_2 B - \omega_3 B^2}{1 - \delta B}\right\} P_t^{II},$$

but only $\hat{\omega}_3$ turned out to be significantly different from zero.

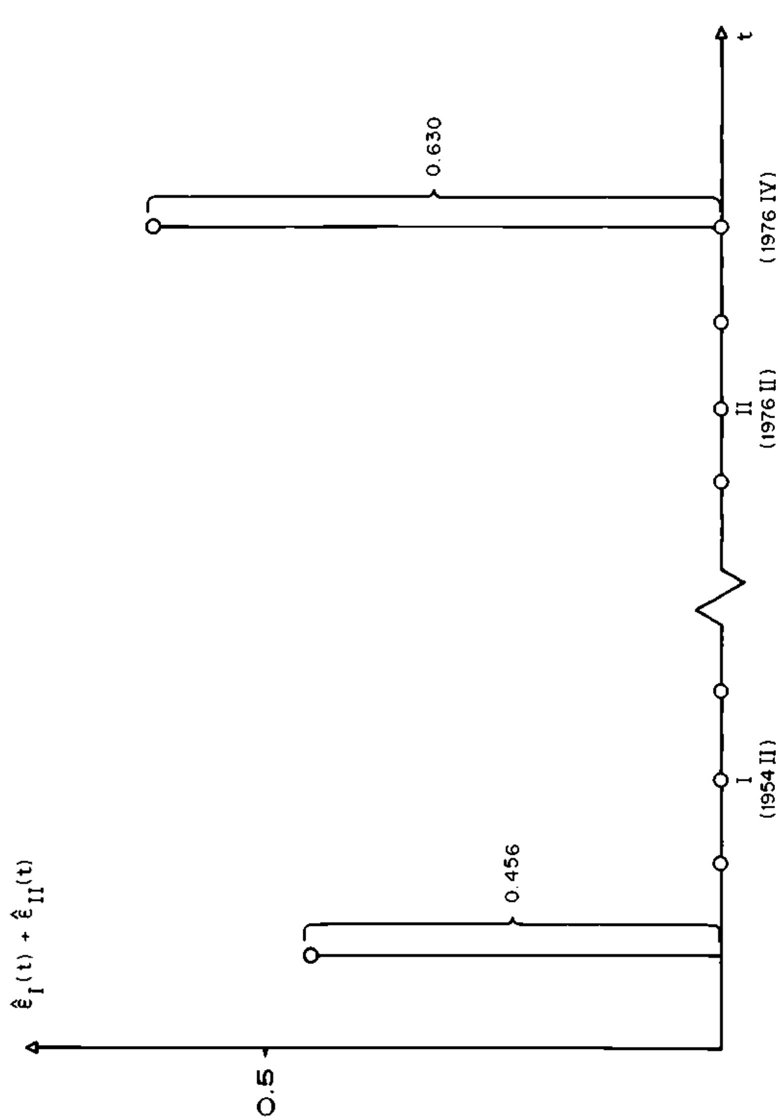

Fig. 4.2 Effects of $\epsilon_I(t) + \epsilon_{II}(t)$.

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Comment

Thomas J. Sargent

The subjects of "dollarization" and seigniorage involve fundamental and still controversial aspects of monetary economics. Views on these subjects stem directly from judgments about the theoretical models appropriate to explain why inconvertible (or "fiat") currencies command value. Currently, a variety of theories about the "demand for money" have adherents. These theories differ in terms of the economic forces that they adduce to assign a currency value, the relevance that they attach to distinctions between "inside" and "outside" money, and whether they give rise to well-defined and stable demand functions for national monies in a world of flexible exchange rates.

Theories of money begin from the observation that there is no role for unbacked fiat currency in the standard general equilibrium model of Arrow and Debreu, with its complete array of frictionless, state contingent futures markets. To provide room for an inconvertible currency, it is necessary to deviate from the Arrow-Debreu assumptions and to posit some source of friction that inhibits at least some of the trades envisaged by Arrow and Debreu. Theories of money differ in the ways that they introduce these frictions and the explicitness with which the theorizing is done.

One popular way of motivating a demand for money in a general equilibrium model is to resort to Sidrauski's (1967) device of adding real balances to the instantaneous utility function of a model that is otherwise isomorphic to a version of a Cass-Koopmans optimum growth model. The representative individuals in such a model are posited to maximize a criterion such as

$$(1) \qquad \sum_{0}^{\infty} u\left(c_t, \frac{m_t}{p_t}\right) e^{-\delta t}, \; u_1 > 0, \; u_2 > 0,$$

where $\delta > 0$ is an instantaneous rate of time preference, c_t is per capita consumption of a single good, m_t is "nominal balances," and p_t is the nominal price level. Such a model is capable of generating a well-behaved, smooth demand function for the aggregate of assets included in

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nominal balances, m_t. This demand schedule permits the assets m_t to be dominated in rate of return by the alternative assets (corporate and government bonds, equities, or physical capital) that households have access to. Real balances are dominated in rate of return by those other assets to the extent that they provide utility directly, that is, to the extent that $u_2>0$. An important aspect of this theory is that very different principles are used to assign value to real balances, on the one hand, and to all other assets, on the other. All other assets are valued according to the utility value of the streams of consumption that they support in equilibrium. There is an asymmetry here, in that all assets except real balances are valued according to the principle of modern finance theory, which prices assets in such a way that no asset's return is dominated in equilibrium by the return on any other collection of assets.

In a theory of this kind, the analyst in effect decides a variety of important issues when he defines precisely what collection of assets enters the category of "real balances," or m_t/p_t. Is m_t/p_t high-powered money, as in the formal models of Sidrauski (1967), Brock (1974), and Fischer, thereby excluding inside money or that portion of demand deposits and time deposits that is not fully backed by high-powered money? The arguments that are used to justify including m_t/p_t in the utility function are widely interpreted as arguing for a broader aggregate including some components of inside debt, such as demand deposits, bank notes, and bills of exchange.[1] A closely related question is: For residents of a given country, are real balances denominated in foreign currencies included in m_t/p_t in (1)? It certainly seems plausible to posit, for example, that, for a two-country world, agents in country j maximize

$$(2) \qquad \sum_0^\infty u\left(c_{jt}, \frac{m^j_{1t}}{p_{1t}} + \frac{m^j_{2t}}{p_{2t}}\right)e^{-\delta t},$$

where c_{jt} is consumption in country j, m^j_{it} is nominal balances of country i held by residents of country j, and p_{it} is the price level in terms of country i currency. At this level of theorizing, positing (2) seems as plausible as positing that agents in country 1 maximize

$$(3) \qquad \sum_{t=0}^{\infty} u(c_{1t}, m^1_{1t}/p_{1t})e^{-\delta t},$$

while agents in country 2 maximize

$$(4) \qquad \sum_{t=0}^{\infty} u(c_{2t}, m^2_{2t}/p_{2t})e^{-\delta t}.$$

1. By introducing some heterogeneity of endowments and preferences across agents in a Sidrauski-like model, markets for consumption and production loans can be included, so that inside debt can be incorporated into the model. The properties of such a model would depend sensitively on what fraction of inside debt one included in the concept of real balances that enters the utility function.

Equations (3) and (4) assert that country 1 residents just happen to have "dollars" in their utility function and not "pounds," while country 2 residents just happen to have "pounds" and not "dollars." While these assumptions give rise to smooth and well-behaved demands for national currencies and a determinate theory of exchange rates, they are not useful for addressing the dollarization phenomenon described by Mr. Ortiz. However, the use of the criterion function (2) in a two-country Sidrauski model can readily be shown to imply a severe dollarization problem under a regime of flexible exchange rates and no capital controls. In particular, the resulting model has the properties that there are *not* smooth, well-defined demand schedules for particular national currencies, and that there is not even a unique equilibrium exchange rate. Thus, the predictions of the model depend very sensitively on the particular aggregate that the analyst chooses for "real balances." No first principles seem available to guide that choice for an analysis conducted at this level.

The same set of questions arises in models with "cash in advance" constraints, of the kind analyzed by Clower and by Lucas (1980). Here the idea is to have individuals maximize a Cass-Koopmans utility functional model involving only consumption

$$\sum_{t=0}^{\infty} u(c_t)e^{-\delta t}, \tag{5}$$

but to add the "cash in advance" constraint,

$$p_t c_t \leq m_{t-1}, \tag{6}$$

to the other intertemporal constraints of a version of a Cass-Koopmans model. A smooth, well-behaved demand schedule for real balances is obtained by forcing individuals to transact in the particular set of assets included in m_{t-1} in the Clower constraint (6). This constraint permits the assets included in m_{t-1} to be dominated in return by the other assets in the model. As in the Sidrauski model, the choice of assets to include in m_{t-1} sensitively conditions the conclusions of the analysis, especially from the point of view of the issues raised in the preceding papers by Fischer and Ortiz.

The same questions again arise if one attempts to use the reasoning underlying the Baumol (1952) and Tobin (1956) transactions costs models: to generate a demand for a particular class of assets called "money" that is dominated in terms of rate of return because business is less costly to transact with it. For example, it is hard to imagine a reasonable specification of a physical transaction cost technology that would naturally give rise to a situation in which, in equilibrium, each country turns out to have its own national money. Again, the Baumol-Tobin setup is silent on the question of the particular class of assets that is to be called money and with which business is less costly to transact.

The final brand of monetary theory that I will mention is based on the insight of Paul Samuelson (1958) that if sufficient "missing links" are introduced into a general equilibrium model, via spatial or temporal separation of agents, then a role for a properly managed inconvertible currency can emerge. Such models obtain a valued fiat currency by direct restrictions on the endowment patterns, locations in time and space, and technological possibilities for transforming goods over time and space. One popular example of this class of models is Samuelson's model of overlapping generations of two-period-lived agents, which has been used by Cass-Yaari (1966), Lucas (1972), Wallace (1980), and others to examine outstanding questions in macroeconomics. However, other models with agents who live more than two periods, such as those analyzed by Townsend (1980) and Tesfatsion (1980), embody the same general kind of missing-links friction that characterizes Samuelson's model. As in the previous kinds of models, issues of inside and outside money and of international currency substitution also arise in the context of these missing-links models. However, in these models the analysis is conducted at a more primitive level that naturally directs the analyst's attention toward the forces that make inside money displace (and devalue) outside money, and that make foreign currency compete with domestic currency.

Kareken and Wallace (1978, 1981) have used a version of Samuelson's model to analyze currency substitution, while Wallace (1980) and Sargent and Wallace (1981) have used such a model to analyze inside-outside money issues. To illustrate the issues raised by this brand of monetary theory for the subject of this paper, I shall briefly consider the following parametric, nonstochastic, two-country, pure exchange overlapping generations model.

At each date $t \geq 1$, there are born in country j N_j two-period-lived agents. Within each country, the agents are identically endowed both within and across time periods. There is a single, nonstorable consumption good. Let $w_s^j(t)$ be the endowment of t period goods of an agent in country j who is born at time s. Let $c_s^j(t)$ be the consumption of t period goods of an agent in country j who is born at time s. I assume the stationary endowment pattern

$$(7) \qquad \begin{aligned} w_t^1(t),\, w_t^1(t+1) &= (\beta_1, \beta_2)\,, \\ w_t^2(t),\, w_t^2(t+1) &= (\alpha_1, \alpha_2)\,. \end{aligned}$$

The young of each generation in each country are assumed to maximize the logarithmic utility function

$$(8) \qquad \ln c_t^h(t) + \ln c_t^h(t+1)\,.$$

This utility function implies the saving function (saving of an agent in country j who is young at t) =

(9) $$w_t^j(t) - c_t^j(t) = \left[\frac{w_t^j(t)}{2} - \frac{w_t^j(t+1)}{2R(t)}\right],$$

where $R(t)$ is the real gross rate of return on saving between times t and $t+1$, denominated in time $(t+1)$ goods per unit of time t goods.

At time $t = 1$, there are N_j old people in country j. The old in country 1 are in the aggregate endowed with $H_1(0)$ units of government-supplied inconvertible paper currency, denominated in "dollars." The old in country 2 are in the aggregate endowed with $H_2(0)$ units of government-supplied inconvertible paper currency, denominated in "pesos." The government of country j has a *policy* of financing a real deficit of $G_t^j \geq 0$, $t = 1, 2, \ldots$ by creating additional fiat money. The government budget constraints are

(10) $$G_t^j = \frac{H_j(t) - H_j(t-1)}{p_j(t)}, j = 1, 2,$$

where $p_j(t)$ is the price of time t goods, measured in units of j country currency per unit of time t goods. Below I shall characterize policy by $H_j(t)$ paths, and *not* G_t^j paths. The G_t^j path will be endogenous.

Consider a free-trade, flexible exchange rate regime in which agents in the two countries are permitted to borrow from and lend to each other freely and to hold each other's national currencies. Since there is no uncertainty, if the fiat currencies are to be valued (i.e., if $p_j(t) < \infty$), they must bear the same real rates of return with each other and with consumption loans (or "inside debt").[2] The real gross rate of return on currency j is $p_j(t)/p_j(t+1)$ at time t. Thus, we have the requirement that

$$\frac{p_1(t)}{p_1(t+1)} = \frac{p_2(t)}{p_2(t+1)}.$$

This implies

(11) $$\frac{p_1(t)}{p_2(t)} = \frac{p_1(t+1)}{p_2(t+1)}.$$

The ratio $p_1(t)/p_2(t) = e(t)$ is the exchange rate, measured in dollars per peso. Equation (11) states that the exchange rate $e(t)$ must be constant over time if the currencies are to bear the same gross real rates of return. So we have $e(t) = e$ for all $t \geq 1$.

2. Tobin's (1958) theory of the demand for money also requires that the return on money not be dominated by the return on any possible portfolio of assets.

The sequence of equilibrium conditions for this two-country, world economy can be written, for $t \geq 1$, as

(net saving of young of country 1)
+ (net saving of young of country 2) =
(net dissaving of old of countries 1 and 2)
+ (net dissaving of government of country 1)
+ (net dissaving of government of country 2).

Net dissaving of the old at t is given by $H_1(t-1)/p_1(t) + H_2(t-1)/p_2(t)$, while net dissaving of government j is G_t^j. Substituting from (9) and (10), and using

$$p_1(t)/p_1(t+1) = p_2(t)/p_2(t+1) = R(t),$$

these equilibrium conditions can be written

$$N_1\left[\frac{\beta_1}{2} - \frac{\beta_2}{2}\frac{p_1(t+1)}{p_1(t)}\right] + N_2\left[\frac{\alpha_1}{2} - \frac{\alpha_2}{2}\frac{p_1(t+1)}{p_1(t)}\right]$$
$$= \left[\frac{H_1(t-1)}{p_1(t)} + \frac{H_2(t-1)}{p_2(t)}\right]$$
$$+ \frac{H_1(t) - H_1(t-1)}{p_1(t)} + \frac{H_2(t) - H_2(t-1)}{p_2(t)}.$$

This equation can be rewritten, using $p_2(t) = p_1(t)/e$, as

$$\left(N_1\frac{\beta_1}{2} + N_2\frac{\alpha_1}{2}\right) - \left(N_1\frac{\beta_2}{2} + N_2\frac{\alpha_2}{2}\right)\frac{p_1(t+1)}{p_1(t)} = \frac{H_1(t) + eH_2(t)}{p_1(t)}. \tag{12}$$

Multiplying by $p_1(t)$ and rearranging, we have the difference equation in $p_1(t)$

$$p_1(t) = \lambda p_1(t+1) + \phi[H_1(t) + eH_2(t)],\ t \geq 1, \tag{13}$$

where

$$\lambda = \left(\frac{\beta_2 N_1 + \alpha_2 N_2}{\beta_1 N_1 + \alpha_1 N_2}\right),\ \phi = \frac{2}{N_1\beta_1 + N_2\alpha_1}.$$

If possible, the difference equation (13) is to be solved for a sequence of price levels $(p_1(t),\ t = 1, 2, \ldots)$ *and* an exchange rate $e \geq 0$. It happens, however, that the difference equation (13) cannot determine all of these endogenous variables. Kareken and Wallace (1981) describe this fact by stating that the equilibrium exchange rate is indeterminate or underdetermined. So long as all the price level $p_1(t)$ for *all* dates $t \geq 1$ is regarded as endogenous, Kareken and Wallace's characterization must be accepted.

We say that a *fiat money equilibrium* exists if the difference equation (13) has a solution with $p_1(t)\epsilon(0,\infty)$ for $t\geq 1$. The general solution of the difference equation (13) is

$$(14) \qquad p_1(t) = \phi \sum_{i=0}^{\infty} \lambda^i H_1(t+i) + e\phi \sum_{i=0}^{\infty} \lambda^i H_2(t+i) + c\left(\frac{1}{\lambda}\right)^t, t\geq 1,$$

where c is *any* arbitrary constant. So long as $G_t^j \geq 0$ and $t\geq 1$ in (10), a necessary condition for the difference equation (13) to have a solution with $\infty > p_1(t) > 0$ is $\lambda < 1$. The parameter $\lambda = (\beta_2 N_1 + \alpha_2 N_2)/(\beta_1 N_1 + \alpha_1 N_2)$ is the real gross rate on consumption loans in the pure consumption loans (or pure "inside debt") economy.[3] This is a version of Samuelson's result: For there to be a role for the "social contrivance" of inconvertible currency, an economy with inside debt alone must not provide a real gross rate of return in excess of the gross rate of growth of the economy.

If $\lambda < 1$, the existence of a fiat money equilibrium depends on the paths of $H_1(t)$ and $H_2(t)$ for $t\geq 1$. To take a concrete case, suppose that

$$H_1(t) = z_1 H_1(t-1), t\geq 1,$$
$$H_2(t) = z_2 H_2(t-1), t\geq 1.$$

We assume that $1 < z_1 < z_2$. Then we have the following situation: If $\lambda z_1 < 1$ and $\lambda z_2 < 1$, a continuum of fiat money equilibrium solutions of (13) is given by

$$(15) \qquad p_1(t) = \frac{\phi}{1-\lambda z_1} H_1(t) + e\frac{\phi}{1-\lambda z_2} H_2(t) + c\left(\frac{1}{\lambda}\right)^t$$

for *any* $\infty \geq e \geq 0$, and *any* $c \geq 0$. If $\lambda z_1 < 1$ and $\lambda z_2 > 1$, then a continuum of fiat money equilibrium solutions of (13) is given by

$$(16) \qquad p_1(t) = \frac{\phi}{1-\lambda z_1} H_1(t) + c\left(\frac{1}{\lambda}\right)^t,$$

3. Notice that where there is no fiat currency, the equilibrium condition for the world economy is

(net saving of young of country 1)
+ (net saving of young of country 2) = 0,

or

$$N_1\left[\frac{\beta_1}{2} - \frac{\beta_2}{2}\frac{1}{R(t)}\right] + N_2\left[\frac{\alpha_1}{2} - \frac{\alpha_2}{2}\frac{1}{R(t)}\right] = 0.$$

The solution for the gross real rate of return of consumption loans is

$$R(t) = (\beta_2 N_1 + \alpha_2 N_2)/(\beta_1 N_1 + \alpha_1 N_2).$$

with $e \equiv 0$, and any $c \geq 0$. If $\lambda z_1 > 1$, the solution of (13) is $p_1(t) = +\infty$, so that neither fiat currency is valued.

The nature of these solutions reveals that the valuation of national currencies is *tenuous* for several reasons.[4] First, when $\lambda z_2 < 1$, so that solution (14) is pertinent, then the equilibrium exchange rate is underdetermined, with *any* constant e in the closed interval $[0, \infty]$ being an equilibrium exchange rate. This is Kareken and Wallace's celebrated result about the indeterminacy of equilibrium exchange rates under laissez-faire. Second, so long as $\lambda < 1$ and $\lambda z_1 < 1$, a continuum of equilibria exists (indexed by the parameter $c \geq 0$). All of these equilibria, except the stationary equilibrium with $c = 0$, have $p_1(t)$ following an explosive, self-fulfilling speculative bubble in which the real value of currency asymptotically goes to zero. Third, confining oneself to the stationary ($c = 0$) equilibrium, the more inside debt there is, or equivalently, the more private borrowers there are relative to private lenders, the higher is the equilibrium price level. Thus, equation (12) can be rewritten

$$\left(N_1 \frac{\beta_1}{2} + N_2 \frac{\alpha_1}{2}\right) p_1(t) = \left[\left(N_1 \frac{\beta_2}{2} + N_2 \frac{\alpha_2}{2}\right) p_1(t+1)\right] + \left[H_1(t) + eH_2(t)\right],$$

where the left-hand side is total nominal debt, the first bracketed term on the right-hand side is "inside" nominal indebtedness, and the second bracketed term on the right-hand side is nominal value of world currency supply; nominal values are measured in dollars. Notice that in a fiat money equilibrium the ratio of inside nominal debt to the total nominal debt is given by[5]

$$\left(\frac{N_1\beta_2 + N_2\alpha_2}{N_1\beta_1 + N_2\alpha_1}\right) \frac{p_1(t+1)}{p_1(t)} = \lambda \frac{p_1(t+1)}{p_1(t)} .$$

The larger the value of λ, the smaller the base of the inflation tax and the smaller the maximal sustained amount of real revenue that can be raised jointly by the two governments. Further, if $\lambda > 1$, we have seen that no fiat money equilibrium exists. Thus, private indebtedness competes with public indebtedness and limits the ability of the government to collect revenues through an inflation tax. Fourth, the valuation of national currencies is tenuous because it depends on the government not running deficits that are too large far into the future, that is, it depends on the government's repeated fiscal *policies*, as is exhibited directly by (14) or by the restrictions on z_1 and z_2 in the special versions of solutions (15) and (16).[6]

4. Neil Wallace (1980) has emphasized this feature of inconvertible currencies.
5. Equations (14) and (15) imply that $p_1(t+1)/p_1(t) > 1$.
6. It is interesting to pose the following "optimal stationary seigniorage" question for this model. Given the exchange rate e, the real rate at which both governments together

Although the equilibrium value of the exchange rate is indeterminate, its value is important to the two governments, since it helps to determine the real value of the inflation tax revenues collected by each government (see [10] and [14]).[7] The scope of trade in inside debt is also significant from the viewpoint of the real amount of inflation tax that each government can potentially collect.[8]

This model thus implies, under a regime of flexible exchange rates and no capital controls, that dollarization will be a very important problem. This is particularly true if the economy with the larger deficits follows so expansionary a fiscal policy (e.g., $\lambda z_2 > 1$) that its currency is predicted to be valueless. The model indicates that a government intent on extracting an inflation tax from its own residents, or intent on preventing other countries from imposing such a tax on its residents, has substantial incentives to deviate from a regime of flexible exchange rates and capital mobility. That is, it has an incentive to impose currency and capital controls. The model also implies that such a government has a strong incentive to restrict and to regulate the scope of both domestic and international financial intermediaries that issue currency-like (i.e., small-denomination, low-risk) assets that compete with domestic currency in the portfolios of private agents.[9]

There are a variety of possible forms that the exchange interventions and regulations of intermediaries can take that are sufficient to render the equilibrium exchange rate determinate and the demand for domestic high-powered money well defined. Kareken and Wallace (1981) and Nickelsburg (1980) have studied several such intervention schemes. Here it should simply be mentioned that various kinds of implicit and state contingent threats, which perhaps need actually never be executed, are sufficient to render the exchange rate determinate. In interpreting time series data, in principle, it may be difficult to determine whether a system is truly operating under a laissez-faire regime "now and forever," or

collect revenues through the inflation tax is $G = H(t) - H(t-1)/p_1(t)$, where $H(t) = H_1(t) + eH_2(t)$. Let the "world money supply" follow the law $H(t) = zH(t-1)$. Then what value of z maximizes the sustainable value of G in stationary equilibrium? If the real gross rate of return on consumption loans in the nonfiat money equilibrium λ is greater than unity, no real revenues can be raised through the inflation tax. If $\lambda < 1$, the revenue-maximizing value of z turns out to be $\sqrt{(1/\lambda)}$.

7. Notice that in this economy there are not well-defined demand functions for the individual countries' currency stocks or for inside debt. Because all of these assets are perfect substitutes in lenders' portfolios, only a demand function for the total indebtedness, which can be thought of as the "total world money supply," is well defined. The real demand for this aggregate is equal to $(N_1\beta_1 + N_2\alpha_1)/2$.

8. The model is silent on the question of what currency inside debts are denominated in terms of.

9. I have set up the model so that residents within each country are identically endowed and have identical preferences. This means that all "inside debt" occurs in the form of international private loans. From the point of view of the points made here, it would have made no substantial difference if I had introduced heterogeneity of agents' preferences and endowments within each country to open up the possibility of within-country inside debt.

whether demands for inconvertible currencies are being influenced by some such implicit threats.

As do the other models of money that we have discussed, the Kareken-Wallace model has serious deficiencies. To get at the issues at an explicit and deep level, while maintaining analytical tractability, the model oversimplifies by severely restricting the technology, the life cycle, and the temporal distribution of agents. In fact, the physical and economic setup is so restricted that no one would seriously entertain econometrically estimating the free parameters of such a model by the appropriate econometric techniques of the post-Lucas critique (1976) era.[10] In interpreting the time series data, Kareken and Wallace do not seem to intend that their model be taken literally. In this sense, the model of Kareken and Wallace cannot yet serve as an entirely rigorous guide in formulating time series econometric specifications. However, it is possible to imagine generalizations of Kareken and Wallace's model along the lines of Townsend's (1980). Such a model would retain the missing-links features and isolate forces such as exchange rate indeterminacy and the tenuous character of fiat money equilibria. At the same time, it could accommodate more realistic and econometrically plausible infinite-period utility functions for households, so that one could think more seriously about formally using the model to interpret time series data. The problem is that such models quickly become analytically difficult to handle. In contrast, the Baumol-Tobin model and the real balances in the utility function models have more readily suggested econometric specifications.

Despite its abstractness and its remoteness from econometric applicability, the Kareken-Wallace model has the virtue of pointing toward forces that have seemed to operate in international currency markets and that other models have to some extent ignored. The history of exchange controls in England since the Second World War, for example, can be understood, at least partly, as a response to the forces pinpointed by their model.[11] So can the concern that monetary authorities in the United States and Europe have exhibited about the implications of Eurocurrency markets for monetary management. There is also Mr. Ortiz's observation that it was only with considerable difficulty that the Mexican authorities were able to induce Mexican citizens to hold domestically issued currency.

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10. These techniques are described in various papers in Lucas and Sargent (1981).
11. See Leland Yeager (1975, chap. 22) for a history of British exchange controls.

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