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Ronald I. McKinnon

The East Asian exchange rate dilemma and the world dollar standard

In the realm of economics, "globalization" refers to the growing interdependence among countries—the cross border flows of goods, services, capital, and technical know how. At first glance, the case for globalization in East Asia as elsewhere seems to be just a more general version of the case for freer trade. And we have persuasive theorems showing that welfare generally (although not necessarily that of particular individuals or firms) increases as the ambit of trade expands. Indeed, the formal theory underlying the advocacy of free trade has it that small countries are the biggest gainers. Outside the United States, why then should globalization make so many people in smaller countries—and even larger ones like China and Japan—so uneasy?

The enhanced hegemony of the United States is a prime source of international uneasiness in the new millenium—just as British military and financial hegemony made other countries uneasy with the spread of freer international trade in the 19th century. In today's military terms, there is just one superpower that sends gunboats— i.e., read aircraft carriers—to keep the

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peace in far away places, at least where its vital interests are concerned. There is also the invasive crass commercialism of multinational firms, mainly American, that non-Americans see as threats to their traditional way of life—as when French farmers set fire to MacDonald's hamburger stands. Other countries, particularly regimes that force their people into subservience through a blinkered religion, see foreign influences undermining national cultures.

However, I will approach the problem of American global hegemony in general, and the associated problem of crafting suitable exchange rate polices in East Asia in particular, quite differently—which at first glance might seem like an arcane exercise in monetary economics. In the absence of a common international money (such as gold in the 19th century), the ever-widening ambit of international trade and finance today accentuates an entirely natural asymmetry among national currencies. A strong central money (or key currency) becomes dominant—as the U.S: dollar now dominates on a worldwide scale outside of Europe, and as the old deutsche mark dominated within Europe before its monetary unification with the advent of the euro. (In the 19th century, Britain was also resented as the world's dominant creditor country that kept the rest of the world somewhat in thrall to the London capital market. But because Britain was then on the gold standard more or less on a par with the other industrial countries, it had much less autonomy in monetary matters than does the United States in today's world of "fiat" national monies.)

We live in an inherently asymmetrical, and perhaps unfair, world because there can be only one central money for facilitating international exchange. In East Asia, the U.S. dollar is the dominant vehicle currency in interbank foreign exchange transacting, and the currency of choice for invoicing the great bulk of commodity trade. Inevitably, this leaves most countries' currencies on the periphery of that central money where countries, particularly developing ones, have domestic financial systems that are naturally more fragile. They live with the ever-present threat of a currency crisis, i.e., a run from their peripheral money into the central one, the American dollar. Indeed, managing foreign exchange and financial policy is more difficult on the periphery than at the center. It is easier to be the U.S. Secretary of the Treasury than to be the Korean, or Argentinian, or Thai, Minister of Finance!

One important aspect of this asymmetry is the nature of currency risk in the foreign exchanges. The U.S. economy is by far

the biggest debtor to the rest of the world—something like $2.7 trillion of net indebtedness, which continues to increase with the current American trade deficit. But nobody thinks that the dollar could really be attacked—or that there could be a currency crisis in the ordinary sense. Insofar as American banks, insurance companies, and so on receive foreign funds as the counterpart of America's trade deficit, this buildup of liabilities to foreigners is entirely denominated in U.S. dollars.

So American banks have dollar-denominated liabilities both to foreigners and to domestic nationals, and they make dollar-denominated loans—largely to American firms and households. Because of this absence of foreign exchange exposure, American financial institutions can absorb this huge capital inflow without currency risk. There are other risks, but they aren't associated with fluctuations in the dollar's exchange rate against other currencies.

However, if smaller debtor economies on the periphery of the dollar standard—such as Korea, Thailand, or any in Latin America—absorb foreign capital, typically the debts are denominated in another country's currency, i.e., mainly the U.S. dollar but also the yen or the euro on occasion. The genesis of the great 1997–98 crisis was the huge short-term inflow of capital into the smaller East Asian economies, but denominated in dollars or yen. This meant their banks and financial institutions were at risk if there were any exchange rate fluctuations. In particular, any devaluation made repaying these external dollar obligations from earnings on domestic assets denominated in won, or baht, or pesos much more difficult.

Paradoxically, in the United States itself, there is surprisingly little appreciation of how today's world dollar standard actually works. Indeed, in the whole postwar academic literature since 1945, the dollar standard has been little analyzed. As a consequence, American policy makers have had little clear guidance in their interactions with other countries—and in their relationships with agencies such as the International Monetary Fund, the World Bank, or the Asian Development Bank. What needs to be done to reform the "International Financial Architecture", so as to make the world a financially safer place, remains in limbo.

Part I of my analysis provides a historical perspective on how the world dollar standard has evolved since World War II—with special concern for developing countries and emerging markets on its periphery. Then, Part II focuses on East Asia. Specifically, I link what I call "the East Asian exchange rate dilemma"—

including the current plight of Japan—to how the dollar standard now works.

1. THE WORLD DOLLAR STANDARD IN HISTORICAL PERSPECTIVE

How did this asymmetrical position of the dollar become established in the world economy? After World War II, the U.S. had the world's only intact financial system. There were inflation, currency controls, and so on in Europe, as well as in Japan and most developing countries. Thus, in open foreign exchange markets, the dollar naturally became the world's vehicle currency for (private) interbank transacting and the intervention currency that governments used for stabilizing their exchange rates. Under the Bretton Woods agreement of 1945, every country pegged to the dollar, and the U.S. did not have a formal exchange rate policy, except for the residual tie to gold.

This was quite natural given the history of the situation. The U.S. had the only open capital market, so countries could easily build up their dollar reserves and have a liquid market in which to buy and sell them. Similarly, private corporations in other countries all built up dollar reserves as well because their own currencies had exchange controls. Because of this accident of history, the U.S. dollar became the intermediary currency in international exchange between any pair of "peripheral" monies.

The Dollar as Facilitator of International Exchange

But why does the dollar continue with this facilitating function even when most other industrial countries—such as Japan and those in Europe—no longer have exchange controls? A little algebra helps explain continued dollar predominance. Suppose you have N currencies, say 150, currencies in the world economy. The markets, themselves, would always pick one currency to facilitate international exchange. The reason for that is a big economy of markets.

If we think of world of N countries with independent national monies, then just from your basic high school probability theory, the total number of country pairs in the system is the combination of N things taken two at a time ($^{N}C_{2}$). If foreign exchange dealers tried to trade across each pair, say, Swedish crowns against Australian dollars, or Korean won against Japanese yen, it

would turn out that there would be a huge number of different foreign exchange markets. With 150 national currencies in the world (N = 150), and you tried to trade each pair, there would be 11,175 foreign exchange markets!

It is expensive for any bank to set up a foreign exchange trading desk, Thus, rather than trading all pairs of currencies bilaterally, in practice just one currency, the Nth, is chosen as the central vehicle currency. Then all trading and exchange takes place first against the vehicle currency before going to the others. By having all currency trading against that one currency, you can reduce the number of markets in the system to N-1. Thus, with 150 countries, we need to have just 149 foreign exchange markets—instead of 11,175. Unlike the Bretton Woods system where all countries set official dollar parities, this result doesn't depend on any formal agreement among governments. In private markets today, choosing one currency like the dollar to be the intermediary currency is the most natural way of economizing on foreign exchange transacting.

But history is important. If one country starts off providing the central money, as the U.S. in the late 1940s did, then it becomes a natural monopoly because of the economies of scale. The more countries that deal in dollars, the cheaper it is for everybody to deal in dollars. If you're a Japanese importer of Swedish Volvos and you want to pay for the Volvos, you first get your bank to convert your yen into dollars on the open market, then use the dollars to buy Swedish crowns. Volvo corporation receives the Swedish crowns and the importer gets the Volvos. However, the dollar is the intermediary currency.

Box 1
The U.S. Dollar's Facilitating Role as International Money
(1945 to 2001)

	Private	*Official*
Medium of exchange	vehicle	intervention
Store of value	banking	reserves
Unit of Account	invoice	peg
Standard of deferred payment	private bonds	sovereign bonds

Using the standard textbook classification of the roles of money, Box 1 summarizes our paradigm of the dollar's central role in facilitating of international exchange. For both the private and government sectors, the dollar performs as medium of ex-

change, store of value, unit of account, and standard of deferred payment for international transacting on current and capital account—and has so from 1945 into the new millenium. It is a slight generalization of a similar table presented by Peter Kenen in 1983, but it remains as valid today as then.

First in Box 1, the dollar is a *medium of exchange.* Because the foreign exchange markets are mainly inter bank, the dollar is the vehicle currency in inter bank transacting serving customers in the private sector. Thus, when any government intervenes to influence its exchange rate, it also finds it cheaper and more convenient to use the dollar as the official intervention currency. (The major exception to this convention had been within Europe prior to the advent of the euro, where for many purposes the old deutsche mark was the central money. And now a fringe of small European countries to the east of Euroland mainly use the euro as their central money.)

Second in Box 1, the dollar is an international *store of value.* Corporations and some individuals hold dollar bank accounts in London, Singapore and other "offshore" banking centers—as well as in the U.S. itself. For governments, international reserves are mainly in dollars—largely U.S. Treasury bonds: Korea has $95 billion, Japan almost $400 billion, China nearly $200 billion, and so on. As a matter of fact, almost half of U.S. Treasury bonds outstanding are held by foreign central banks.

Third in Box 1, the dollar serves as a *unit of account* for much of international trade. Trade in primary commodities shows a strong pattern of using the dollar as the main currency of *invoice*. Exports of homogeneous primary products such as oil, wheat, and copper all tend to be invoiced in dollars, with worldwide price formation in a centralized exchange. Spot trading, but particularly forward contracting, is concentrated at these centralized exchanges—which are usually in American cities such as Chicago and New York, although dollar-denominated commodity exchanges do exist in London and elsewhere.

Invoicing patterns for exports of manufactured goods are more complex. Major industrial countries with a strong currencies tend to invoice their exports in their home currencies. Before European Monetary Union, more than 75 percent German exports had been invoiced in marks, more than 50 percent of French exports invoiced in francs, and so on. But these illustrative ratios were dominated by intra-European trade. With the advent of the European Monetary Union, how much continental European countries will invoice their exports outside of Europe in euros remains unknown.

Within East Asia, however, foreign trade is invoiced mainly in dollars: Korean trade with Thailand is typically dollar invoiced. Even Japanese trade with other East Asian countries is invoiced more in dollars than in yen. Outside of Europe, the prevalence of dollar invoicing is also true in other parts of the world. For example, intra Latin American exports are almost entirely dollar invoiced.

For pricing manufactures, more than pure invoicing is involved. Exporters everywhere outside of Europe typically opt to quote selling prices for their products in dollars, and then keep these dollar prices fairly constant in industrial catalogs and other published price lists. In effect, they price to the world market—and not just to the American one—in dollar terms. Thus national central banks aiming to stabilize the international purchasing power of their currencies, often opt—either formally or informally—to peg against the dollar, and thus against the huge sticky-priced mass of internationally traded goods that it represents.

Fourth in Box 1, if we think of *a standard of deferred payment*—which is also a traditional role of money—private and sovereign bonds in international markets are largely denominated in U.S. dollars, though some are now in euros. In international bond markets, U.S Treasuries are taken as the bench-mark or "risk-free" asset. That is, dollar-denominated sovereign bonds issued by emerging markets the world over have their credit ratings (by Moody's, Standard and Poor's, or Fitch) measured relative to U.S Treasuries. Thus, risk premia in interest rates on these bonds are typically quoted as so many percentage points over U.S. Treasuries.

The Dollar as Nominal Anchor

Beyond facilitating international exchange, the dollar has a second and complementary international function. Foreign monetary authorities may better anchor their own domestic price levels by choosing to peg, officially or unofficially, to the dollar. By opting to keep their dollar exchange rates stable, foreign governments are essentially opting to harmonize—without always succeeding—their monetary policies with that of the United States. This monetary harmonization has two avenues: (1) international commodity arbitrage—the *arbitrage avenue*, and (2) the *signaling avenue* where other central banks take their cue from actions of the U.S. Federal Reserve Bank.

The arbitrage avenue arises naturally out of the dollar's facili-

tating role in international finance. Because international trade in goods and services is largely dollar invoiced (including trade between countries outside of the United States), international arbitrage in the markets for goods and services through a fixed dollar exchange rate can be a powerful device to anchor any one country's domestic price level. Putting the matter the more negatively, if other countries fail to prevent their dollar exchange rates from fluctuating, the degree of pass-through of these exchange rate fluctuations into their domestic prices is (ultimately) very high. (The one big exception would be countries in the large euro area—whose domestic price levels are fairly well insulated from fluctuations in the euro's exchange rate against the dollar.)

Asymmetrically, because both American imports and exports are invoiced in dollars, America's own domestic price level is relatively insulated from fluctuations in the dollar's exchange rate. More generally in the world at large, the *dollar* prices of internationally traded commodities are relatively invariant to fluctuations in the dollar's value against other currencies. So, as the Nth country in the system, the U.S. alone can carry out an independent monetary policy to target its own domestic price level without being much disturbed by exchange rate fluctuations. For the other N–1 countries, however, direct international commodity arbitrage through a fixed exchange rate can help stabilize their own internal price levels.

In securing monetary harmonization with the United States, the signaling avenue can also be important. If any one national government resists upward pressure on its currency in the foreign exchanges, the resulting increase in its official dollar reserves signals the need for domestic monetary expansion—and vice versa. The national central bank can even takes its cue directly from what the Fed is doing. For example, the Bank of Canada typically changes its own discount rate (interbank lending rate) relatively quickly in response to changes in the U.S. Federal Funds rate.

However, for the dollar to function successfully as nominal anchor, two important conditions must be satisfied:

(1) the American price level, as measured by a broad index of tradable goods prices, is stable and expected to remain so; and

(2) most countries, and certainly neighboring ones, are on the same international standard, i.e, they also fix their exchange rates to the dollar.

In the history of the postwar dollar standard, these two conditions were satisfied in some periods—but not so in others. Indeed, in contrast to the dollar's ongoing robustness as the facilitator of international exchange under either fixed or floating exchange rates, its function as nominal anchor has continually metamorphosed.

High Bretton Woods, 1950 to 1968

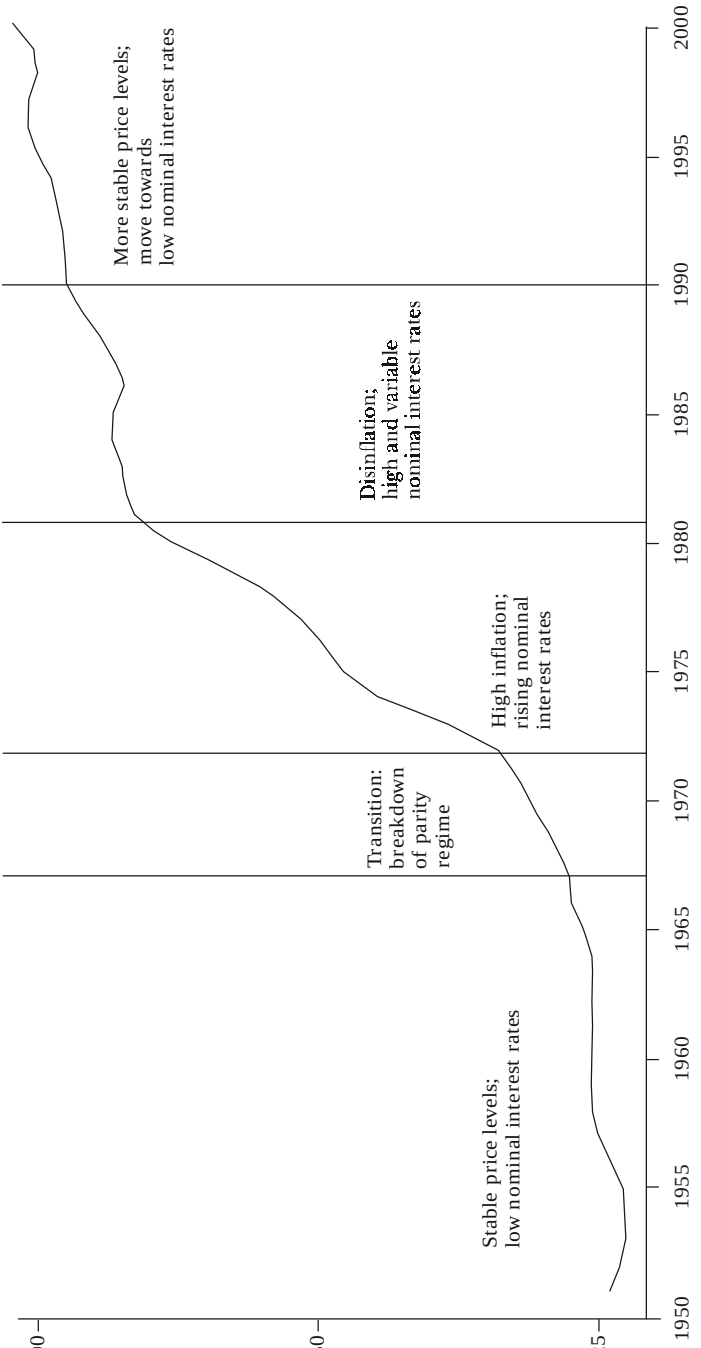
From the 1950s through 1968, the first panel of Figure 1 shows that the U.S. price level for tradable goods prices—as measured by the U.S. wholesale price index—was stable. Also interest rates on dollar assets were low and stable because of the absence of expected inflation. So, under the old Bretton Woods par value system, all other countries willingly declared dollar parities—and kept their market exchange rates within a narrow band of 2 percent around these central parities, which were seldom changed. During this period of "high" Bretton Woods, IMF member countries could use price stability in the center country as an anchor for their own domestic price levels.

But more than just the behavior of the center country was involved in this anchoring process. Because virtually all the major industrial countries were on the same fixed exchange rate regime, the "world" price level was more secure. Precipitate devaluations (or appreciations) of any one country, which could impart deflationary pressure to a neighboring one, were avoided. In addition, potentially inflationary national macroeconomic shocks were dampened. The inertia or "stickiness" in each country's price level was greater because all of them were committed to, and bound together under, a common monetary standard—albeit one ultimately dollar based.

During this high Bretton Woods regime, even the American price level itself was more stable because of the generally fixed exchange rates. In the short and medium terms, the center country could benefit from commodity arbitrage with neighboring countries across the fixed exchange rates to dampen potentially inflationary shocks originating at home. In the end, however, the system could not survive persistent inflationary pressure in the center country—as we shall see.

Finally, as the initial panel of Figure 1 indicates, nominal interest rates in the industrial countries were low and remarkably stable in the 1950s and 1960s. Until the very late 1960s, the common rate of price inflation was so low that ordinary Fisher effects

FIGURE 1. THE WORLD'S NOMINAL ANCHOR: U.S. WHOLESALE PRICES, 1951-2000



SOURCE: *International Financial Statistics*, IMF, august 2001.

in interest rates were largely absent. In these immediate postwar decades, the perceived continued stability in exchange rates meant that cross-country interest differentials remained modest—despite the presence of capital controls in most of the industrial countries. This commitment to fixed dollar parities by the industrial countries finally collapsed in early 1973. However, the common monetary anchor undergirded that era's famously high real economic growth—not matched in the industrial world in any sustained way before or since.

For the less developed countries with immature domestic financial markets, having price and interest rate stability in the core industrial economies was particularly advantageous. They would have had great trouble controlling domestic inflation independently of stabilizing their dollar exchange rates. Instead, most simply opted to lock into the high Bretton Woods dollar standard. Of course, some in Latin America and elsewhere had too much domestic inflationary pressure to be able to keep their dollar exchange rates fixed. But even when any one LDC experienced a currency crisis with devaluation, the authorities usually avowed to return to the fixed rate dollar standard when able—thus dampening expectations of further inflation.

Losing the Anchor 1968-73: The Advent of Floating Exchange Rates

With hindsight, the old fixed rate dollar standard began to unravel in the late 1960s as WPI inflation in the United States—the center country—began to escalate toward 3 percent per year (Figure 1, second panel). Other countries—particularly Germany—became unwilling to maintain their old dollar parity and import even moderate inflationary pressure. The deutsche mark was revalued upward in 1969. More importantly, the United States was then hampered by the Keynesian belief (as encapsulated in the so-called Phillips curve) that disinflation would permanently increase domestic unemployment. So largely for doctrinal reasons, the center country refused to embark on a serious program of disinflation.

But the ongoing inflation reduced America's industrial competitiveness. Worried about America's declining foreign trade position, President Nixon in August 1971 closed the vestigial "gold window": America's formal commitment under the old Bretton Woods articles to formally fix the dollar's value in terms of gold. Simultaneously, Nixon imposed an across-the-board tariff of 10

percent on American imports of manufactures, and insisted that the tariff would not be removed until all the other industrial countries appreciated their currencies against the dollar. They all appreciated between 10 and 20 percent before re-establishing their new "Smithsonian" dollar parities in December 1971. However, because the center country continued to inflate, the Smithsonian dollar parities were destined to fail. In February 1973, the industrial countries gave up on their dollar parities and moved to no-par floating.

In the 1970s into the 1980s in the United States, high and variable price inflation coupled with high and volatile nominal interest rates—see the third panel in Figure 1—largely eroded the dollar's usefulness as nominal anchor. In most developing countries as well as many industrial ones, inflation also increased sharply. Many industrial countries were now quite willing to have their currencies *appreciate* against the dollar to better insulate themselves from what had become a maelstrom of variable inflation rates worldwide. (Europeans were induced to look for a new center currency as anchor—and tried to rebuild monetary stability around the deutsche mark. This effort culminated with the successful advent of the euro in the late 1990s.)

The collective effect of this worldwide monetary instability on world productivity growth was catastrophic. Without a common anchor for domestic price levels and exchange rates, productivity in the industrial world and its periphery—except for the East Asian "tigers"—slowed dramatically after 1973 through to the early 1990s.

Paradise Regained in the 1990s?

But from the early 1990s into the new millenium, the last panel in Figure 1 shows a return to price stability in the United States—with U.S. interest rates becoming moderate to low once more. Thus, the dollar has again become attractive as an international anchor currency, and as the predominant reserve asset worldwide. After the dollar's decline as a reserve asset in the inflationary 1970s and 1980s, the dollar's share in official foreign exchange reserves has greatly increased over the last decade. Table 1 shows the dollar rising from 51.3 percent of official holdings of foreign exchange (of members of the International Monetary Fund) in 1991 to 68.2 percent in 2001. And if one assumed a pro rata share of "unspecified currencies" to be dollars, the dollar's current share in international reserves seems well over 75 percent.

Surprisingly, the advent of the euro has not reduced the dollar's predominance in international reserve holdings. Table 1 also shows that the share of euros in official foreign exchange reserves in 1999 and 2000 was no greater than was the sum of the old legacy currencies—mark, francs, and guilders—before the advent of the euro on January 1, 1999. Although euro has been very successful for securing regional monetary integration in Europe, the dollar remains king in international finance worldwide.

However, in the new millenium, this stronger form of the international dollar standard differs from High Bretton Woods of the 1950s and 1960s in at least two important respects:

(1)In non crisis periods, most governments in developing economies stabilize their exchange rates against the dollar but without declaring official dollar parities. And such informal pegging is also "soft" in the sense that many exchange rates drift.

(2)Most countries on the periphery of the dollar standard are no longer willing or able use capital controls. Thus dollar encroachment on the natural domestic domains of their national monies has become acute.

Let us discuss soft pegging and the encroachment problem in turn.

Soft Pegging

In their landmark study of 155 country exchange rate regimes using monthly data, Guillermo Calvo and Carmen Reinhart show that the only truly floating exchange rates are the euro, dollar, yen, and possibly the pound sterling, against each other. Month-to-month variance in these industrial countries' exchange rates is high—and variance in short-term interest rates is low: short-run shifts in cross-currency portfolio preferences are mainly absorbed by exchange rate changes—while their central banks target short-term interest rates as an instrument of domestic monetary policy.

In contrast, in developing or emerging-market economies, Calvo and Reinhart show that their monetary policies are arranged so that monthly variance in their exchange rates against some key currency—either the dollar or the euro—is low, but that monthly variance in their interest rates is much higher than in the core industrial countries. Except for an Eastern European fringe of countries keying on the euro, the others key on the dollar. The main shock absorber for cross-currency shifts in interna-

TABLE 1. SHARE OF NATIONAL CURRENCIES IN TOTAL IDENTIFIED OFFICIAL HOLDINGS OF FOREIGN EXCHANGE, END OF YEAR,[1] 1991-2000 (in percent)

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
All countries										
U.S. dollar	51.3	55.3	56.7	56.6	57.0	60.3	62.4	65.9	68.4	68.2
Japanese yen	8.5	7.6	7.7	7.9	6.8	6.0	5.2	5.4	5.5	5.3
Pound Sterling	3.3	3.1	3.0	3.3	3.2	3.4	3.7	3.9	4.0	3.9
Swiss Franc	1.2	1.0	1.1	0.9	0.8	0.8	0.7	0.7	0.7	0.7
Euro	-	-	-	-	-	-	-	-	12.5[2]	12.7[2]
Deutsche mark	15.4	13.3	13.7	14.2	13.7	13.1	12.9	12.2	-	-
French franc	3.0	2.7	2.3	2.4	2.3	1.9	1.4	1.4	-	-
Netherlands guilder	1.1	0.7	0.7	0.5	0.4	0.3	0.4	0.4	-	-
ECUs[3]	10.2	9.7	8.2	7.7	6.8	5.9	5.0	0.8	-	-
Unspecified currencies[4]	6.2	6.6	6.6	6.5	8.9	8.3	8.4	9.3	8.9	9.2
Industrial countries										
U.S.dollar	43.6	48.8	50.2	50.8	51.8	56.1	57.9	66.7	73.5	73.3
Japanese yen	9.7	7.6	7.8	8.2	6.6	5.6	5.8	6.6	6.5	6.5
Pound Sterling	1.8	2.4	2.2	2.3	2.1	2.0	1.9	2.2	2.3	2.0
Swiss Franc	0.8	0.4	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.2
Euro	-	-	-	-	-	-	-	-	10.7[2]	10.2[2]
Deutsche mark	18.3	15.1	16.4	16.3	16.4	15.6	15.9	13.4	-	-
French franc	3.1	2.9	2.6	2.4	2.3	1.7	0.9	1.3	-	-
Netherlands guilder	1.1	0.4	0.4	0.3	0.2	0.2	0.2	0.2	-	-
ECUs[3]	16.6	16.7	15.2	14.6	13.4	12.0	10.9	1.9	-	-
Unspecified currencies[4]	4.9	5.7	4.8	5.0	7.0	6.7	6.4	7.4	6.9	7.6

Developing countries										
U.S.dollar	63.3	64.4	64.3	63.0	62.4	64.4	66.2	65.3	64.6	64.3
Japanese yen	6.7	7.7	7.5	7.6	7.0	6.5	4.7	4.5	4.7	4.4
Pound Sterling	5.5	4.1	4.0	4.4	4.4	4.8	5.1	5.2	5.3	5.2
Swiss Franc	1.8	1.9	2.0	1.7	1.5	1.4	1.1	1.1	1.1	1.1
Euro	-	-	-	-	-	-	-	-	13.9	14.6
Deutsche mark	10.8	10.8	10.5	11.9	11.0	10.6	10.3	11.3	-	-
French franc	2.7	2.3	2.0	2.4	2.3	2.0	1.8	1.5	-	-
Netherlands guilder	1.0	1.0	1.0	0.8	0.6	0.5	0.6	0.5	-	-
ECUs[3]	-	-	-	-	-	-	-	-	-	-
Unspecified currencies[4]	8.2	7.7	8.7	8.1	10.9	9.8	10.1	10.7	10.4	10.4

NOTE: Components may not sum to totals because of rounding.

[1] Only IMF member countries that report their official holdings of foreign exchange are included in this table. [2] Not comparable with the combined share of euro legacy currencies in previous years because it excludes the euros received by euro area members when their previous holdings of other euro area members' legacy currencies were converted into euros on January 1, 1999. [3] In the calculation of currency shares, the ecu is treated as a separate currency. Ecu reserves held by the monetary authorities existed in the form of claims on both the private sector and European Monetary Institute (EMI), which issued official ecus to European Union central banks through revolving swaps against the contribution of 20 percent of their gross gold holdings and U.S. dollar reserves. On December 31, 1998, the official ecus were unwound into gold and U.S. dollars; hence, the share of ecus at the of 1998 was sharply lower than a year earlier. The remaining ecu holdings reported for 1998 consisted of ecus issued by the private sector, usually in the form of ecu deposits and bonds. On January 1, 1999, these holdings were automatically converted into euros. [4] The residual is equal to the difference between total foreign exchange reserves of IMF member countries and the sum of the reserves held in the currencies listed in the table. [5] The calculations here reply to a greater extent on IMF staff estimates than do those provided for the group of industrial countries

tional asset preferences is changes in their domestic interest rates—except for those developing countries with effective capital controls.

This surprising difference between the core industrial economies at the "center" and emerging-market economies on the "periphery" is even more pronounced at higher frequencies of observation. By accepting higher volatility in domestic short-term interest rates, monetary authorities in emerging markets generally succeed in keeping their dollar exchange rates relatively constant on a day-to-day or week-to-week basis. However, at low frequencies, e.g., quarter-to-quarter, these soft pegs sometimes drift; and, in major crises, even short-term exchange rate stabilization may be impossible.

This new regime of informal i.e., undeclared, dollar pegs for countries on the periphery of the United States differs from High Bretton Woods with its officially fixed dollar parities. In East Asia outside of Japan, for example, all the countries are dollar peggers to a greater or lesser degree. But only Hong Kong with its currency board admits to an official dollar parity of HK$ 7.8 for one American dollar. The others all claim to be "independently floating", or a "managed float", or pegged to a "currency basket". Although the Chinese call their regime a "managed float", the RMB's exchange rate of 8.3 yuan to the dollar has hardly moved since 1994. The others' dollar pegs may drift a bit more when measured at low frequencies, but the variance in their dollar exchange rates is an order of magnitude less than that in the yen/dollar exchange rate.

Negligence of the International Monetary Fund

Why this reticence of governments in emerging markets in East Asia and elsewhere to admit to keying on the dollar—or to go further and declare official dollar parities? The reasons are both political and economic.

On the political side, the asymmetry among national monies—with a center and a periphery—is simply too impolitic to admit. Nationalists in any peripheral country would get restless if their government admitted, by declaring an official dollar parity, that it was in thrall to the United States. De jure, the original Bretton Woods Agreement appeared to treat all its member countries symmetrically. Under Article IV of the 1945 Agreement, all members were obligated to declare an official parity for their exchange rate against gold or any currency tied to gold. In the

event, only the United States adopted a very limited form of a gold peg—whereas all the others chose to peg to the dollar as the Nth currency (as described above). Nevertheless, in the 1950s and 1960s, the Bretton Woods Articles provided an acceptable political fig leaf for disguising what was really a dollar standard. But now the IMF's parity obligation for membership exists no more; it was blown apart by the American inflation of the 1970s.

On the economic side, the modern reluctance of any one government to declare an official dollar parity appears too risky precisely because neighboring countries have not done so. If Country A (say, Argentina) declared an official dollar parity, and then a its close neighbor Country B (say, Brazil) allowed its currency to depreciate against the dollar, Country A could lose competitiveness and be badly hurt. Better for A not to commit itself formally to a particular dollar exchange rate to begin with in case it may want to depreciate in response to a surprise depreciation by B. Hence A dare not commit if B, C, D..... have not committed—and vice versa. In effect, there is a need for collective action—as in 1945—to re-institute a more general system of dollar parities to prevent beggar-thy-neighbor devaluations.

But the old collective agreement under high Bretton Woods was undermined by the American inflation of the 1970s into the 1980s. With no stable anchor currency, maintenance of the old regime of exchange parities became impossible. Now, although the American price level has now been quite stable for almost a decade, the IMF has not attempted to orchestrate a collective return to a parity regime. Whence the prevalence of soft dollar pegging where governments, forced to act individually, are unwilling to commit themselves to anything harder.

The IMF's Article VIII—the commitment of member countries to work toward current-account convertibility, i.e., to remove all restrictions on making or receiving payments from importing or exporting or repatriating interest and dividends, was equally important for the success of high Bretton Woods—and retains its crucial importance today.

But, in the 1950s and 1960s, the obligation of member countries to liberalize exchange controls stopped with Article VIII. Because of the bad experience with "hot' money flows in the 1930s, the peripheral countries around the United States all retained some degree of control over international capital movements—particularly short-term financial flows. The industrial countries of Western Europe retained capital controls well into the 1970s—and Japan into the early 1980s. Indeed, the IMF's ar-

ticles required any member country receiving funds under a Fund program to impose capital controls if there was any danger of capital flight.

In summary, the IMF's policies today suffer from major sins of omission and of commission. On the omission side, it has failed to promote regional exchange rate stabilization (where feasible) by encouraging the restoration of official exchange rate parities—as if the beggar-thy-neighbor exchange rate devaluations of the 1930s had been forgotten. Apart from outright dollarization, the IMF has even leaned on individual developing countries to flex their exchange rates as if the effect of such changes on neighboring countries did not matter.

For its sin of commission, the IMF has actively encouraged peripheral countries to jettison their capital controls too soon in the process of liberalization—not recognizing the natural asymmetry between a strong center and naturally weaker periphery. (Although within the last year or two there are signs that the IMF may be repenting.) Consequently, dollar encroachment on the monies of developing countries and emerging markets in domestic uses is more pronounced than need be.

The Problem of Dollar Encroachment

This central role of the dollar in international finance today has a darker side: the potential displacement of national monies for domestic uses—displacement that is particularly marked in the Latin American context. Box 2 summarizes how the U.S. dollar might encroach (has encroached) on the natural domains of national monies as medium of exchange, store of value, unit of account, and standard of deferred payment within the country in question. In countries with a history of high and variable price inflation, the dollar encroaches on the national monetary domains in all four dimensions. But outside of this inflationary extreme, encroachment is still a problem.

To be sure this dollar encroachment is not now a problem in the industrial economies, although it was a potential problem in the aftermath of World War II when European and Japanese currencies suffered from a complete loss of confidence. Most countries in Western Europe, as well as Japan, retained capital controls well into the 1970s—in large part to protect the domains of their domestic currencies. But step-by-step European unification, culminating in the late 1990s with the adoption of the euro, ended any lingering problem of dollar encroachment in Europe.

This huge new, but highly credible, euro-based regime can operate on a stand-alone basis with perhaps the world's largest market for long-term bonds.

But for countries outside of Europe in the new millenium, let us consider the problem of dollar encroachment in the context of each of the basic domestic functions of money—as laid out in Box 2—in turn.

As *medium of exchange* as per Box 2, the dollar now circulates widely as hand-to-hand currency throughout Latin America, Africa, and many part of the former Soviet Union. In several Latin American countries, dollar bank accounts (interest-bearing and some checking) have even been legalized. This parallel circulation means that comprehensive capital controls, designed to prevent switching between the domestic money and dollars, are impossible to enforce. (But mild reserve requirements or taxes on foreign borrowing, as in Chile until recently, may still be feasible.)

Box 2
Dollar Encroachment on National Monies in Domestic Uses: Developing Countries on the Dollar Standard's Periphery

- *Medium of Exchange.* Dollar banknotes or deposits circulate in parallel with domestic money in many Latin American, African, and FSU countries but not generally in Asia.
- *Safe Haven (Store of Value).* In normal times, domestic currency assets held only at higher real interest rates than those on similar-term dollar assets: the existence of positive country- or currency-risk premia against the dollar. Private and official liquid dollar assets partially displace holdings of domestic liquid assets.
- *Unit of Account.* Money wage and other short-term domestic contracts directly or indirectly linked to dollar exchange rate. Most common in emerging markets with a history of financial volatility—or ones in the throes of an attempted stabilization program. Uncommon in Asia.
- *Standard of Deferred Payment*: Short-term foreign borrowing—trade credit or interbank borrowing—as well as longer term sovereign bond issues to foreigners are usually dollar denominated. U.S. Treasuries are the "risk-free" asset against which risk premia in interest rates for national dollar bonds are measured. Private long-term bond markets in the domestic currency hardly exist—being dominated by international dollar-bond markets.

Why have Latin American monetary authorities and several elsewhere allowed such invasive parallel circulation in dollars, where the demand for the domestic monetary base erodes and becomes quite unstable, to develop?

First, many governments, with short time horizons of their own, want to attract emigrant remittances to the home country.

So they offer domestic dollar deposits to nationals returning money to the country. (Even if Mexico's banking system does not now offer dollar-linked bank accounts, Mexico's long border with the United States with heavy two-way migration makes holding of interest-bearing dollar bank accounts just across the border very easy.)

Second, where records of illegal export earnings don't exist for very important export products, such as narcotics, the national government can neither tax them nor force conversion of dollar export proceeds back into its domestic currency. Better to keep at least some of the dollar proceeds from the coca trade in banks within the country by offering attractive domestic deposit facilities in dollars.

Last, but not least, is the long history in almost all Latin American countries of persistent financial instability: high inflation, temporary stabilizations, currency crashes, renewed inflation, and so on. Holders of naked cash balances in the domestic currency have been heavily taxed in the past. Thus, the precautionary motive for holding at least some dollar balances, at home or abroad, is strong. Similar relatively large dollar holdings are commonplace in much of Africa and in the disintegrated fragments of the old Soviet Union—including Russia itself.

But the internal circulation of dollars in parallel to domestic currencies is not a general phenomenon. Virtually all the economies of East Asia provide counter examples. By and large, they did not have the same turbulent history of inflation and currency attacks so common in Latin America in the postwar. Even in those economies—Indonesia, Korea, Malaysia, Philippines, and Thailand—whose currencies were attacked in the great crisis of 1997-98, the internal circulation of U.S dollars was negligible before the attacks began and (with the possible exception of Indonesia) and is negligible today. These crisis economies—as well as the non crisis ones of China, Hong Kong, Singapore, and Taiwan—all had what looked like sustainable, if informal, fixes for their dollar exchange rates before 1997 and after 1998.

However, as a *store of value* as per Box 2, interest-bearing dollar assets dominate domestic assets of the same term to maturity in Asia as well as in Latin America and other developing countries—unless protected by effective capital controls (as in China). A political or economic crisis in any one of the developing countries on this periphery of the dollar standard generates pressure from domestic nationals to fly into interest-bearing dollar assets as a safe haven.

Even in East Asia (except for Japan), firms and households will only willingly hold domestic bonds or interest-bearing deposits if they bear a real rate of return higher than those on dollar bonds at an equivalent term to maturity. In effect, a substantial risk premium must be paid on term deposits (or bonds) in domestic currency compared to term deposits (or bonds) denominated in dollars—and this risk premium is typically much greater at long term than at short term. Indeed, the risk premium on long-term bonds denominated in domestic currency may be so great that an open market at the long-end of the maturity spectrum usually doesn't exist.

How to measure this risk premium, i.e., distinguish it from the expected annualized depreciation (or appreciation) of the domestic currency, is a tricky econometric problem. Moreover, within developing economies, interest rates are highly variable—both in time series and across countries. Before the 1997 currency attacks began in Thailand, the relevant risk premia on three-month deposits in the East Asian debtor economies averaged about 4 percentage points, whereas in Latin America they averaged closer to 5 to 6 percentage points, above those on benchmark dollar assets.

In the financial markets, *unit of account* and *standard of deferred payment* in Box 2 are closely related concepts, and refer to money's role as a numéraire in domestic contracts: the former is more of short-term concept whereas the latter is longer term. For longer term private debt contracts within Latin American countries, the dollar is commonly used as the standard of deferred payment even when the domestic currency is used as the means of settlement. The presumption is that dollar keeps its real purchasing value through time better, and that one can get instantaneous exchange rate quotes on the value of the dollar in domestic currency when the contract matures. Correspondingly, private debt contracts are seldom linked to domestic price indexes—such as the WPI or CPI—in part because of doubts over the statistical reliability of such indexes and because of lags in collecting price data.

Even with the dollar as numéraire for domestic private and many sovereign bond issues, such bond issues are usually short term—or have a floating interest rate set by the yield on short-term (30-day) assets. Dollar predominance in the international long-term bond markets—where U.S. Treasuries are considered to be the world's "risk-free" asset—provides a competing asset that inhibits the issue of long-term bonds, particularly those issued by the private sector in developing countries. The absence

of a firm long-term exchange rate parity that keeps the purchasing power of domestic bonds fairly constant in terms of the world's risk free asset, i.e., U.S. Treasuries, significantly hinders markets in domestic long-term bonds in the peripheral countries.

The upshot is what Ricardo Hausmann calls "original sin" in emerging-market economies. Finance remains very short-term—and the (large) international component of borrowing and lending is denominated in someone else's currency, i.e., dollars. Without a domestic bond market, financial systems in the peripheral countries are more accident prone—which in turn reinforces the inherent asymmetry between weak currencies on the periphery and the strong currency at the center. Both the domestic financial instability that he emphasized, and the international competition from dollar assets that I emphasize, combine to make redemption from original sin very difficult.

II. THE EAST ASIAN EXCHANGE RATE DILEMMA

With this view of how the world dollar standard works in the modern era, what are its implications for East Asia? The East Asian economies including Japan now trade as much with each other as they do with the rest of the world. Because this economic integration continues, a common monetary standard is becoming more necessary. Interest rates must be better aligned and exchange rates made more stable.

Otherwise, in the face of great interest rate disparities and uncertain exchange rates, "hot" money flows—cycles of overborrowing followed by capital flight and currency crashes—as in Indonesia, Korea, Malaysia, Philippines, and Thailand, in 1997-98—will recur. When exchange rates change, the spillover effects from one country to another can generate waves of regional inflation or deflation. Thus much of the potential economic benefit from the ongoing integration in goods and capital flows in East Asia could be lost—as the countries of the European Union (EU) learned to their discomfort before the advent of the euro in January 1999.

On the positive side, East Asian countries collectively have the fiscal potential for securing regional monetary stability. Each—with the possible major exception of Indonesia—has sufficient taxing capability, or a large enough domestic banking system, to support its government's finances without inflating. True, their governments can fail to properly regulate their banks and control

their money supplies. But, unlike most countries in Latin America and Africa, countries in East Asia need not resort to the inflation tax and ongoing currency depreciation out of fiscal necessity. Thus, East Asian governments could collectively decide on regional monetary harmonization with stable domestic monies. "Could" is not the same as "will" of course. But, unless the economic pros and cons are spelled out, the political *will* will always be lacking.

Short of introducing an "Asian euro" (and certainly none is in prospect), what monetary impasse inhibits collective progress towards regional exchange rate stability? This East Asian dilemma" has three interrelated facets.

First, all the East Asian countries except Japan have more or less pegged their currencies to the U.S. dollar—both before and since the 1997-98 crisis. In the absence of major crises, dollar pegging had served before 1997, and does serve now, as a nominal anchor for their domestic price levels while reducing risks in international flows of short-term capital. But the continued use of an "outside" currency as the monetary basis for securing economic integration seems anomalous and remains controversial.

Second, Japan's position with respect to the United States is peculiarly unbalanced. Although Japan is the region's and world's largest creditor country, most of its accumulated claims on foreigners are denominated in a foreign currency, i.e., dollars. When the yen appreciates, Japanese financial institutions suffer balance-sheet losses (measured in yen). Moreover, since 1945, Japan has been vulnerable to American pressure to change this or that domestic policy. Sometimes this pressure is warranted—as when the Americans push for greater liberalization of the Japanese economy. On the negative side, however, episodic American pressure on Japan to appreciate the yen from 1971 into 1995, ostensibly to reduce Japan's trade surpluses, imparted the deflationary momentum to Japan's economy which continues today. Since the late 1970s, this expectation of an ever higher yen and ongoing deflation has helped drive nominal interest rates on yen assets about 4 percentage points below those on dollar assets.

Since 1995, however, the yen has not appreciated on net balance—although it continues to fluctuate widely against the dollar. Nevertheless, the interest differential between yen and dollar assets at all terms to maturity remains as wide as ever—3 to 5 percentage points. Part of the differential could be explained by the market's fear that American mercantile pressure on Japan to appreciate the yen might return—particularly if the American

economy turns down. A second part of the differential arises from the risk that Japanese financial institutions now see from holding large stocks of dollar assets, which have been accumulated over the past 20 years of Japan's current account surpluses. Because the yen value of these dollar assets fluctuates with the exchange rate, a negative risk premium reduces interest rates on yen compared to those on dollar assets. Otherwise, private Japanese financial institutions would have insufficient incentive to hold the "surplus" dollar assets.

These two sources of upward pressure on the yen, i.e., the fear of American mercantile pressure and the huge stocks of dollar assets now owned by Japanese financial institutions, force Japanese nominal interest rates below American when the yen/dollar rate is untethered. But, as long as American nominal interest rates were high as in the 1970s and 1980s, having interest rates lower in Japan was relatively harmless. However, when American interest rates themselves fell to lower levels (on average) from the mid-1990s through 2001, short- and long-term nominal interest rates on yen assets became trapped near zero. In this "externally imposed" liquidity trap, the Bank of Japan remains helpless to deal with the country's deflationary slump.

Third, the financial *interaction* between Japan and the East Asian dollar bloc has been a major source of instability caused by unpredictable changes in the untethered yen/dollar exchange rate when the other East Asian countries are tethered to the dollar. These fluctuations in the yen/dollar rate aggravate fluctuations in income and employment. When the yen is overvalued against the dollar, it is also overvalued against all its East Asian trading partners. This induces an inverse business cycle: other things being equal, when the yen is high, the other smaller economies boom while Japan's is depressed—and vice versa.

Also, the discrepancy between the very low interest rates in Japan and the normally higher interest rates in the dollar bloc of East Asian trading partners exacerbates "hot" money flows in the region. For both banks and non financial corporations in East Asian emerging markets, the margin of temptation to borrow unhedged in foreign exchange can be overwhelming when interest rate differentials are large.

The so-called yen carry trade is a case in point. Before the 1997-98 crisis, banks in some of the East Asian debtor economies would accept low-interest dollar or even lower interest yen deposits; then they would on lend at the much higher yields available on domestic-currency loans. This risky currency mismatch was

not confined to financial institutions in the debtor economies themselves. With a low-cost deposit base in yen, Japanese banks acquired higher yield assets in dollars, baht, won, rupiah and elsewhere. Last but not least were (and are) the highly speculative so-called hedge funds that would borrow in Tokyo and on lend in Seoul, Bangkok, Jakarta, and so on. These hedge funds move funds immediately with any whiff of a possible exchange rate change—very hot money indeed!

Such hot money flows were the genesis of the 1997-98 crisis. In the debtor economies of Indonesia, Korea, Malaysia, Philippines, and Thailand, corporations and banks had built up huge uncovered dollar and yen liabilities. When their currencies were attacked, these short-term foreign currency liabilities could not be rolled over. This sudden switch from capital inflows to capital outflows left them helpless to prevent their currencies from depreciating. The depreciations made repaying of their foreign-currency debts, from earnings streams denominated in their domestic currencies, impossible.

A less well-known consequence of the crisis was severe deflation in the *dollar* prices of all goods entering East Asian trade. As the demand for imports by the crisis economies collapsed, and their exports were artificially stimulated by the deep devaluations of their currencies against the dollar, the American nominal anchor could not hold. That is, commodity arbitrage with the center country was insufficient to prevent the dollar prices of goods and services in East Asia from dipping substantially below those prevailing in the United States. Thus, those East Asian economies which were not forced to devalue—China and Hong Kong have maintained their pre-crisis dollar exchange rates to the present day—suffered severe internal deflations, i.e., price declines measured in terms of their domestic currencies. But their exchange rate steadfastness in the face of falling domestic price levels saved East Asian economies from the much greater calamity that would have ensued if China and Hong Kong had depreciated as well.

Clearly, the East Asian monetary system remains unbalanced and accident prone. The post-crash "honeymoon" of 1999 until the present—where short-term interest rates in the crisis economies fell to unusually low levels, and financially chastened corporations, banks, and bank regulators, turned ultra cautious—will not persist indefinitely. The unusually low interest rates on baht, won, and ringgit bank deposits reflect overshooting (overdevaluation) of their currencies, leading to some net expectation of mild

appreciation. Once equilbrium real exchange rates are restored, interest rates in these peripheral economies will increase, and the interest differential with the US and Japan (the margin of temptation to overborrow) will widen once more—particularly with Japan stuck in a deflationary slump where short-term interest rates remain close to zero.

Reform Objectives

To overcome this financial fragility and lessen incentives for hot money flows, what should be the key objectives of a reformed East Asian dollar standard? A reformed regime should aim for

(1)greater *long-run* exchange rate security among all the East Asian economies—not only among the current dollar bloc countries but with Japan itself;

(2)a common and highly credible monetary anchor against

(i) the risk and fear of *inflation* in the debtor economies, and

(ii) the risk and fear of *deflation* in Japan;

(3)mutual understanding of more appropriate policies for regulating banks and international capital flows.

One incidental consequence would be a better interest rate alignment—smaller interest differentials between debtor and creditor. Speculative hedge funds would no longer be attracted to the yen carry trade. The need for draconian regulation of banks and other financial institutions to prevent undue foreign exchange exposure and overborrowing would be lessened. However, for some emerging-market countries, capital controls (as in China) to prevent undue financial risk-taking would still be necessary.

A second consequence would be the dampening, or elimination, of the intra-East Asian business cycle generated from fluctuations in the yen/dollar rate. However, even a reformed East Asian dollar standard would remain vulnerable to worldwide disturbances—including those associated with the United States itself.

A third consequence would be help in overcoming Japan's prolonged economic slump. The expectation of ongoing deflation in Japan is now so ingrained that a major international program for ending the threat of yen appreciation and ongoing internal deflation must be seriously considered.

The East Asian Dollar Standard

For more than a decade, the Japanese government has lobbied for the formation of a yen zone in East Asia. Fluctuations in the yen/dollar exchange rate have been all the more disruptive in Japan itself because other East Asian nations—ever more important trading partners—have been pegged de facto to the dollar. Thus prominent economists in Japan and elsewhere advocate weaning Japan's East Asian trading partners away from their fixation with the dollar towards pegging to a trade-weighted currency composite. In such a "basket peg", the yen would have a heavy weight reflecting Japan's role as the largest East Asian trading country. Then, with each of the other East Asian countries pegged to such a basket, changes in their real exchange rates and Japan's would be dampened as the yen/dollar rate fluctuated.

Although smoothing regional fluctuations is all well and good, this basket-peg approach misses the main motivation of why the smaller East Asian economies choose to peg—however loosely and unofficially—to the dollar. The world is on a dollar standard where trade flows in East Asia are overwhelmingly dollar invoiced. Concomitantly, international flows of finance—including huge flows of short-term payments—are also largely dollar denominated. Thus, in non crisis periods, monetary authorities in emerging markets in East Asia have a dual motivation for trying to keep their exchange rates from moving much against the dollar:

(1) Each central bank seeks an *external nominal anchor* as a target or instrument, or both, for securing its national price level when its domestic capital market is underdeveloped. To anchor the domestic price level effectively, a country's dollar exchange rate can't be allowed to move too much on a low frequency basis, i.e., measured monthly or quarterly, although a few East Asian countries have allowed some drift either up or down at these frequencies.

(2) Because finance is so short term in emerging markets generally and in East Asia in particular, monetary policy is organized so as to keep dollar exchange rates very stable at high frequency levels, i.e., measured on a weekly or even a daily basis. *Foreign payments risk is reduced* under high frequency dollar pegging.

So if any East Asian emerging market changes its policy and opts to peg—both at low and high frequencies—against a com-

posite currency basket, its dollar exchange rate will necessarily fluctuate more widely. Hence that country's nominal anchor for domestic prices will become less secure and domestic financial risks will increase—possibly leading to a higher risk premium in its domestic interest rates.

Why not go to the opposite extreme and have all emerging markets in East Asia peg to the yen? The problem is that the yen is not an international currency. Official yen pegs—certainly at high frequencies—would increase the risks of making high frequency dollar payments. Nor would a peg to the yen on a monthly or quarterly basis be a satisfactory nominal anchor for prices and interest rates in other East Asian countries. For over a decade, Japan has been unable to shake its ongoing price deflation and economic slump. Thus other East Asian countries would not want to import that deflation by pegging to the yen, and still less would they want interest rates near zero as in Japan. In contrast, U.S. monetary policy in the 1990s until today presents a better choice for a common East Asian monetary anchor. But, unlike diamonds, nothing is forever.

East Asia still does not have the degree of economic integration of the countries in the European Union. Nor is it anywhere close to having the necessary political cohesion to impose the fiscal conditions on member countries necessary—in the mode of the Maastricht Treaty—for introducing an independent regional currency similar to the euro. Thus, to resolve the exchange rate dilemma, the East Asian dollar standard needs to be rationalized rather than jettisoned.

New Rules for the Dollar Standard Game: A Return to Fixed Exchange Rate Parities?

One way of creating a zone of greater exchange rate stability around Japan would be to require the other East Asian countries to peg more to the yen. But then the 10 emerging markets in East Asia would collectively, and against what they (correctly) perceive to be their own best interests, have to change their existing exchange rate practices of keying on the dollar. Instead, the political economy of the situation suggests an alternative route. To build an East Asian zone of monetary and exchange rate stability around Japan, Japan itself should join the dollar bloc: "if you can't beat 'em, join 'em".

Could fixing the yen to the dollar within a narrow range in the medium term, and with no upward drift in the longer term, ever

be done credibly? Only if there is an explicit agreement with the United States. Beginning in 1971, episodes of American pressure to get the yen up in the face of high and rising Japanese trade surpluses set in train, by the 1990s, much of the deflationary pressure and near zero interest rates we see in Japan today. Thus, quashing the expectation of an ever-higher yen and ongoing deflation requires a pact between the U.S. and Japan with two main provisions:

(1)a commercial accord, perhaps in the form of a bilateral free-trade agreement, for mediating trade disputes *without* resorting to, or advocating, changes in the yen/dollar exchange rate;

(2)a monetary agreement establishing a long-term parity or benchmark value for the *nominal* yen/dollar rate close to its purchasing power parity (PPP), i.e., that rate which approximately equalizes producer costs in the two countries on the day that the agreement is signed.

To maintain this new parity, say 120 yen/dollar, the two governments would stand ready in the short run to intervene jointly—but only if the market rate began to diverge sharply from 120. Without committing themselves to a narrow band with hard margins, they would stand ready to keep nudging any errant market rate back toward 120. As long as these interventions were done jointly and in a determined fashion, the signaling effect to the markets would be sufficiently strong that little if any immediate monetary adjustment would be required in either country.

However, to maintain the constant rate in the medium and longer terms, monetary adjustment would be necessary. The main responsibility for adjusting would be with the Bank of Japan rather than with the U.S. Federal Reserve Bank. As nominal interest rates on yen assets rose toward those on dollar assets (Japan escapes from the liquidity trap), the Bank of Japan would stand ready to withdraw or inject domestic base money into the system to maintain the yen/dollar benchmark parity.

In contrast, the Federal Reserve would not adjust the American monetary base to fluctuations in the yen/dollar rate—or in any other exchange rate. Instead, as befits the center country, the Fed would focus—as it does now—on managing the U.S. money supply to stabilize the American price level. Under the dollar standard, the American price level becomes the anchor to which other countries adjust.

Once the “loose cannon”, i.e., the yen/dollar rate, is properly

secured over the long term, the other East Asian countries could more easily convert from informal dollar pegging with drift, to fixed dollar parities with no long-term drift. But why should they even bother converting to more formal long-term exchange parities? The answer is threefold.

(1)A currency attack on any one country becomes less likely, and less damaging if does occur. If the long-term parity is credible, then any sudden crisis where the government has to float the currency and let it depreciate sets up the regressive expectation that the domestic currency must eventually appreciate back to its long-term parity level. Regressive exchange rate expectations limit the extent of any immediate crisis-induced devaluation while reducing the increase in short-term interest rates necessary to defend the currency.

(2)Contagion through (inadvertent) beggar-thy-neighbor devaluations is better contained. If markets know that an unexpected devaluation by any one country is only temporary, then the mercantile pressure on neighboring East Asian countries to let their currencies depreciate will be less. And to complete the virtuous circle, any one East Asian country would find it much easier to maintain the credibility of its long-term dollar parity if neighboring counties, which are also mercantile competitors, were on the same exchange rate regime.

(3)Developing a long-term domestic bond market while reducing risk premia at all terms to maturity becomes easier. Under the world dollar standard, U.S. Treasury bonds are the "risk free" or safe haven asset in the international capital markets. For a smallish and financially open emerging market economy, domestic long-term bond issues will never be attractive unless their payouts at maturity have the same (rough) purchasing power as U.S. Treasuries.

So the payoffs from formalizing the East Asian part of the world dollar standard could be substantial. More secure exchange rate commitments by the smaller, crisis-prone debtor economies—and by Japan as the big creditor—would mutually reinforce the common nominal anchor. A fixed yen/dollar exchange rate is a more powerful anchor against ongoing deflation in Japan if Japan's East Asian neighbors also have secure long-term dollar parities. And vice versa. Emerging markets like Korea would find that long-term dollar pegging is much more attractive when the yen/dollar rate is finally tethered.

Because of China's rapid economic growth and now huge GNP, its ongoing commitment to a longer-term dollar parity is (would be) particularly beneficial for the East Asian economic system as a whole. Indeed, China's maintaining a fixed exchange rate of 8.3 yuan to the dollar during the great crisis of 1997-98 prevented contagious devaluations from being much worse.

China now has an additional reason for formalizing its exchange rate commitment at 8.3 yuan per dollar. Because of the recent large influx of Chinese exports into Japan, Japanese businessmen and farmers are lobbying with some success for tariff and quota protection against Chinese goods. And they also want the Chinese government to appreciate the renminbi! But, of course, appreciation of the RMB would force more deflation on China—just as the lobbying by American businesses to get the yen up in the 1970s through 1995 forced deflation on Japan! Better to secure the East Asian economy by formalizing long-term parity commitments such that governments can't be credibly accused of manipulating their exchange rates for commercial advantage. The common monetary standard in East Asia should be neutral, and seen to be impartial, to the ebb and flow of mercantile competition.

Paul Gilbert
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Towards new money measures

1. INTRODUCTION

1.1 Overview

Monetary aggregates have been used for half a century to predict economic activity and inflation, more successfully in some periods than others. However, since the late 1970s, successive waves of financial innovations have made it increasingly difficult to measure the underlying growth of money. In particular, it is hard to differentiate balances used for transactions from those used for savings. Having a good measure of transactions money is important because theory suggests it will have the most predictive power for output and inflation. This paper presents preliminary work from

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a project to develop a new measure of money that has a more satisfactory means to identify and remove the effects of financial innovations. The proposed measure also differs significantly from previous measures in that it is not an aggregate. By this we mean that it measures activity instead of account balance items. Activity refers to economic agents' behaviour.

More precisely, we attempt to establish indexes of intended usage (e.g. transactions and savings) rather than aggregate deposit balances according to some classification scheme. The classification scheme was once designed to provide a proxy for these underlying phenomena but the classification scheme is breaking down and we now think it is better to move to an explicit attempt to measure an index of intended usage.

The next sub-section of this *Introduction* explains the motivation of the larger project, for which this paper presents some preliminary results. The section on *Monetary Aggregates* surveys current methodologies and aggregates, outlining the literature and known problems. The section *A New Approach to Measuring Money* describes the new proposed approach, including some simulation results from studying the estimation techniques and some preliminary results. The final section outlines future directions.

1.2 Motivation

Past attempts to improve Canadian monetary measures have included the development of the narrow aggregates M1+ and M1++ which include a broader range of accounts than M1, and adjusted M1 which is a model based definition of money.[1] However, none of these is completely satisfactory. M1+ and M1++ aggregates include savings balances, and adjusted M1 mutes some of the predictive power of money.

Official monetary aggregates in Canada are a simple sum of currency and various deposits, classified according to their characteristics. Narrow aggregates attempt to measure transactions money and so are composed of currency, demand deposits, and some other deposits traditionally associated with transactions.

[1] M1+ is defined as the sum of currency held by the public and all chequable (demand and notice) deposits at chartered banks, credit unions and caisses populaires (CUCPs), and trust and mortgage loan companies (TMLs). M1++ is the sum of M1+ and all non-chequable notice deposits at chartered banks, CUCPs, and TMLs. For general background about analysing the monetary aggregates at the Bank of Canada see Maclean (2001).

Broad aggregates also include deposits associated with savings. Technological progress poses two major problems for the measurement of transactions money. Firstly, transaction money is a measure of purchasing power, but this purchasing power can now be accessed in a variety of ways. Savings and transactions balances are not held in clearly defined separate accounts, but rather are mixed together. Also, investment accounts and stock market-oriented deposits have become more popular in the late 1990's. While aimed more at savings balances, the money in these accounts is still very liquid and available for any kind of transaction. Soon many deposits may be in accounts "tailor-made" for the habits of a person, not for the purpose of which the money in the account is intended to be used. Secondly, many transactions balances are held in accounts that are not included in current narrow monetary aggregates and there are new deposit-taking institutions not included in the aggregates, such as investment dealers, life insurance companies and near banks, which offer new types of deposits. Moreover, the information revolution has considerably changed agents' behaviour regarding their money management and, in particular, money can be moved from one account to another very easily and quickly. A simple phone call or a visit on the Internet is sufficient. When this money is transferred between institutions included in the aggregates and those excluded, it produces spurious fluctuations in the aggregates which can reduce their predictive ability.

For these reasons the old classification system is breaking down. Currently individual problems are dealt with on a case-by-case basis but this is becoming increasingly difficult. Research is needed to develop a new measure of money that can be used by analysts as the current classification system continues to break down and eventually fails. These new money measures should not depend on features of the different accounts, as these are becoming increasingly diverse and very difficult to classify and measure.

We propose using dynamic factors to overcome the two problems identified above. Dynamic factors allow us to focus on measuring the underlying economic activities rather than the amounts in historical deposit classifications. We think this approach offers the best way to address the innovation problems because it distinguishes the underlying economic activities (economic agents intentions to transact or save) from the measured items (balances in accounts), which are affected by the above mentioned financial innovations. Despite the instability in the characteristics of deposit

accounts we believe the technology revolution has not changed the fundamental uses of money for economic activities that we are trying to measure.

One important difference between the proposed dynamic factor approach and the traditional aggregation approach is that it is no longer necessary to include all deposit-taking institutions to compute a valid measure. Only a good sample of deposits is required to get a measure representative of the fundamental activities, while aggregation requires correct classification and data from all institutions to build good aggregates.

2. MONETARY AGGREGATES

2.1 Existing Methodologies

Official monetary aggregates in Canada are a simple sum of currency and various deposits with weights for all components set to one. This implies that all monetary assets should be dollar-for-dollar perfect substitutes. This is not true since some are clearly less liquid and give a higher yield than currency and demand deposits. Hence, the monetary aggregates constructed by a simple summation provide a good measure of the stock of nominal monetary wealth but are not a structural economic variable.

To account for substitutability, and for the fact that certain kinds of accounts have both a transaction and a saving nature, attempts have been made to consider weights for components. Barnett (1980)2[2] suggests the Divisia index. This monetary aggregate is constructed by combining monetary theory with statistical index number theory and micro economic aggregation theory. It measures the flow of services produced by the component assets.

The Divisia index is a time-varying weighted monetary aggregate where the weights are expressed in terms of the contribution of each component to the total value of services provided by all monetary assets. This index is derived from the optimization behaviour of economic agents. It is reputed to have better theoretical foundations than the simple-sum monetary aggregates. Also, some consider that the Divisia index is better adapted to the context of continuous financial innovations because it internalizes substitution effects. However, monetary authorities are reluctant

[2] See also Barnett and Serletis (2000).

to publish these monetary aggregates because their construction requires various subjective choices that make them almost impossible to reproduce.[3, 4]

Others have worked to measure transaction balances. Spindt (1985) suggests a weighted monetary aggregate (MQ) derived from the quantity theory of money equation, $MV = PQ$. Weights are based on each monetary asset's velocity (turnover rate). Another attempt to measure the liquidity services is the currency-equivalent (CE) monetary aggregate proposed by Rotemberg, Driscoll and Poterba (1995). This aggregate has some improvements but is similar to Divisia in the sense that it is derived from an optimization problem. Nevertheless, it has not been used because practical issues in addition to those related to the Divisia index have emerged. For example, weights tend to be highly volatile, which complicates interpretation and empirical use.

2.2 Empirical Evidence in Canada

Many studies have assessed the performance of monetary aggregates in terms of various criteria such as their information content, money-income causality, and stability in money demand equations. In general, the results are mixed. For Canada, Cockerline and Murray (1981) find that Divisia aggregates contain less information on contemporaneous and future levels of income than summation aggregates. Summation aggregates also appear to be superior in causality tests. On the other hand, the study finds Divisia indices to be more stable in money demand equations, which is consistent with the fact that these aggregates tend to follow more consistent time paths than their summation counterparts.

Hostland, Poloz and Storer (1987) also look at the information content of alternative monetary aggregates. They compare summation aggregates with Fisher ideal indices of monetary services.[5] They conclude that the information loss through simple-sum aggregation is not significant. In other words, the Fisher ideal aggregates add very little information to improve income and price

[3] The Bank of England and the Federal Reserve Bank of St-Louis are the only institutions that publish Divisia indices in their official statistics.

[4] For a detailed discussion on the disadvantages of Divisia indices, see Cockerline and Murray (1981), Fisher, Hudson and Pradhan (1993) and Longworth and Atta-Mensah (1995).

[5] Like Divisia, Fisher ideal monetary aggregates are known as *superlative* indexes.

forecasts. Serletis and King (1993) examine the empirical relationships between money, income and prices, comparing summation aggregates to Divisia. They find that the growth rates of Divisia aggregates are more useful than summation aggregates for forecasting nominal income fluctuations, while the growth rate of the summation aggregate M2+ is the best leading indicator of inflation.

The results in these Canadian studies are consistent with those of other researchers using data for different countries.[6] Despite the theoretical advantages of Divisia aggregates, they have not been shown clearly superior to summation aggregates.

2.3 Adjusted M1

In recent years, movements in M1, the traditional measure of transactions money used by the Bank of Canada, have been affected by financial innovations.[7] This has changed the relationships between money, output and inflation and, as a result, the M1-based models have been unstable. Since alternative aggregates described above were not very successful, economists at the Bank of Canada create a new model-based measure of transaction balances called adjusted M1.[8]

The objective of adjusted M1 was to correct instability in the main money-based model used at the Bank of Canada (the M1-VECM model).[9] It is obtained in two steps. First, using the money-forecasting equation from a M1 VECM estimated with a sample ending in 1993 (the beginning of the second wave of innovations according to Aubry and Nott (2000)), a forecast of M1 is obtained for the period 1992Q1 to the last quarter of available data (National Accounts). This time-series is called "distortion-free" M1 and can be interpreted as an estimate of what M1 would have been if no changes in the data-generating process had occurred in the 1990s. Second, this series is regressed on the components of the monetary aggregates. This step relates the distortion-free money to the observed money data released every

[6] See, for example, Bailey et al.(1982a, 1982b), Driscoll et al. (1985), Horne and Martin (1989) and Subrahmanyam and Swami (1991).

[7] See Aubry and Nott (2000) for a detailed discussion on financial innovations.

[8] See Adam and Hendry (2000) for details on the development of adjusted M1.

[9] The M1-VECM is developed in Hendry (1995).

month. Adjusted M1 is thus a weighted sum of components' levels.

Unfortunately, adjusted M1 is not free of problems. Some serious deficiencies are associated with each step of the procedure. In the first step, the choice of the estimation period is problematic. 1993 was chosen as the end of the sample under the assumption that most financial innovations occurred after this period. However, M1 was probably distorted before this date.

Calculating "distortion-free" M1 from stable money demand is another problem, since it implies that structural changes over the 1990's affected only the money supply, but money demand could also have shifted in response to these changes.

The way adjusted M1 is constructed it may lose valuable information as a money measure for analysis. The construction mutes some of the predictive power of money. For example, fundamental movements can be removed while attempting to remove distortions. In addition, we find that the weights on the components are unstable and very sensitive to the choice of the sample in the second step. Some weights are also counter-intuitive (e.g. the weight on currency is above 1). Finally, adjusted M1 is a model-dependant money measure which is quite dangerous. If the model is wrong, then adjusted M1 may not measure transactions money. All things considered, this approach has not been as successful as hoped. This leads us to now consider a completely different approach that does not rely so fundamentally on a specific economic theory.

3. A NEW APPROACH TO MEASURING MONEY

3.1 Dynamic Factor Analysis (DFA)

A factor is an index that can be used to indicate the evolution of an activity. Indexes are already familiar to economists and statisticians. Brillinger (1975) in introducing the technique used in this paper quotes Bowley (1920):

> *"Index numbers are used to measure the change in some quantity which we cannot observe directly, which we know to have a definite influence on many other quantities which we can observe, tending to increase all, or diminish all, while this influence is concealed by the action of many causes affecting the separate quantities in various ways."*

In recent years, economists have made increasing use of DFA (sometimes called dynamic latent variables) for estimating "un-

derlying" processes. These processes may correspond closely to the economic concepts which macro economists have in mind when they build models. The techniques have been used to propose better measures of underlying inflation,[10] applied to the real side of the economy,[11] and used in arbitrage pricing theory models of financial decision making.[12] Despite the conceptual appeal of the techniques, to our knowledge no one has used these methods to measure transactions and monetary savings activities. One reason may be that the deposit data have not been organized in a suitable way for applying these techniques. Our first job was to fix that problem by adjusting money components to account for changes such as acquisitions that occurred in the financial sector. Previously this was only done for the aggregates and not for the components.

In broad terms, DFA is a branch of multivariate statistical analysis in which the observed variables xi (i = 1, 2,..., p) at each period t are expressed in terms of r factors (or latent variables) fj, where $r < p$, and idiosyncratic terms ei (residuals). The model is given by the equation:

$$X_i = \sum_{j=1}^{r} A_{ij} f_j + e_i \qquad (1)$$

at each period t, or in matrix form

$$x_t = A f_t + e_t \qquad (2)$$

where A is a $p \times r$ matrix of weights.

There are $p*r$ unknown weights (also known as *factor loadings*) and r factor series to be estimated with only p observed series. All these weights and factors are estimated simultaneously. In a following section, the constraints imposed so as to obtain a unique solution are discussed.

3.2 Intuition

The new approach has some resemblance to weighted aggregates but, in fact, it is not an aggregation at all. Rather, it is an attempt to measure the common underlying (or latent) factors (of

[10] See for example Bryan and Cecchetti (1993).

[11] See for example Forni and Reichlin (1996), Geweke and Singleton (1980), Quah and Sargent (1994) and Stock and Watson (1999).

[12] See for example Conner an Korajczyk (1988), Garcia and Renault (1999) and Roll and Ross (1980).

which *transactions money* and *savings money* are the two most important) that influence the use of currency and the money in different types of accounts.

A narrow aggregate is an attempt to add up currency and deposits used as transactions money. A weighted aggregate would attempt to divide deposits into the portion used for transactions and the portion used for savings. Because measuring an item requires a complete coverage of the data, the intuition of aggregation is that, if everything is measured and allocated correctly we would have an exact measure. In contrast, factors are latent variables which cannot be measured directly. This approach treats *transactions* and *savings* as two fundamental underlying activities in the economy. Data on currency and a wide range of deposits are used to estimate the two activities, and each measured monetary instrument (i.e. deposit type and currency) can be expressed in terms of these factors. This can be written as

$$currency = w_1\, transactions + w_2\, savings + e_{currency}$$

$$demand = w_3\, transactions + w_4\, savings + e_{demand}$$

$$notice = w_5\, transactions + w_6\, savings + e_{notice}$$

$$mutual\ funds = w_{n-1}\, transactions + w_n\, savings + e_{mutual\ funds}$$

where the weights w_i are estimated simultaneously with the savings and transactions processes. Each type of deposit is a weighting of the two factors, not the other way around as is done in aggregation. Intuitively, we would expect that in the case of currency, for example, transactions activity has the heaviest weighting and savings activity a minimal weighting. The idiosyncratic process e_{xxx} indicates amounts specific to a particular measured monetary instrument and not explained by the factors.

On the real side of the economy there are considerably more data associated with underlying factors than is the case on the monetary side. (Stock and Watson, 1999, use thousands of variables.) However, our application has the advantage that we expect very few factors, while on the real side one expects many factors to be important. The idea is explained above in terms of savings and transactions activities but it is possible, for example, that corporate transactions and personal transactions should be distinguished as different factors. It is even possible that financial institution transaction activity, which we now think of as a "distortion" to the aggregates, is a separate factor. Thus we may find

more than two factors, but we would be surprised if we find many more factors than this.

In this approach, each deposit provides an additional measure of the underlying factors. (We must have more monetary instruments than factors in order to solve the problem mathematically.) More deposit types provide more measurements and thus more precision. Omitted deposit types mean fewer measurements and thus less precision. In the aggregation approach, by contrast, omitted deposit types mean something is missing and the aggregate is not correct in an accounting sense.

As mentioned previously, one result of financial innovations is that an account type may start to be used in a different way. Modelling this phenomena is challenging. In the new approach, any changes affecting many of the measured variables should result from the factors, but the idiosyncratic components mean the measured variables can include changes that are not a result of factors. They flag anomalies (or distortions) since they should usually be small. A persistently important idiosyncratic component signals that the usage of a deposit may have 13 changed, and suggests the need to reconsider the weights used for that measured variable. Thus weights will vary over time and the necessity of a change in the weights is more clearly indicated.

Even though balances are shifting around, the objective of this approach is to get a transactions money measure which avoids noisy fluctuations coming from financial innovations that cause measurement problems due to their effect on deposit accounts. Savings money growth should also be more stable in this sense. Variable weights are required to absorb the effects of shifts due to innovations. However, given the large number of unknown parameters, it is impossible to solve the system of equations mathematically with continuously variable weights. Eventually, as a first step to address this, we will identify break points, that is, periods when financial innovations modified the usage of certain accounts.[13] For example, the elimination of differential reserve requirements on business demand and notice deposits in the early 1990's removed the incentive for banks to distinguish between these two types of accounts. Using the new methodology, in response to this financial innovation, demand and notice deposits should have comparable weights on transactions and savings fac-

[13] Aubry and Nott (2000) discuss the major financial innovation waves in Canada. This could be used to determine the dates of the changes.

tors while before this change, notice deposits were used more as a saving account than demand deposits.

3.3 Data Problems

The proposed methodology for measuring transactions and savings money helps solve certain kinds of measurement problems, but more importantly, it should help to quickly pin-point new problems so that corrections can be applied. This sub-section discusses certain types of problems which occur, what there effect will be, how they are dealt with in this paper, and how they might eventually be resolved.

It is important to distinguish between two modes in the process of collecting data. One is the usual *operational mode* which is the situation when new data is obtained but the weights in the "data measurement model" are fixed and not being estimated. The second is *estimation mode,* which is the situation when the weights are initially estimated and occasionally re-estimated. Data problems are not corrected in operational mode, but the calculation of the measures should flag problems quickly and well before they have a substantial effect on the measurements. The problems can then be corrected in a timely way.

The first type of data problem is a shift in the usage of a certain deposit classification. For example, demand deposits previously paid little interest and were rarely used for savings deposits. Now they often pay attractive interest rates and are sometimes used for savings. This kind of structural break will require a re-estimation of the weights. This is slightly different from the effect of a structural break on aggregates. Firstly, there is an explicit error (idiosyncratic) term which provides an automatic mechanism to partially ignore the effect for some time. That is, the change affects the error term much more than it affects the measure. Secondly, the error term quickly flags the break. Thirdly, there is a specific mechanism for making the eventual correction: re-estimate the weights for the problematic data classification. By contrast, there is no simple mechanism to deal with known structural breaks in the current aggregates.

The second type of data problem is a shift among data classifications. For example, Canadian savings bonds decreased in popularity in the second half of the 1990s and at least part of that was a shift into mutual funds, which increase substantially in the same period. This shift has more to do with availability or marketing of different types of financial instruments than it does with the un-

derlying phenomena of interest. One simple way to compensate for this problem is to amalgamate the data classifications involved. Then the shift is internal to the classification and does not show in the data at the level of aggregation of the components that are used. This is the approach used in the example in this paper, because of its simplicity. It is probably not the best way to handle this problem. A second simple way to compensate is to omit the affected classifications. As mentioned earlier, the methodology requires only samples and not a complete accounting, so omitting some classifications is a possibility. A more satisfying way to deal with this kind of problem is to build a second level into the data measurement model, one that accounts for shifts among classifications. This additional level of complexity is not discussed in this paper but eventually will be necessary. There is additional information which can be used at this level, so the second level does not depend only on the data and techniques as discussed here.

The third type of data problem is a shift of market share among institutions. In the current calculation of the aggregates this is only a problem if it is a shift between institutions included and not included in the aggregates. However, an additional level of sophistication, which will not be discussed elsewhere in this paper, entails adding a breakdown by institution. In order to do this it is necessary to build a third level into the data measurement model, one that accounts 15 for shifts among institutions. In this paper that is not necessary because we are using data aggregated across institutions (and we will ignore shifts between institutions included and not included in the aggregates).

Finally, there is a distinction between problems with initial estimation and problems (identified in operational mode) which lead to re-estimation. In the later case, underlying factors will already be established for large parts of the sample and the timing and nature of a new breakpoint will have been identified (in operational mode). During initial estimation there is no established baseline for the factors, and structural break points also need to be established. There are several possibilities for dealing with the special problems at this initial stage. One, used in this paper, is to amalgamate some problematic data classifications. Another, not yet investigated, is to begin with sample periods when structural changes appear to be less problematic.

This paper does not elaborate on the details of the data measurement model outlined above but focuses on a somewhat simplified version of one data measurement model. The above details

will eventually become very important, and there are ways to deal with them, but there are more fundamental issues to address first.

3.4 Identification Issues

The term "factor analysis" is sometimes used in a generic sense to describe several techniques including *principal components analysis* (PCA) and it is sometimes used in a more specific sense to describe a special interpretation of equation (2). (See, for example, Basilevsky, 1994.) Specifically, the factors should result in an idiosyncratic term *et* with a diagonal correlation matrix. That is, factor analysis attempts first to explain common movements in the measurements rather than the most variation as in PCA. Of course, explaining as much variation as possible is also interesting, so this difference is really one of relative emphasis. An important difference is that principal components are uncorrelated (orthogonal) but factors are not necessarily. One would not expect transactions and savings to be uncorrelated, so in the current problem factors are more logical than principal components. PCA is sometimes suggested as a technique for estimating factors (see, for example, Johnson and Wichern, 1998). This results in orthogonal factors which can then be rotated to find "oblique factors." The problem is then to find the appropriate rotation. That approach is not attempted here as it seems more natural to apply constraints on the estimation, which will then result in the oblique factors.

Perhaps the most difficult and technically controversial aspects of estimating DFA models are the specification of the objective function and the imposition of identifying (or uniqueness) constraints. It is necessary to determine constraints which make the statistical estimation well defined, so that there are not multiple solutions. This is a common problem in econometric work, but here we have the additional objective of trying to do this in a way which is relatively neutral with respect to economic theories. That is, we would like to achieve measures of factors which are economically interesting but do not require imposing too much (potentially controversial) theory in order to achieve the measurement. In other words, the measures should be good for a wide range of economic theories.

One aspect of this identification problem is that any invertible matrix G defines new factors *(G ft)* and weights *(AG-1)* and the equation

$$x_t = (AG^{-1})(G f_t) + e_t \quad (3)$$

gives identical measured variables *xt* and idiosyncratic terms *et* as in equation (3). Thus these models cannot be distinguished statistically and some otherwise motivated constraint must be imposed. The simplest example of this is simply a different relative scaling of the factors and weights. Since the factors are treated as an index this scaling problem can be resolved by specifying that the factors have value 1.0 in the first period. (And thus they should only be interpreted in growth rates not in levels.) However, rotations preserving the magnitude are still a concern. A second aspect is that different idiosyncratic terms *et* may result in similar objective function values and thus cannot be distinguished in the estimation.

A possible constraint which may be related to the rotation problem is that the factors and weights should be positive. This is consistent with the way we intuitively think of the concept of money. Another possible consideration for a constraint is a "roughness penalty" as used in the functional data analysis theory of Ramsay and Silverman (1997). This is similar in some respects to a filter, but the penalty is on rapid variation of the underlying factor rather than the measurements themselves as would be typical with a filter. In this regard it is closer to a Kalman filter, but there is no attempt here to model the underlying dynamics as with a Kalman filter. (Modelling the underlying dynamics may be interesting in the future, but is an economic modelling problem and the present work is focused primarily on measurement issues.) The 17 theoretical justification for this roughness penalty is that the underlying phenomena of interest for economic modelling and policy should be smoother than the measured data. The disadvantage is that too high a penalty may obscure rapid variations that are important.

The best combination of constraints and penalties (or objectives) is a matter of ongoing investigation. This is complicated by the fact that the estimation algorithms are being investigated simultaneously. The estimates are typically done by an iterative procedure and can be very slow. As previously mentioned, both the weights and the factor series are parameters in the estimation, so there are a very large number of parameters (over 700 in the preliminary experiments discussed below). This means the estimation is fairly difficult even when the problem is not ill-conditioned, and some combinations or too few constraints do give ill-conditioned problems.

To summarize, possible constraints and objectives being considered include

(i) factors set to 1.0 at the first period (or something equivalent like 1.0 in January 2000).

(ii) *et* has a diagonal correlation matrix (or covariance matrix) E(*eti, etj*) = 0 for *i* not equal *j*, where *i* and *j* indicate different financial instruments.

(iii) Minimum diagonal of the covariance of *et*.

(iv) Factors should not be correlated with the idiosyncratic term E(*ft, et*) = 0.

(v) Factors and weights should be positive.

(vi) Roughness penalties.

The relative importance of each of these remains to be determined.

3.5 Estimation with Simulated Data

This section reports results of simulation experiments used to test the estimation algorithms. Data was generated by adding noise to two known factors multiplied by known weights to give artificial measurement data. The estimation algorithms were then tested to see if they would recover the original factors. This sort of simulation experiment should be treated with some caution as it really only shows that estimation works in the single artificial situation used to generate that data. Nonetheless, it does help eliminate many problems, especially coding problems. It also suggests that the algorithms work for small samples, and theoretical small sample results are typically very difficult to obtain.

There are some further caveats which should be mentioned. The example here is one estimation technique which worked fairly well, but there were many that did not. Hopefully this is an indication of a reasonable estimation/identification combination, but given the nature of these experiments at this stage it could also be a random draw. Also, the two simulated factors are relatively uncorrelated, which may help estimation. Furthermore, good starting conditions were known. We intend to do considerably more testing of the algorithms with simulated data, including simulations which mimic the actual data more closely. This is necessary in order to better understand the technique and the interpretation of factors.

The simulated data is shown in Figure 1. Twelve series were generated using two factors. Figure 2 shows the actual factors used to generate the data (solid) and the estimated factors (dashed). Table 1 shows the estimated weights together with the true weights in brackets.

TABLE 1: ESTIMATED WEIGHTS (true in brackets)

Component	*Factor 1*	*Factor 2*
Series 1	0.9711753 (0.9)	0.02132972 (0.1)
Series 2	0.5787789 (0.5)	0.34110143 (0.5)
Series 3	0.2179484 (0.1)	0.62290401 (0.9)
Series 4	0.7867802 (0.7)	0.16416504 (0.3)
Series 5	0.8677186 (0.8)	0.09618929 (0.2)
Series 6	0.4158194 (0.3)	0.46269413 (0.7)
Series 7	0.9953030 (0.9)	0.00000000 (0.1)
Series 8	0.6367933 (0.5)	0.30587756 (0.5)
Series 9	0.2263639 (0.1)	0.63344682 (0.9)
Series 10	0.7769181 (0.7)	0.17132445 (0.3)
Series 11	0.8724282 (0.8)	0.10439224 (0.2)
Series 12	0.4024281 (0.3)	0.47958831 (0.7)

The estimation was done using a minimization routine[14] and objective function defined by summing together two objectives and a roughness penalty. The first objective was to minimize the square of the elements of the covariance matrix of the idiosyncratic components. The second was to minimize the square of the elements of the covariance between the idiosyncratic components and the factors, so idiosyncratic components will then be residuals in the sense that they cannot be explained by the factors. These covariance elements are squared because it is important that the objective associated with off-diagonal elements is not negative, and because the objective function should be differentiable for this optimization routine. Using the squared elements of the covariance matrix of the idiosyncratic components serves dual objectives of minimizing the off-diagonal elements (so factors explain correlated movements in the data) and minimizing the variance (so factors explain as much variation as possible). However, using the squares may distort this intuitive objective by putting dis-

[14] Option "L-BFGS-B" of the optim function in the programming language R (Ihaka and Gentleman, 1996, see <http://www.r-project.org/>). Code and specific details are available from the authors and will eventually be on the web site http://www.bank-banque-canada.ca/pgilbert.

FIGURE 1. SIMULATED DATA

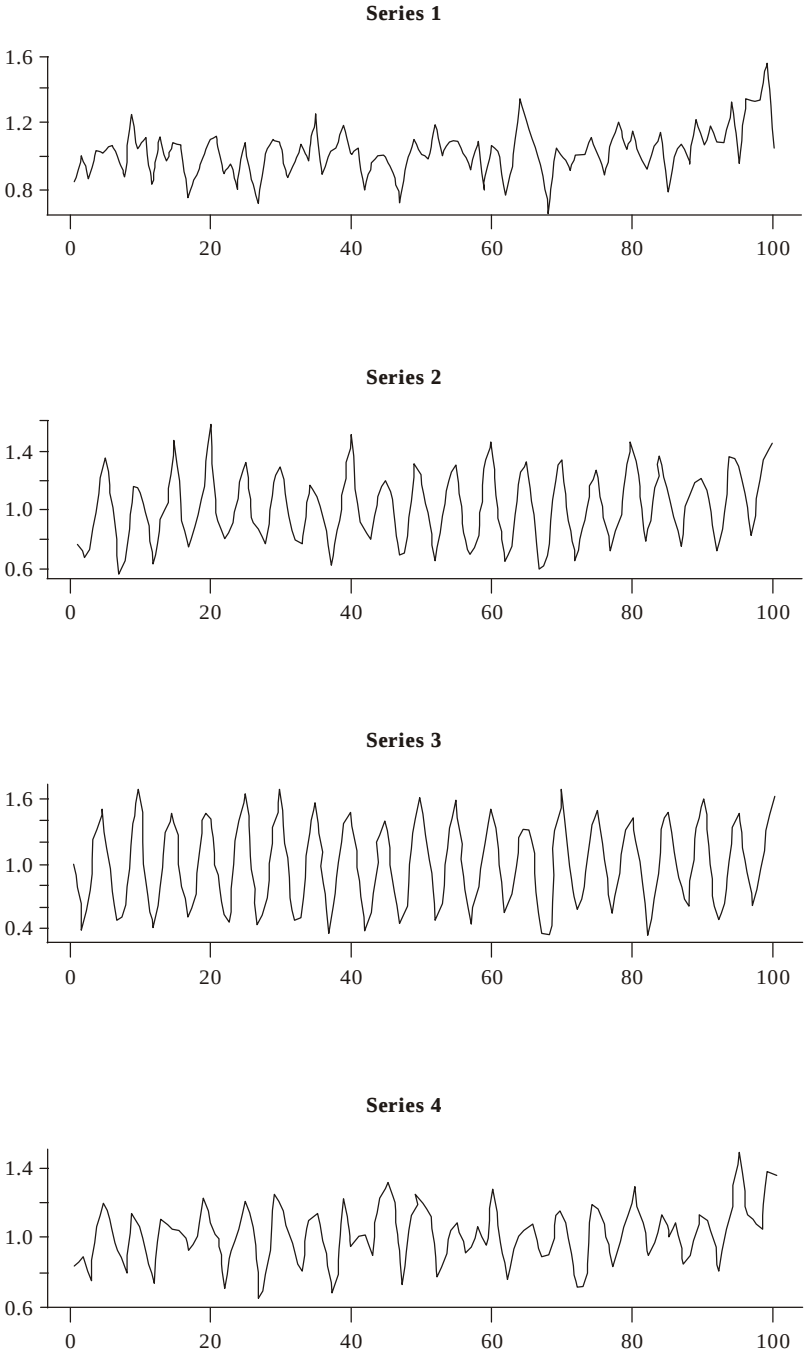


FIGURE 1

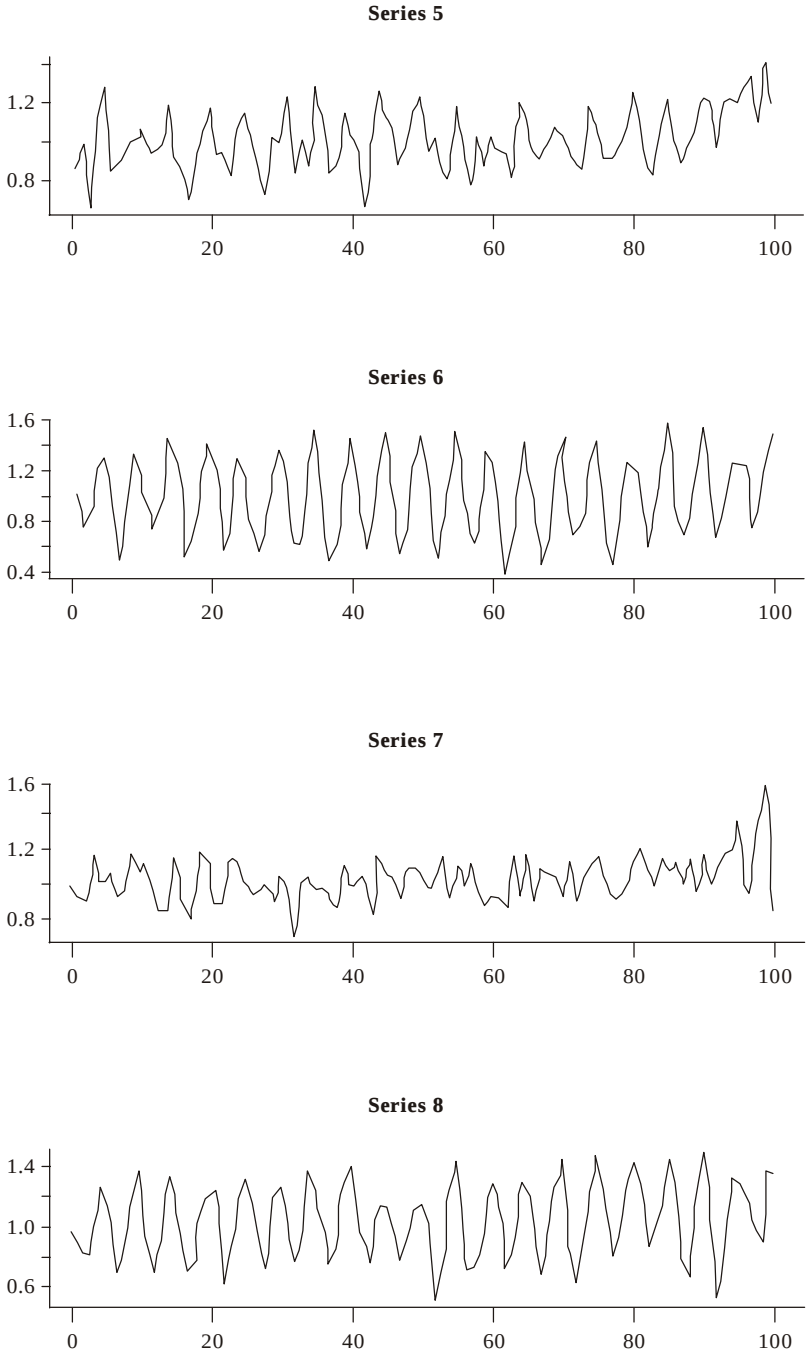
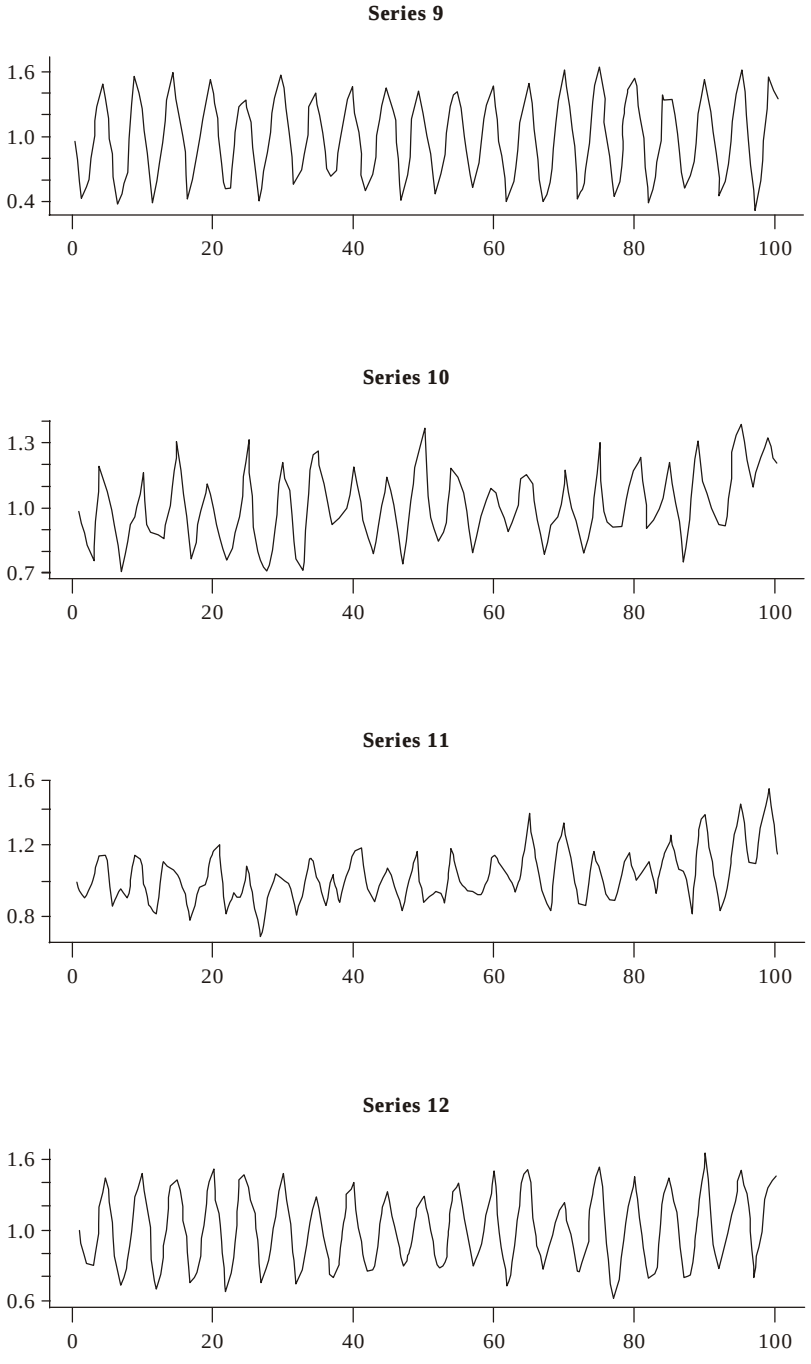
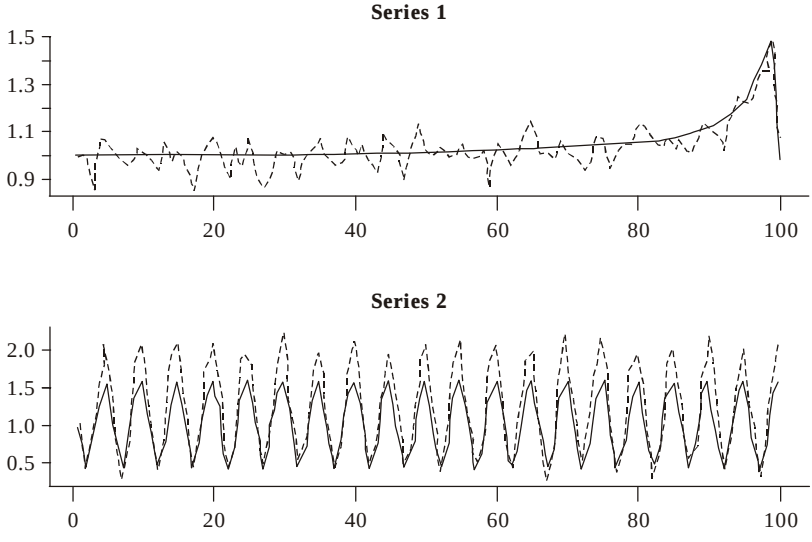

Series 5
1.2
0.8
0
20
40
60
80
100
Series 6
1.6
1.2
0.8
0.4
0
20
40
60
80
100
Series 7
1.6
1.2
0.8
0
20
40
60
80
100
Series 8
1.4
1.0
0.6
0
20
40
60
80
100

FIGURE 1


Series 9
1.6
1.0
0.4
0
20
40
60
80
100
Series 10
1.3
1.0
0.7
0
20
40
60
80
100
Series 11
1.6
1.2
0.8
0
20
40
60
80
100
Series 12
1.6
1.0
0.6
0
20
40
60
80
100

proportionate weight on larger elements. The roughness penalty was defined by the sum of the square of the second difference in the factor series. The relative importance of the roughness penalty is controlled by a scale factor which was 19 set to $1x10^{-8}$. The effect of this scaling penalty is to eliminate sharp variations in the factors. In this example, a larger penalty decreases the difference between the peaks of the true and estimated factors in the second panel of Figure 2. While several problems remain, the overall impression from these experiments is that the techniques can work, potentially quite well when adequately refined.

FIGURE 2. TRUE FACTORS (SOLID) AND ESTIMATED FACTORS (DASHED)



3.6 Preliminary Experiments with Canadian Data

This section summarizes preliminary results using Canadian data on currency and several different deposit types. The results are preliminary in several respects:

• The most appropriate identification constraints, as discussed above, are still a matter of ongoing investigation

• The estimation algorithms and convergence criteria need to be refined.

• The component data has been adjusted for institutional take-

overs and some reporting errors by banks. Previously these adjustments have only been done for aggregates and not for the components, however, the DFA methodology requires that the adjustments be made to the components. This has been done but the dataset is still preliminary.

• The results are based on assuming two and only two factors are important, and that has not yet been properly established. We will need to test for the appropriate number of factors given the phenomena we are trying to measure.

• It is possible that there are large structural breaks due to shifts in usage of some deposit classifications and thus different weights need to be established for different parts of the sample Once weights are established the idiosyncratic component helps identify shifts in usage, but that is not true during initial estimation.

• As discussed previously, shifts among data classifications can substantially affect the effort to estimate factors representing the phenomena of interest. One instance of this is that mutual funds have become very popular in recent years. Possibly related is the fact that Canadian savings bonds have decreased substantially in popularity at the same time. As a temporary measure these categories have been added together, however this is not a completely satisfactory solution.

• The sample used here begins only in January 1977 because some components begin then. However, many of the components begin in 1968 and some even earlier. One of the advantages of the proposed measure over aggregation techniques is that it should be possible to extend it in a consistent way, even when some of the sampled deposit categories change. For simplicity, this extension has not been considered yet.

Figure 3 shows the component series data. One feature of the data is that a certain portion of the growth can be explained by population growth. This would be common to both the savings and the transaction factors, but in estimation the effect on both may tend to be accumulated in a single factor. Therefore, at least for estimation purposes, calculations have been done with per capita data.

Over the sample period our knowledge of the Canadian economy suggests we would expect that savings and transaction money

FIGURE 3. COMPONENTS OF CANADIAN MONETARY AGGREGATES, 1975-2000

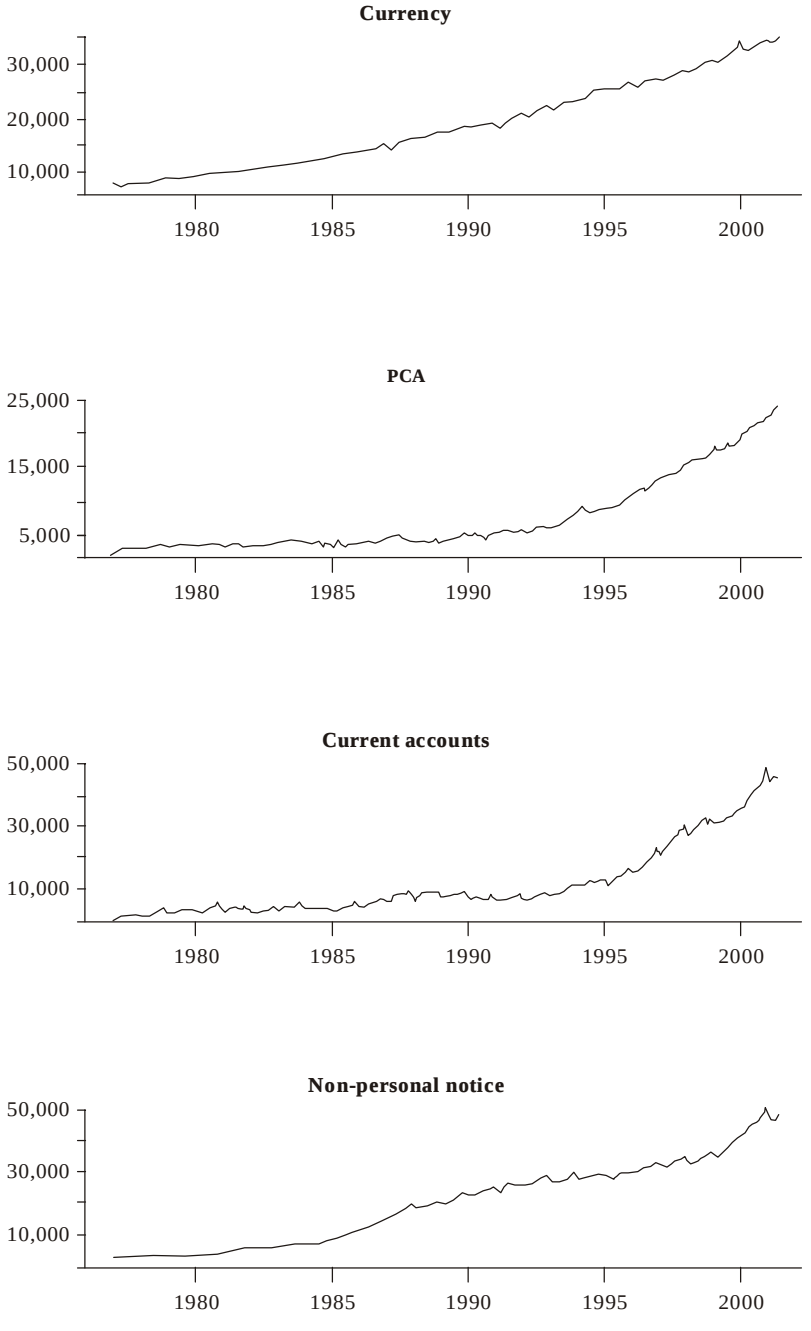
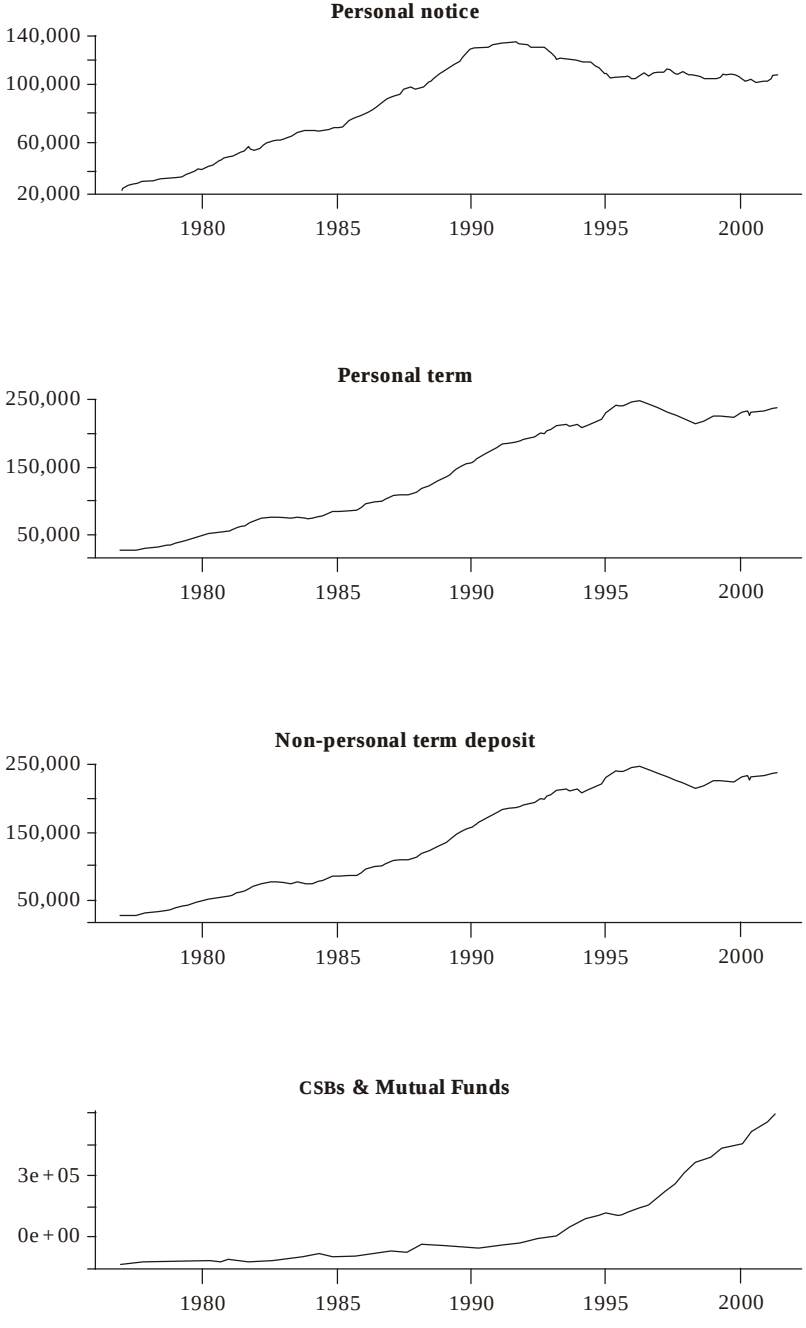


FIGURE 3


Personal notice
140,000
100,000
60,000
20,000
1980
1985
1990
1995
2000
Personal term
250,000
150,000
50,000
1980
1985
1990
1995
2000
Non-personal term deposit
250,000
150,000
50,000
1980
1985
1990
1995
2000
CSBs & Mutual Funds
3e+05
0e+00
1980
1985
1990
1995
2000

have grown most of the time, with a possibility of some levelling off and possibly some short periods of contraction. The decline in the series "personal notice" and to some extent "personal term," as shown in Figure 3, cannot be explained by these factors. We know that some deposit types included in this "personal notice" series have been largely abandoned for deposits with more attractive features. Deposits have shifted into all purpose checking accounts which offer comparable interest. Since the data is a weighting of the factors in the model (2) it is relatively important, at least during estimation, that the data does not have features clearly at odds with all the factors we are trying to measure. Once weights are estimated then anomalies, such as those caused by shifts between deposit categories, will be evident in the idiosyncratic component. However, during estimation the procedures may try to find factors to explain these features rather than the transactions and savings phenomena of interest. These shifts between categories are difficult to deal with and some accommodation for them does need to be done before the estimation will work properly.

FIGURE 4. ESTIMATED FACTORS, 1975-2000

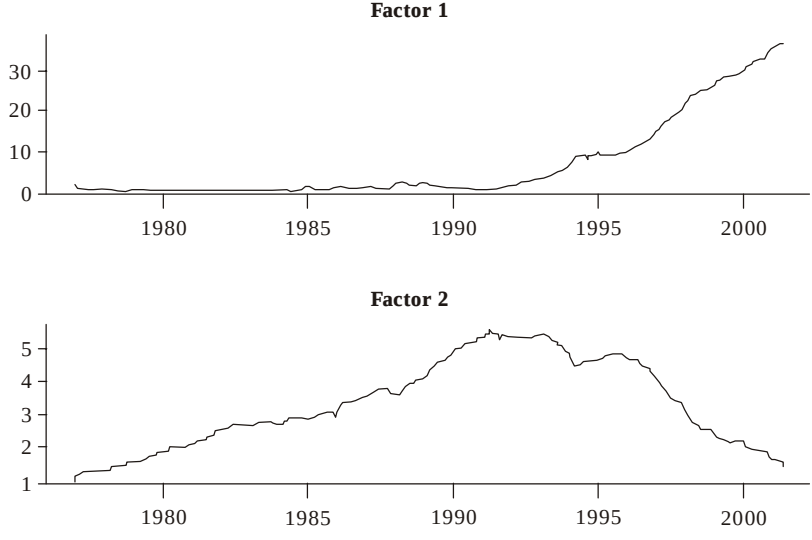


Figure 4 shows the estimated factors and Figure 5 the component data with the dashed line indicating the portion explained by the two factors. The estimation was done minimizing an objec-

tive function defined by adding together two objectives. The first was the sum of the squares of the elements of the covariance of the idiosyncratic component and the second is the sum of the squares of the elements of the covariance between the idiosyncratic component and the factors. There was no roughness penalty in this example. The factors and weights were constrained to be positive. Currency and personal term deposits were used as the basis for the initial starting values of the two factors in the iterative estimation (but this choice should be of relatively little importance other than to speed convergence). The covariance matrix of the idiosyncratic component has some fairly large elements, so this part of the specified objective has not been obtained as well as one might expect. The relative importance of the diagonal and off-diagonal parts of the covariance of the idiosyncratic component requires more consideration. As mentioned previously, the best combination of objectives and constraints is the subject of ongoing research. Some experimentation has also been done using an EM algorithm, but simultaneous optimization of weights and factors has been more successful.

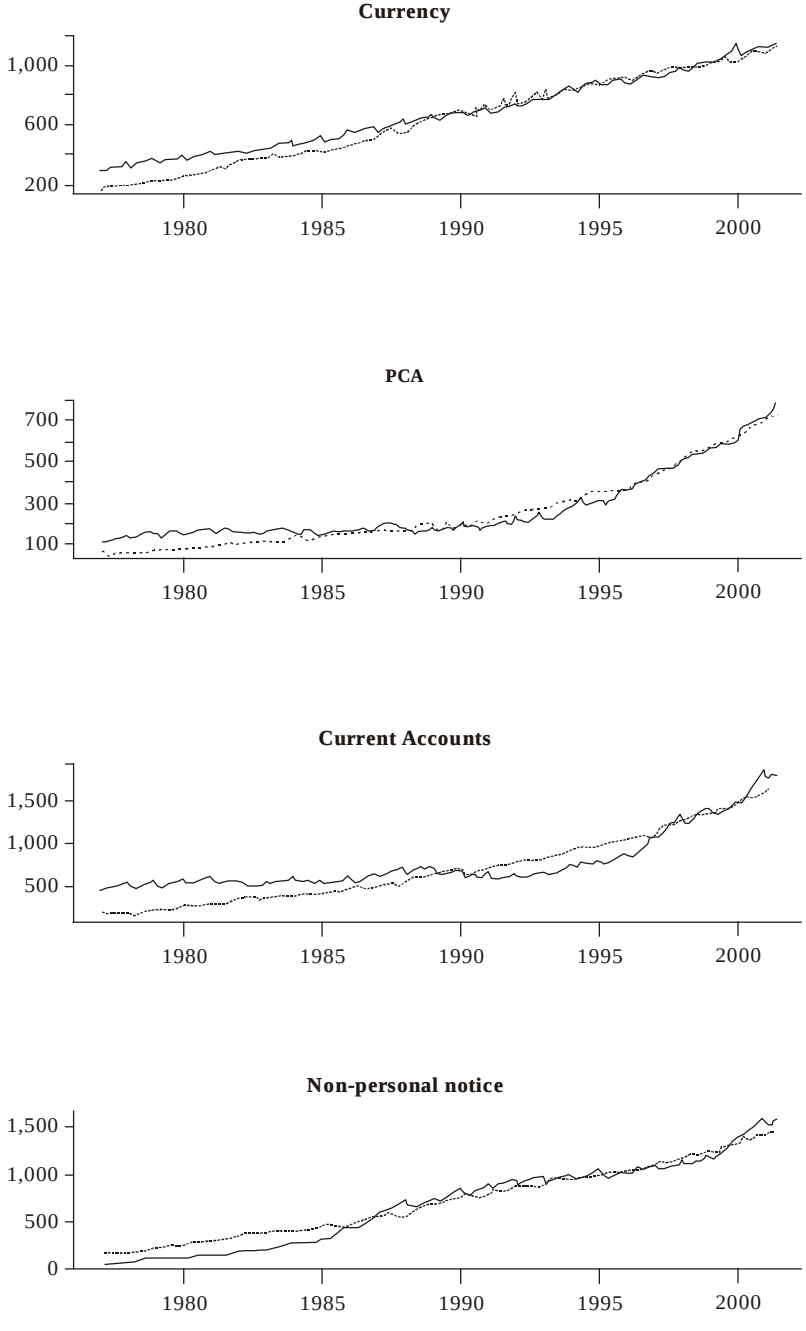
The estimated weights are shown in Table 2. While initial conditions have some influence, the estimation procedure does not guarantee which factor should be interpreted as the transaction money component. That can be discovered from the estimated weights on components such as currency, which we expect to be more heavily weighted on the transaction component. Focusing on currency, it seems likely that the second factor is transactions. However, the weighting is also fairly heavy on the second factor for deposits normally associated with savings.

At this point, we have to keep in mind that these results are very preliminary. Other disturbances in the data during initial estimation can prevent the factors from capturing the economic

TABLE 2: FACTOR LOADINGS

Component	*Factor 1*	*Factor 2*
Currency	24.81976	140.85855
Personal chequing accounts	18.05468	41.47066
Current accounts	39.55737	133.09486
Non-personal notice	34.01550	147.22757
Personal notice	45.86092	840.47074
Personal term	173.34623	1194.59430
Non-personal term deposits	94.60341	339.61453
Mutual Funds & Canadian Savings bonds	415.91869	485.70514

FIGURE 5. PER CAPITA COMPONENTS (SOLID) AND PORTION EXPLAINED BY FACTORS (DASHED), 1975-2000



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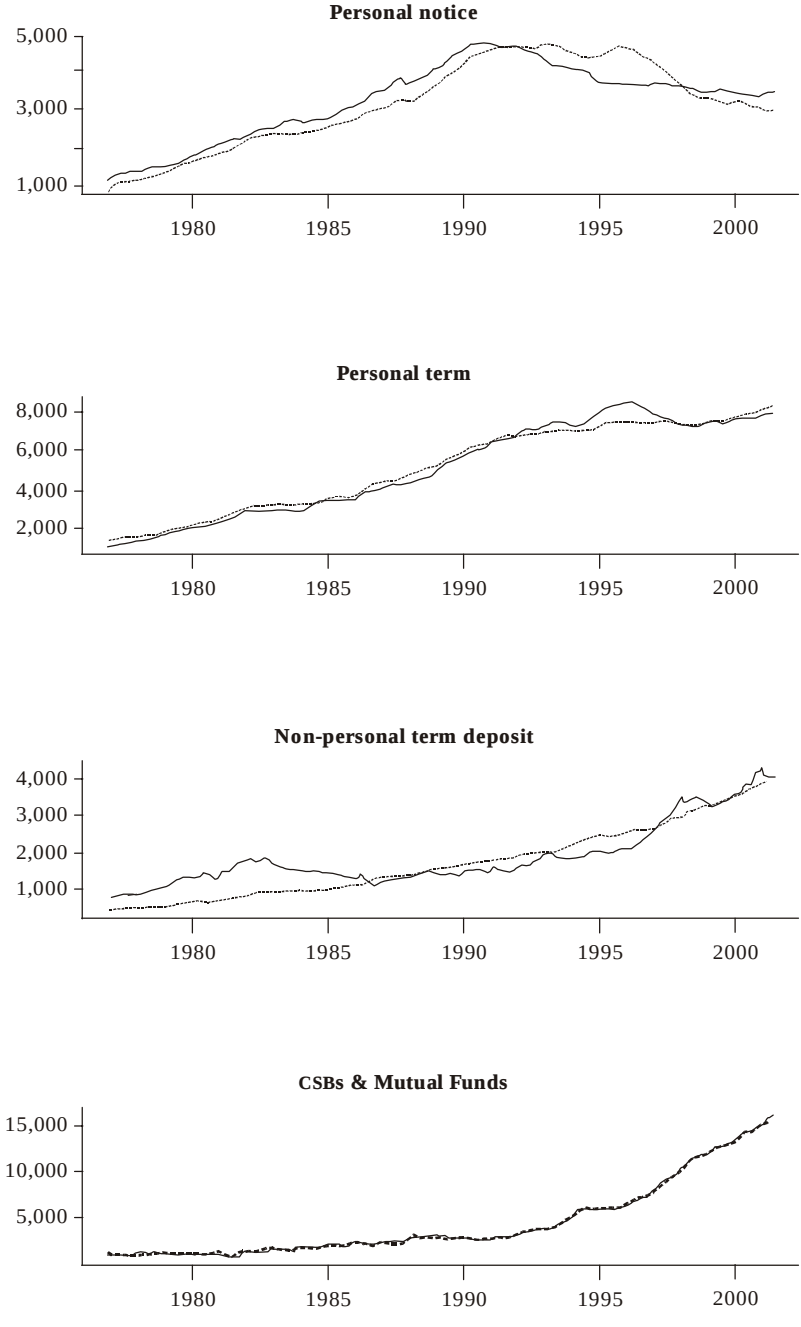
Personal notice
5,000
3,000
1,000
1980
1985
1990
1995
2000
Personal term
8,000
6,000
4,000
2,000
1980
1985
1990
1995
2000
Non-personal term deposit
4,000
3,000
2,000
1,000
1980
1985
1990
1995
2000
CSBs & Mutual Funds
15,000
10,000
5,000
1980
1985
1990
1995
2000

phenomena. There is a decline in certain deposit types, possibly due among other things to a phasing out of these deposit types by the banks. As mentioned earlier, it is important that this type of structural break be accommodated in some way during estimation so that the estimated factors are not trying to explain the change in structure. Also, we impose only two factors, but three or four may be necessary. Further tests will be done to determine the location of structural breaks and the number of factors.

Finally, the constraints and penalties in the estimation are not yet very refined and it is likely that they do not yet restrict the estimated factors sufficiently to impose the interpretation we would like. This is the subject of ongoing work.

It is also important to understand that the saving process, in the present work, is very narrow and not a measure of aggregate saving in the economy. *Savings*, in the context of this paper, is only money. The broader concept of saving (as defined in the National Accounts, for example) includes other financial assets such as stocks, bonds,[15] and also real assets, accumulated by households and firms. By including mutual funds we have included one portion of savings which expanded rapidly in the 1990's.

It seems clear from the relative weights that the first factor is trying to explain this phenomena, but this is not a complete picture of savings portfolios. In terms of monetary policy, we are particularly interested in extracting the transaction money process. We think that this index will be a purer measure of the underlying phenomena and a better indicator for output and inflation forecasts than current monetary aggregates.

4. CONCLUSIONS

If this approach to measuring transaction and savings money proves successful it would be the most fundamental reformulation in the way money is measured since the introduction of monetary aggregates a half century ago. The results presented here are preliminary. The conceptual formulation is intriguing, both statistically and economically very interesting, and preliminary indications are that the method can work. However, many technical and practical problems still need to be overcome. The next steps

[15] A small portion of these assets will be included in our estimation, because a certain quantity of stocks and bonds is held through mutual funds.

are to refine the estimation procedure, objective function and constraints. The procedures need to be robust, or at least any sensitivities well understood. The estimation objectives and constraints need to make sense in the context of different economic theories. Anomalies in the data which can be attributed to other causes may need to be accommodated in some way; if they are too important they, rather than the phenomena of interest, will be estimated as the factors. Eventually there will be efforts to validate the new measures. The validation should not rely too heavily on specific economic theories. Possibilities include comparisons with current aggregates, comparisons of the weights with prior information about deposit type usage, and comparison of break points and corresponding weight changes with known structural changes. The ultimate test, at least from a policy perspective, is whether the estimated measures provide better information for forecasting inflation and output.

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Priscilla Maria Villa Lhacer
Márcio I. Nakane

The determinants of bank interest spread in Brazil

1. INTRODUCTION

Bank interest rates have been the focus of recent (October 1999) policy attention by the Brazilian Central Bank. In a highly publicised report,[1] this institution showed a great concern for the high levels of the bank loan interest rates observed in the country. This report concluded that high default levels as well as high operating costs are amongst the main culprits for the high bank interest margin seen in the country.

The economic and policy relevance of such topic is beyond any questioning. However, the Central Bank report lacks a more formal approach to support their main conclusions. The decom-

[1] See Banco Central do Brasil (1999) and the 2000 and 2001 follow-ups.

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position of the bank interest margin among different factors is based on accounting identities and on a restricted sample of banks rather than on a bank profit maximization model.

The purpose of this paper is to provide an econometric account of the main determinants of the bank interest margin in Brazil. The study makes use of the two-step regression approach advanced by Ho and Saunders (1981) to uncover the influence of bank characteristic variables as well as macroeconomic influences as the main explanatory factors of the bank spread in the country.

The paper is structured as follows: after this Introduction, section 2 reviews the relevant literature. Section 3 overviews the recent behavior of bank interest rates in Brazil. Section 4 describes the methodology to be applied in the paper. Section 5 introduces the empirical model to be estimated. Section 6 deals with the sample and data issues. Section 7 presents the main results. Section 8 summarizes the main findings and concludes the paper.

2. LITERATURE REVIEW

In a comprehensive study, Demirgüç-Kunt and Huizinga (1999) investigate the determinants of bank interest margins using bank-level data for 80 countries in the years 1988-1995. The set of regressors include several variables accounting for bank characteristics, macroeconomic conditions, explicit and implicit bank taxation, deposit insurance regulation, overall financial structure, and underlying legal and institutional indicators. The variables accounting for bank characteristics and macroeconomic factors are of special interest since they are close to the ones included in the regression estimated in our paper.

Demirgüç-Kunt and Huizinga report that the bank interest margin is positively influenced by the ratio of equity to lagged total assets, by the ratio of loans to total assets, by a foreign ownership dummy, by bank size as measured by total bank assets, by the ratio of overhead costs to total assets, by inflation rate, and by the short-term market interest rate in real terms. The ratio of non-interest earning assets to total assets, on the other hand, is negatively related to the bank interest margin. All the mentioned variables are statistically significant. Output growth, by contrast, does not seem to have any impact on bank spread.

Another branch of the literature is concerned with the adjust-

ments of bank interest rates to the market interest rate.[2] These studies show that, in the long run, one cannot reject the hypothesis that bank interest rates follow the market interest rate in a one-to-one basis, i.e. that there is full adjustment to changes in the market interest rate. In the short-run, though, the departures of bank interest rates from the market interest rate are relevant and there is some evidence that adjustments towards the long run equilibrium are asymmetric, i.e. the adjustment varies according to whether one observes positive or negative unbalances.

There is some evidence of price rigidity in local deposit markets with decreases in deposit interest rates being more likely than increases in these rates in the face of changes in the market interest rate [Hannan and Berger (1991)]. One reason for such behavior is market concentration: banks in concentrated markets were found to exacerbate the asymmetric adjustments [Neumark and Sharpe (1992)].

The same sluggishness has been observed for the loan interest rate. Cottarelli and Kourelis (1994) apply a two-step approach to investigate the reasons for the stickiness of bank lending rates for a sample of countries. In the first step, the impact multipliers of changes in the market interest rate are calculated for each country in the sample. In the second step, such impact multipliers are regressed against a large set of explanatory variables controlling for cross-country differences in the competition within the banking system, in the extent of money market development and openness of the economy, in the banking system ownership, and in the degree of development of the financial system. Of interest are the results that the impact multiplier is higher for countries where inflation is higher and where public banks do not dominate the banking systems.

Angbazo (1997) studies the determinants of bank net interest margins for a sample of US banks using annual data for 1989-1993. The empirical model for the net interest margin is postulated to be a function of the following variables: default risk, interest rate risk, an interaction between default and interest risk, liquidity risk, leverage, implicit interest payments, opportunity cost of non-interest bearing reserves, management efficiency, and a dummy for states with branch restrictions. The results for the pooled sample suggest that the proxies for default risk (ratio of

[2] See, among others, Hannan and Berger (1991), Neumark and Sharpe (1992), Cottarelli and Kourelis (1994), Cottarelli *et al.* (1995), Scholnick (1996), and Heffernan (1997).

net loan charge-offs to total loans), the opportunity cost of non-interest bearing reserves, leverage (ratio of core capital to total assets), and management efficiency (ratio of earning assets to total assets) are all statistically significant and positively related to bank interest margins. The ratio of liquid assets to total liabilities, a proxy for low liquidity risk, is inversely related to the bank interest margin. The other variables were not significant in statistical terms.

Some recent contributions have made use of more structural models based on profit maximization assumptions for banks operating in imperfect markets to develop empirical equations to understand the behavior of bank interest rates. Recent contributions include Barajas *et al*. (1999) for Colombia, Catão (1998) for Argentina, and Randall (1998) for the Eastern Caribbean region.

Barajas *et al*. (1999) document significant effects of financial liberalization on bank interest spreads for the Colombian case. Although the overall spread has not reduced with the financial liberalization measures undertook in the early 1990s, the relevance of the different factors behind bank spreads were affected by such measures.

In a single equation specification, the bank lending rate is regressed against the ratio of the deposit rate to (one minus) the reserve ratio, a scale variable represented by the volume of total loans, wages, and a measure of loan quality given by the percentage of nonperforming loans. A test for market power is performed with the results showing that the banking sector in Colombia was imperfect before the liberalization but that a competitive industry describes the data well in the post-liberalization period. Another change linked with the liberalization process was an increase in the coefficient of loan quality after the liberalization. The authors notice that "this change could signal a heightened awareness on the part of bank managers regarding credit risk, and/or it could reflect an improved reporting of nonperforming loans" (p. 212). A negative sign found for the scale variable indicates that economies of scale are prevalent for both periods.

The regression results are then used to decompose the bank intermediation spread into four factors: financial taxation (reserve requirements and forced investments), operating costs, market power, and loan quality. For the pre-liberalization period, operating costs made up about 38% of bank spread while market power, financial taxation and loan quality accounted for 36%, 22% and 4% of the spread, respectively. For the post-liberalization period, the impact of market power is set equal to zero to be con-

sistent with the regression results. Loan quality now accounts for 29% of the spread while operating costs and financial taxation were responsible for, respectively, 45% and 26% of the spread.

Unlike other Latin American countries, Argentina used to operate a currency board arrangement with the widespread use of foreign currency (US dollar) alongside the domestic one. Domestic banks are allowed to intermediate freely in domestic as well as in foreign currency.

Using monthly data for Argentinean banks for the June 1993 to July 1997 period, Catão (1998) studies the determinants of the intermediation spread for loan and deposits denominated both in domestic as well as in foreign currencies. Both intermediation margins are related to the average tax ratio, to the cost of reserve requirements, to operating costs, to problem loans, to the exchange rate risk, and to the market structure as measured by the Herfindahl index.

The only marked difference between the domestic and foreign currency markets is a positive and significant impact of the market structure on spread for the former markets and a non-significant impact for the latter. Catão observes that such difference reflects "the fact that most peso borrowers cannot arbitrage between domestic and foreign sources of funds, thus becoming subject to the monopoly power of local banks" (p. 21). By contrast, "interbank competition for the typical US dollar borrower is bound to be considerably fiercer and the scope for banks to exert monopoly power over the client is therefore much reduced" (p. 21).

For both markets, the intermediation spreads are mostly affected by operating costs and problem loans. The quantitative effects of both factors are nearly the same for the domestic currency market while operating costs seem to be more important than problem loans in the US dollar market. The impact of reserve requirements on spread is economically small "reflecting the fact that banks' reserves at the Central Bank are remunerated at interest rates close to that of time deposits" (p. 21).

Randall (1998) documents that for the Eastern Caribbean countries,[3] unlike the evidence gathered above, the impact of loan loss provisioning has been to reduce bank interest margin

[3] The Eastern Caribbean region is comprised by the following countries, in alphabetical order: Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines. These countries share a common currency and a common central bank.

rather than to increase it once the tendency of banks to under provision in the case of government loans is accounted for. Like in other countries, operating expenses seem to have a large impact on bank spreads in the Eastern Caribbean region. Over the sample period, the ratio of operating expenses to total asset explains 23% of the estimated spread.

Ho and Saunders (1981) advocate a two-step procedure to explain the determinants of bank interest spreads in panel data samples.[4] In the first-step, a regression for the bank interest margin is run against a set of bank-specific variables such as non-performing loans, operating costs, the capital asset ratio, etc. plus time dummies. The time dummy coefficients of such regressions are interpreted as being a measure of the "pure" component of a country's bank spread. In the second-step, the constant terms are regressed against variables reflecting macroeconomic factors. For this second step, the inclusion of a constant term aims at capturing the influence of factors such as market structure or risk-aversion coefficient, which reflect neither bank-specific observed characteristics nor macroeconomic elements.

Brock and Rojas-Suarez (2000) apply the two-step procedure for a sample of five Latin American countries during the mid 1990's (Argentina, Bolivia, Colombia, Chile, and Peru).[5] For each country, the first-stage regressions for the bank interest spread include variables controlling for non-performing loans, capital ratio, operating costs, a measure of liquidity (the ratio of short term assets to total deposits) and time dummies. The coefficients on the time dummies are estimates of the "pure" spread.

Their results show positive coefficients for capital ratio (statistically significant for Bolivia and Colombia), cost ratio (statistically significant for Argentina and Bolivia), and the liquidity ratio (statistically significant for Bolivia, Colombia, and Peru). As for the effects of non-performing loans, the evidence is mixed. Apart from Colombia, where the coefficient for non-performing loans is positive and statistically significant, for the other countries the coefficient is negative (statistically significant for Argentina and Peru). The authors explain these findings as "a result of inadequate provisioning for loan losses: higher non-performing loans would re-

[4] Section 4 discusses this approach in more detail.

[5] The period of analysis varies for each country: January 1995 to April 1996 for Argentina, February 1992 to April 1996 for Bolivia, February 1991 to March 1996 for Colombia, April 1991 to April 1995 for Chile, and March 1993 to April 1996 for Peru.

duce banks' income, thereby lowering the spread in the absence of adequate loan loss reserves" (p. 130). The result for Argentina is striking given the opposite findings reported by Catão (1998).

In the second stage, Brock and Rojas-Suarez (2000) run a regression for the measure of "pure" bank spreads on macroeconomic variables reflecting interest rate volatility, inflation rate and GDP growth rate. Their results show that interest rate volatility increases bank spread in Bolivia and Chile; the same happens with inflation in Colombia, Chile and Peru. For the other cases, the coefficients are not statistically significant.

On balance, bank spreads in Bolivia are explained by micro variables, while bank spreads in Chile and Colombia are accounted for by both macro and micro factors. As for Argentina and Peru, there is still a large fraction of the spread that cannot be explained by any of the above factors.

In addition to the studies concerning Latin American countries, Saunders and Schumacher (2000) apply Ho and Saunders two step method to a sample of banks of seven OECD countries (namely Germany, Spain, France, Great Britain, Italy, United States and Switzerland). The purpose of the authors is to decompose the determinants of bank net interest margins into regulatory, market structure and risk premium components.

Among the three control variables used in the first step, the one with the major impact is the implicit interest rate, a fee proxy. That is, for almost all countries, banks have to increase margins to finance implicit interest payments. Besides that, the coefficients for the opportunity cost of reserves were positive and significant in most countries and years. At last, bank capital ratios were also in general significant and positive.

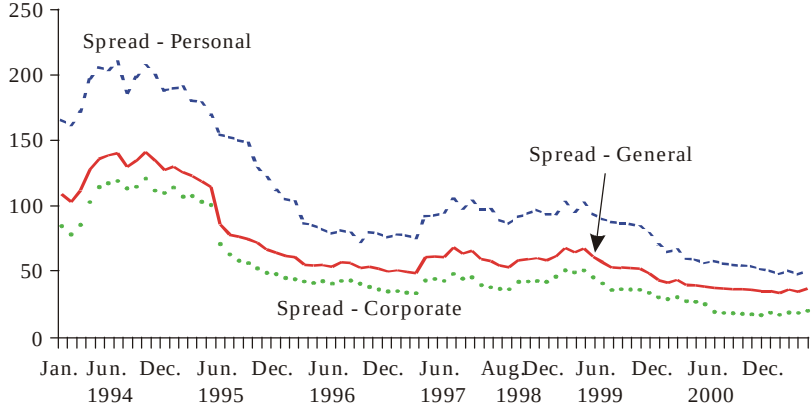
The intercepts of these first step regressions can be understood as the common pure spread across all banks in a single country at the same time. The authors then ran a cross-country second step regression, in which the dependent variable was the estimated pure spreads from the first step. This second stage is supposed to measure the sensitivity of the margins with respect to market structure and interest rate volatility. The results showed that, first, the more segmented and restricted the system is, the higher the spreads are, probably due to the monopoly power, and, second, that the volatility of interest rate has also a significant impact on the margins. These findings suggest that the pure spreads are sensitive to both, market structure and volatility effects, and also that the effects are quite heterogeneous across countries.

3. RECENT EVOLUTION OF BANK INTEREST RATES IN BRAZIL

The Brazilian banking system has traditionally been characterized by high lending rates and low levels of credit as a proportion of GDP. Recently, with inflation under control and a stable macroeconomic environment there has been a notable trend towards a more balanced credit market, with a vigorous fall in bank interest margins and an increase in credit.

Figure 1 illustrates the behavior of the bank interest spread in Brazil for both the corporate and the personal sectors. Since 1995, interest spreads in Brazil have been in a downward trend. The overall interest spread has fallen from a rate of 135% p.a. at the beginning of 1995 to 35% p.a. in early 2001.

FIGURE 1. BANK INTEREST SPREAD IN BRAZIL, 1994-2001
% p.a.



The stabilization plan (Plano Real) launched in July 1994 succeeded in controlling inflation rates and creating a more stable macroeconomic environment. As a result, the basic interest rate reduced (excepting the immediate post-Real period, when the government introduced very restrictive temporary policies to control credit expansion,[6] and periods of external shocks) and output growth resumed.

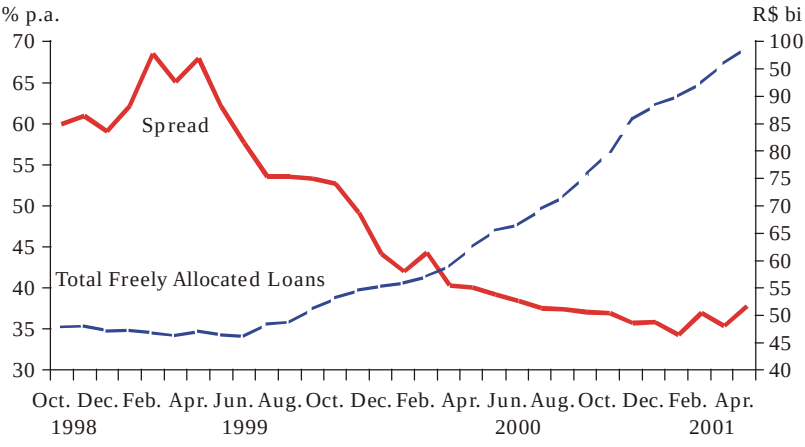
In 1999, the Brazilian government adopted some measures with the declared purpose of curbing banks' spread, namely a

[6] Those measures included a marginal 100% reserve requirement on time deposits and a 15% reserve requirement on loans, causing a sharp increase in bank interest spreads at the end of 1994/beginning of 1995.

gradual reduction of reserve requirements – from 75% to 45% for demand deposits and from 20% to zero for time deposits – and cuts in financial market taxation for household loans – from 6% to 1.5%, same level of corporate loans.[7]

Figure 2 illustrates that the drop in the spread rates since mid-1999 was simultaneous to an expansion of freely allocated credit in the economy. Total freely allocated loans in the banking system increased 127% in the two-year period from April 1999 to April 2001, rising from R$ 44 billion to R$ 100 billion. It is important to emphasize though that overall credit in the economy has increased in a more moderate term. Directed credit in the economy (including housing and rural credit) has even declined, allowing overall credit to stay stable at 29 percent of GDP, notwithstanding the strong growth in free credit observed in Figure 2.

FIGURE 2. BANK INTEREST SPREAD AND TOTAL FREELY ALLOCATED LOANS, 1998-2001



Despite the recent downward trend observed for the bank spread in Brazil, such rates are still very high by international standards. Table 1 compares the observed spread interest rates for Brazil and other selected countries. The difference in the bank spread observed in Brazil and those observed for the devel-

[7] In addition to these measures, some other changes were also implemented, including the following: new credit risk rating system and provisioning rules; broadening of the coverage of loan transactions reported to the Central Bank risk bureau (*central de risco*); public availability of interest rates charged on overdraft accounts by each bank; creation of certificates of bank credit (*cédulas de crédito bancário*), a new bond supposed to be easier to recover when defaulted.

oped countries is of one order of magnitude, i.e. ten times or larger. Even when Latin America is taken as the benchmark, Brazil tops the list in spite of the drastic drop observed in 2000.[8]

TABLE 1. SPREAD RATES FOR SELECTED DEVELOPED AND LATIN AMERICAN COUNTRIES – % P.A., 1995-2000

	Spread Rates (lending - deposit rates)						*Inflation*
	1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2000*
Developed Countries							
USA	2.91	2.88	2.82	2.88	2.66	2.77	3.4
Canada	1.50	1.73	1.37	1.57	1.53	1.57	2.7
Australia	3.79	4.14	4.19	3.37	-	4.66	4.5
Japan	2.50	2.36	2.15	2.05	2.04	2.00	-0.6
UK	2.58	2.91	2.95	2.73	-	-	2.9
Euro Area	-	4.80	4.18	3.53	3.20	3.15	2.3
Latin America							
Argentina	5.95	3.15	2.27	3.08	2.99	2.75	-0.9
Bolivia	32.15	36.81	35.32	26.59	23.11	23.62	4.6
Brazil*	130.45	67.79	54.62	60.71	57.50	38.72	7.0
Brazil**	-	-	53.84	58.36	54.42	38.57	7.0
Chile	4.43	3.91	3.65	5.26	4.07	5.64	3.8
Colombia	10.38	10.84	10.09	9.66	9.08	14.21	9.5
Mexico	20.47	12.19	9.89	14.95	16.26	11.96	9.5
Peru	11.46	11.17	14.95	15.69	14.52	14.62	3.8
Uruguay	60.86	63.39	51.94	42.84	39.03	36.94	4.8
Venezuela	15.02	11.83	8.99	11.51	10.85	8.90	16.2

SOURCES: Brazil*: our calculation. Brazil** and Other Countries: IMF, *International Financial Statistics*, lines 601 and 60p.

The last column of Table 1 shows that the difference in the interest spreads cannot be explained on the basis of inflation differentials among the countries. Inflation in Brazil was lower than inflation in Colombia, Mexico, and Venezuela.

Table 2 compares the simple correlation coefficients of the bank spread with the loan and deposit rates for Brazil, Argentina, Chile and Mexico. Different from other Latin American coun-

[8] The purpose of the table is just to illustrate the orders of magnitude of the bank interest rates found in different countries. We recognize that financial systems across the world are very heterogeneous and therefore cross-country comparisons should be viewed with caution.

tries, the variation of the interest spread in Brazil is strongly correlated with both the loan and deposit rates. For the other Latin American countries, the loan rates impact more significantly the spread, probably due to the fact that the deposit interest rate in these countries are set in accordance to the behavior of international interest rates.

TABLE 2. CORRELATION OF SPREAD WITH LOAN AND DEPOSIT RATES FOR SELECTED LATIN AMERICAN COUNTRIES, 1991-96

Country	*Loan Rate*	*Deposit Rate*
Brazil (1994-2000)	0.97	0.87
Argentina	0.89	0.05
Chile	0.75	0.22
Mexico	0.42	-0.33

SOURCES: Brazil – our calculation. Other Countries – Brock and Rojas-Suarez (2000).

In addition to the high-observed temporal variation of the bank interest rates in Brazil it is also worth highlighting the important cross-sectional dispersion of such rates. Table 3 computes the coefficients of variation for the loan, deposit and spread rates both over time and across banks for all the banks in the country.[9]

TABLE 3. COEFFICIENTS OF VARIATION FOR THE LOAN, DEPOSIT AND SPREAD RATES, 1997-2000

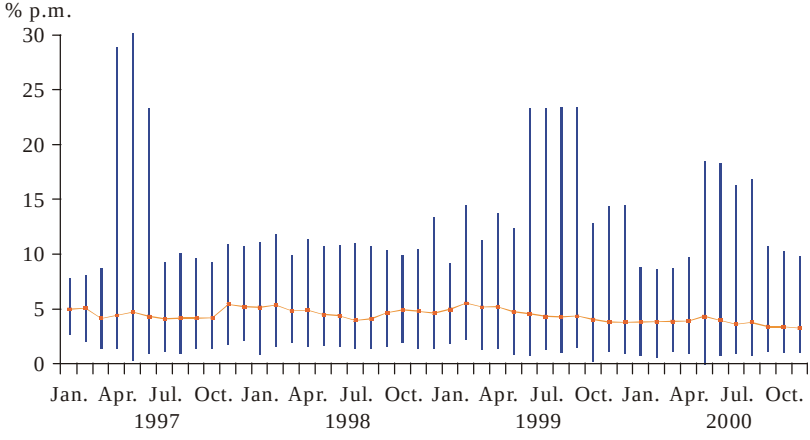
	Loan Rate		*Deposit Rate*		*Spread*	
	Over Time	*Across Banks*	*Over Time*	*Across Banks*	*Over Time*	*Across Banks*
1997	0.0931	0.4436	0.2634	0.5413	0.0491	0.5435
1998	0.0771	0.4038	0.1839	0.4877	0.0607	0.5221
1999	0.1451	0.4222	0.3467	0.5679	0.0843	0.5459
2000	0.0820	0.5402	0.0524	0.6758	0.1363	0.5479
1997-2000	0.1701	0.4656	0.3111	0.5266	0.1427	0.4870

[9] The coefficient of variation is the ratio of the standard-error to the mean of the corresponding series. The column “Over Time” shows the coefficients of variation when the individual observations that make the series up are the average rates (for all the banks) for each month. In contrast, the column “Across Banks” shows the coefficients of variation when the observations that make the series up are the average rates (for every month) for each bank.

The results of Table 3 show that the cross-section dispersion of the interest rates is even more pronounced than the temporal variation. Such across banks dispersion is observed for all the three bank rates. Table 3 also shows that the cross-section dispersion of interest rates has not significantly changed over the years.

The same evidence can be gathered by the observation of Figure 3. This figure shows, for each month, the minimum and maximum lending rates observed in the market for the universe of banks in the country. One can see that the dispersion is not only quite significant but also very persistent over time.[10]

FIGURE 3. MEAN, MAXIMUM AND MINIMUM LOAN RATE, 1997-2000



The temporal variation of the interest spreads observed in Brazil, the still high levels of such rates, the dispersion of rates charged across banks, and the persistence of such dispersion justify our use of panel data techniques to analyze the behavior of the interest margins in the country. Specifically, our aim is to decompose the main determinants of the interest spread into microeconomic (inefficiencies or lack of competition of the sector, for example) and macroeconomic (volatility of the basic interest rate, inflation and economic growth) variables.

[10] The isolated peaks observed in Figure 3 reflect marginal operations performed by very small banks. Part of the dispersion may be due to market segmentation strategies pursued by different banks.

4. METHODOLOGY

The methodology to be applied to the data borrows from the two-step approach advanced by Ho and Saunders (1981). Their applied methodology is based on an adaptation of a model of bid-ask prices of security dealers [see, e.g. Ho and Stoll (1980)] to the determination of the bank interest margin.

The representative bank is modeled as a risk-averse agent that acts as a dealer in a market for the immediate provision of deposits and loans. It holds illiquid assets and it therefore runs the risk of an unbalanced portfolio with either excessive demand for loans or insufficient supply of deposits. The bank sets both the deposit and the loan rates with the aim of maximizing a mean-variance objective function in end-of-period wealth.

Depositors and borrowers are supposed to arrive randomly according to Poisson processes. Ho and Saunders assume linear symmetric specifications for the Poisson arrival rates of loans and deposits:

$$\lambda_L = \alpha - \beta b \, , \lambda_D = \alpha + \beta a \tag{1}$$

where *a* and *b* are the fees charged on deposits and loans.

The equilibrium bank interest margin has then the following simple specification:

$$s = a + b = \frac{\alpha}{\beta} + \frac{1}{2} R \sigma_I^2 Q \tag{2}$$

The bank interest spread is thus the sum of two terms. The first term (α/β) is a measure of the "risk neutral spread" in the sense that it is the bank spread that would be chosen by a risk neutral bank. The risk neutral spread is the ratio of the intercept (α) to the slope (β) of the symmetric deposit and loan arrival probability functions. Ho and Saunders interpret this first term as a measure of market power, since if a bank faces relatively inelastic demand and supply functions in the two markets, it exercises market power by charging a greater spread.

The second term is a measure of risk premium and it reflects the composition of three elements, namely the coefficient of absolute risk aversion (R), the variance of the interest rate on net credit inventories (σ_I^2), and the size of the deposit/loan transaction (Q).

The basic model was extended by, among others, Allen (1988), McShane and Sharpe (1985), and Angbazo (1997) to consider

more than one type of loans, other sources of interest rate uncertainty, and asymmetric arrival probability functions.

Ho and Saunders develop a two-step methodology to empirically evaluate the main determinants of the bank interest spread. The first step makes use of a panel of banks to relate the bank-level interest spread to a vector of bank observable characteristics plus a set of time dummies. The time dummy coefficients are interpreted as a measure of the pure bank spread.

The time dummy coefficients are then used as the dependent variable in the second step regression. The set of regressors in the second step includes a measure of interest rate volatility plus other macroeconomic variables.

This two-step approach has been applied to bank data by Ho and Saunders (1981) and Angbazo (1997) for US banks, by McShane and Sharpe (1985) for Australian banks, by Brock and Rojas-Suarez (2000) for Latin American banks (Argentina, Bolivia, Chile, Colombia, Mexico, Peru, and Uruguay), and by Saunders and Schumacher (2000) for a bank sample for US and six European countries (Germany, Spain, France, Great Britain, Italy, and Switzerland).

5. EMPIRICAL MODEL

The empirical model to be estimated in this paper makes use of a panel data set for Brazilian banks to implement the two-step approach described in the previous section. The following equation is used for the first step:

$$s_{it} = \delta + \boldsymbol{D}\tilde{\boldsymbol{a}} + \boldsymbol{X}_{it}\hat{\boldsymbol{a}} + \varepsilon_{it} \qquad (3)$$

where s_{it} is the interest spread for bank i in period t (i = 1, ..., N; t = 1, ..., T) measured as the difference between the loan and the deposit rates, $\boldsymbol{D}$ is a set of T time dummy variables taking the value one for period t, $\boldsymbol{X}_{it}$ is a vector of bank characteristics, ε_{it} is the statistical disturbance, and δ, $\tilde{\boldsymbol{a}}$, and $\hat{\boldsymbol{a}}$ are parameters to be estimated.

The vector of bank characteristics includes the following variables: a) number of bank branches; b) the ratio of non-interest bearing deposits to total operational assets; c) the ratio of interest-bearing funds to total earning assets; d) operating costs; e) bank liquidity; f) the ratio of service revenues to total operational reve-

nues; g) the bank net worth; and h) bank leverage. Details on the calculation of each variable are given in section 6.

The measure of the pure bank spread is the estimate of $(\delta + \gamma_t)$, where γ_t is the t^{th} element in the $\tilde{\boldsymbol{\alpha}}$ vector. Let ps_t denote the estimate of the pure spread. In the second-step of the procedure, the following equation is estimated:

$$ps_t = \phi + \boldsymbol{Z}_t \ddot{\boldsymbol{e}} + u_t \tag{4}$$

where $\boldsymbol{Z}_t$ is a vector of macroeconomic variables, u_t is the statistical disturbance, and ϕ and $\ddot{\boldsymbol{e}}$ are parameters to be estimated.

The vector of macroeconomic variables contains the market interest rate, a proxy for risk premium, the inflation rate, the output growth rate, the required reserve ratio on demand deposits, and a financial taxation rate.

6. SAMPLE AND DATA

Monthly data for all the commercial banks operating in Brazil during the period from February 1997 to November 2000 is used in the study. Bank observations that were missing, misreported or that constituted clear outliers were excluded from the sample. Banks with less than twelve months of observations were also excluded from the sample. The final sample is an unbalanced panel data with 142 commercial banks. The total number of observations is 5,578. The average number of observations per period is 121.3.

The deposit interest rate is the rate paid on 30-day certificates of deposits. The loan interest rate is the average rate charged on fixed-rate free-allocated operations. In other terms, both floating-rate operations as well as credit directly channeled through legal requirements (mainly credit to the housing and rural sectors) are excluded from the computation of the loan rate.

Both interest rates are posted rates. By contrast, most of the literature makes use of reported interest income and interest expenses when computing bank interest margins. The advantage of our measure is that the posted rates are more likely to be influenced and to respond to changes in the economic environment than interest income and expense. One possible drawback of posted rates is that they can be far from the effective rates paid to depositors and charged from borrowers due to the exclusion of factors such as payment of fees, commissions, idle resource re-

quirements, etc. in their calculation. Moreover, being an ex ante measure, posted rates do not account for loan losses of any nature.

Balance sheet and income statement data come from *COSIF*, a monthly report that all financial institutions in Brazil are required to submit to the Central Bank.

The bank characteristic variables included in the first-step regression aim at controlling for different individual factors that are due to affect the bank interest spread. The main factors considered in the paper include the bank size, its operational policies, and its exposure to risks of different kinds. Our proxies for these factors include the number of bank branches, the ratio of non-interest bearing deposits to total operational assets, the ratio of interest-bearing funds to total earning assets, operating costs, bank liquidity, the ratio of service revenues to total operational revenues, bank net worth, the leverage ratio, and a dummy variable for foreign-controlled banks.

The number of bank branches (*b*) is our measure of bank size. The expected sign for this variable is not clear *a priori*. On one side, bigger banks can have more market power, which is conducive to higher interest spreads. On the other hand, economies of scale can lead bigger banks to operate with lower average costs, which work to reduce bank spreads. Another possibility is that, due to market segmentation, some small and specialized banks can operate in niche markets charging low lending rates.

Non-interest bearing deposits are mainly demand deposits. Banks are forbidden by law to pay any interest on demand deposits. Total operational assets are total bank assets minus fixed assets. The ratio of non-interest bearing deposits to total operational assets (*nibd*) measures the channeling of non-interest-bearing resources to fund bank activities on the asset side. Non-interest bearing deposits are less costly than interest-bearing resources. Thus, one can expect that banks with higher values for *nibd* are associated with lower values for the interest spread. However, one can also argue that this variable is actually capturing the effect of the opportunity cost of non-interest bearing reserves, in which case one would expect a positive sign for it in the interest spread equation.[11]

[11] Courakis (1984) shows that, when banks operate in imperfect markets, it is possible that an increase in the reserve requirement ratio can lead to lower interest spread.

Moreover, although non-interest bearing deposits may imply less interest costs for the bank, it is not clear that banks that rely heavily on non-interest bearing deposits have overall lower costs. Due to the distortions created by a long period of high inflation, many Brazilian banks developed a large and costly branch network with the aim of attracting non-interest bearing deposits subject to inflationary corrosion.

It is therefore unclear what the expected sign for *nibd* should be.

Interest-bearing funds include interest-bearing deposits (mainly passbook savings and time deposits) plus purchased funds. Total earning assets are defined as total operational assets less the sum of foreign-denominated resources, demand deposits, and public sector resources.

The ratio of interest-bearing funds to earning assets (*ibf*) tries to capture the importance of costly resources to fund the bank asset activities. The expected sign for this variable is not *a priori* certain due to the same reasons given for the *nibd* variable.

Operating cost (*opc*) is the ratio of administrative costs to total assets. Banks with higher operating costs are expected to have higher interest spreads.

Bank liquidity (*liquid*) is defined as the ratio of total operational assets to total bank liabilities. This variable is expected to be negatively related to interest spread. An increase in liquidity reduces the bank liquidity risk, which reduces the interest spread due to a lower liquidity premium charged on loans.

Service revenues include mainly revenues from fee collection. Operational revenues include service plus interest revenues. The ratio of service revenues to operational revenues (*servr*) proxies for the importance of bank's off-balance sheet activities. Angbazo (1997) argues that off-balance sheet activities have two opposing effects on banks. On one hand, off-balance sheet activities "should increase profitability since they permit banks to expand in investments that would be passed up if restricted to equity- or deposit-financing" (p. 76). But, on the other hand, since these activities are subject to lower capital requirements, there is a moral hazard effect that may lead banks to "increase off-balance sheet activities in a manner that increases asset risk and enhances the subsidy value of deposit insurance if the premium does not reflect the marginal risk associated with new investment opportunities" (p. 76).

The bank net worth (*netw*) is a summary measure of its earnings performance. The effect of the net worth on interest spread

is expected to be negative. Large net worth provides a cushion for banks to better face the different risks involved in their activities, which reduces the interest spread.

The leverage ratio (*lever)* is defined as the ratio of total liabilities plus net worth to bank net worth. An increase in the leverage ratio is interpreted as an increase in the bank solvency risk, which is conducive to higher interest spread.

A dummy variable for foreign-controlled banks (*forgn*) was also included in the regression.

In the second-step regression, the estimate of the pure spread is related to a set of macroeconomic variables, which include the market interest rate, a risk premium measure, inflation rate, output growth, the required reserves on demand deposits, and financial taxation.

The market interest rate is the overnight *Selic* rate. The proxy for risk premium is the C-bond spread over a US Treasury bond of equivalent maturity. The inflation rate is measured as the monthly rate of change of the general price index (IGP-DI) as calculated by Fundação Getúlio Vargas.[12] Output growth is measured by the first difference of the logarithm of the seasonally adjusted industrial production series as calculated by IBGE. Financial taxation is the burden of indirect taxes on a typical loan operation funded with 30-day certificates of deposits.[13]

One expects that the bank interest spread increases when the basic interest rate (*irate*) or the proxy for risk premium (*ivol*) increase. The same is expected to happen when inflation rate (*infl*), or the required reserves on demand deposits (*rres*), or financial taxation (*tax*) increase. As for the effect of output growth (*ygr*) on interest spread, it can be either positive or negative. On one hand, higher output growth signals a greater demand for bank loans, leading banks to charge more on their loans. On the other hand, to the extent that economic growth is indicative of increased competition and macroeconomic stability, one can expect that lower spread is associated with stronger growth.

[12] The measure of inflation used in this study is not the same as the one targeted by the Central Bank as part of the inflation targeting monetary regime. The last one is a consumer price index, IPCA calculated by Fundação IBGE. We chose a broader price index due to the fact that the focus of this paper is on overall bank loans, both to households as well as to companies.

[13] The taxes considered in the analysis are the IOF (Tax on Financial Operations), PIS-COFINS (Taxes on Gross Revenues), and CPMF (Tax on Debit Transactions).

7. RESULTS

The first-step equation was estimated by means of a within-group estimator where the observations for each bank constitute a group. This estimation procedure amounts to estimate equation (3) by ordinary least squares with the inclusion of time dummy variables for each month in the sample. Dynamic adjustments of the bank spread to changes in the regressors are allowed through the inclusion of lagged terms in the equation. Six lags of each variable were included in the unrestricted model. Non-significant terms are then excluded. The statistic of the Wald test on the validity of the imposed restrictions is equal to 39.65 for a Chi-squared (30) distribution [*p-value* equal to 0.112]. Equation (5) reports the implied long-run results of the first-step regression:[14]

$$\hat{s}_{it} = \underset{(11.4)}{3.068} + \underset{(0.25)}{0.015}\ln b_{it} + \underset{(4.13)}{0.053}\, nibd_{it} - \underset{(1.44)}{3.12\times10^{-3}}\, ibf_{it} + \underset{(2.17)}{0.039}\, opc_{it} + \underset{(1.54)}{3.47\times10^{-4}}\, liquid_{it} + \underset{(2.36)}{0.032}\, servr_{it} + \underset{(1.42)}{7.93\times10^{-4}}\, lever_{it} - \underset{(2.81)}{0.778}\, forgn_{it} + D_t\hat{\gamma} \quad (5)$$

R^2 = 18.19%; $\hat{\sigma} = 1.817$; Joint Significance: χ^2 (27) = 333.9; Time Dummies Significance χ^2 (39) = 280.1

The results of the first-step regressions suggest that large banks charge higher interest spreads but the coefficient is not precisely estimated though.

The ratio of non-interest bearing deposits to total operational assets (*nibd*) affects positively the interest spread. One reason for this positive link is related to the fact that the opportunity cost of non-interest bearing reserves increases when *nibd* is high, leading banks to charge higher spreads.

The same reason can explain why the ratio of interest-bearing funds to earning assets (*ibf*) is negative in equation (5).

As expected, operating costs (*opc*) act to increase the bank interest margin. The expected negative sign for liquidity (*liquid*), however, is not confirmed.

The ratio of service revenues to operational revenues (*servr*) is found to have a positive impact on the interest spread. To the ex-

[14] The long run shows the sum of the coefficients of each variable and its significant lags. In order to spare space, the coefficients on the time dummy variables are not reported. The estimated standard deviations for each coefficient are based on the robust Huber-White sandwich estimators. The t-values are reported in parentheses.

tent that this variable proxies for the relevance of off balance sheet activities, our results may be capturing some moral hazard behavior due to the regulatory treatment of such activities leading to higher asset risk and, as a result, to higher bank spread as well.

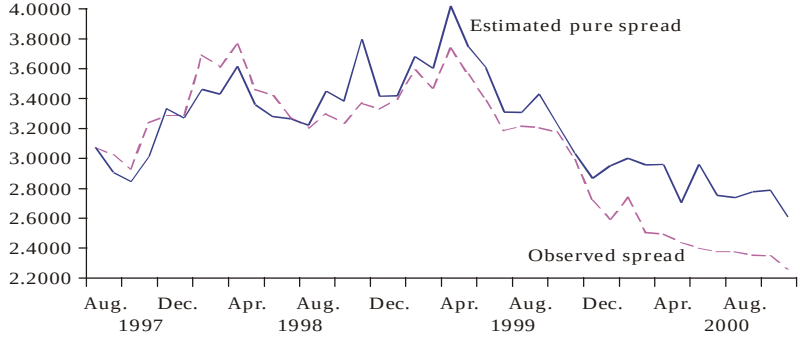
The variable bank net worth (*netw*) is completely eliminated in the specification search.

An increase in bank leverage (*lever*) is associated with higher interest margins due, probably, to higher solvency risk. The estimated coefficient for this variable is not statistically significant though.

The dummy variable for foreign-controlled banks (*frgn*) is negative indicating that these banks charge lower interest spreads on average.

The estimated values for the constant term plus the coefficients on the time dummy variables are our measure of the bank pure spread. Figure 4 contrasts the estimate for the pure spread with the average bank spread. The average bank spread is calculated for the whole banking system rather than for the banks present in our sample.

FIGURE 4. BANK INTEREST SPREAD AND PURE SPREAD, 1997-2000



Both series track each other fairly closely up to October 1999. In the first part of the sample the actual bank spread was larger than the estimated pure spread whereas the opposite seems to be true towards the end of the period.

These results suggest that microeconomic factors (in the form of individual differences amongst banks) do not seem to be a ma-

jor determinant of interest spreads in Brazil.[15] The lack of influence of microeconomic factors on the interest spread is even more pronounced after October 1999 when the Brazilian Central Bank launched a series of measures with the aim of reducing the interest spreads (see Section 3).

It remains to be presented the possible relevance of the macroeconomic factors as determinants of the interest margin in the country.

The second step regression makes use of a general to particular specification search. First, an unrestricted model is estimated. The unrestricted model is a distributed lag one with five lags of the explanatory variables included. Second, a reduction process is implemented through the elimination of the non-significant variables. The final model is the restricted version of the two-step equation. Third and last, the long-run implied equation is computed from the restricted model.

The long run solution associated to the estimated restricted equation is shown below:[16]

$$ps_t = \underset{(8.15)}{1.399} + \underset{(5.90)}{0.398}\, irate_t + \underset{(3.60)}{0.080}\, risk_t - \underset{(4.24)}{0.167}\, infl_t + \underset{(4.09)}{0.117}\, ygr_t + \underset{(0.67)}{0.335}\, rres_t + \underset{(2.06)}{0.665}\, tax_t \quad (6)$$

$$R^2 = 97.85\% \quad \hat{\sigma} = 0.0739 \quad F(19,16) = 38.39 \quad AR1-1F(1,15) = 0.342$$

$$ARCH1\, F(1,14) = 0.0003 \quad Normality\, \chi^2(2) = 3.478 \quad RESET\, F(1,15) = 0.632$$

The restricted equation shows no sign of mis-specification. Moreover, the imposed restrictions are not rejected by the data. The Wald statistic on the restriction is equal to 0.503, with a *F(11,5)* distribution [*p-value* is equal to 0.8411].

The results suggest that the pure spread increases with rises in either the basic interest rate or in the risk premium, as expected. Increases in the required reserves are also accompanied by surges in the interest spread, although the coefficient is not statistically

[15] Recall that the pure spread is what one would observe for the interest spread after accounting for the influence of the microeconomic factors. Thus, if such factors were relevant one would expect to find a large displacement between the pure and actual spreads.

[16] The t-statistics are shown in parentheses. Some diagnostic tests are also reported: *AR*1 is a Wald test for the presence of serial auto-correlation of order one; *ARCH1* is a Wald test for the presence of ARCH residuals of order one; *Normality* is Jarque-Bera test for normal residuals; and *RESET* is Ramsey regression specification test for functional form mis-specification. See Doornik and Hendry (1996) for further details.

significant. The impacts of the output growth and of the financial taxation are also to increase the bank spread.

Contrary to expectations, however, inflation rate affects negatively the pure spread. One possible explanation for this finding is that inflation may be capturing the effect of bank seigniorage collection on interest spreads. Commercial banks collect seggniorage (or an inflation tax) on non-interest bearing demand deposits. According to Cardoso (2002), when seigniorage revenue (or inflationary revenue) falls, commercial banks can pass this loss of revenue on to depositors who will receive lower interest rates on deposits and to borrowers who will face higher interest rate on loans. One would therefore observe higher interest spreads. Cardoso (2002) finds empirical support for this relation for the post-Real period in Brazil.

The high coefficient of determination of equation (6) suggests that macroeconomic factors are important determinants of the bank interest spread in Brazil.

The constant term in equation (6) shows what one would expect for the estimated spread once the macroeconomic factors have been accounted for. Ho and Saunders (1981) interpret this coefficient as measuring the impact of market power on the bank interest margin. The significance for this term suggests that other factors apart from those controlled for in the regressions may be relevant to explain the movements of the pure spread. Market power can be one of such factors although the results obtained by Nakane (2001), showing that the banking industry in Brazil is fairly competitive, do not support this conjecture. Regulatory restrictions in the form of compulsory credit at subsidized rates for rural and real estate loans are another contender.

8. CONCLUSIONS

Bank interest spread in Brazil has shown an impressive downward trend in the recent period. A stable macroeconomic environment as well as the official priority given to the reduction of the interest margins are the main factors behind this behavior.

Another important feature of bank interest spreads in Brazil is its high and persistent cross-sectional dispersion. These elements disclose a market where productive inefficiencies and regulatory burden allow that some banks keep operating even charging rates much higher than their rivals.

These stylized facts are consistent with the findings of our econometric results. Using a panel data of 142 Brazilian banks for the February 1997-November 2000 period, the two-step approach due to Ho and Saunders (1981) is implemented. The results show the relevance of the macroeconomic conditions over bank's observable characteristics as the main determinants of bank interest spreads in Brazil. However, some yet unidentified factors still account for a large portion of the spread behavior in the country.

Despite all the recent developments, bank interest margins in Brazil have remained stubbornly high by international standards. It is not clear if further reductions can still be expected from the development of the macroeconomic conditions. Given the nature of the cross-section dispersion of the interest spread, we foresee that the possible trend is now for such rates to be more and more affected by changes in the microeconomic environment that shakes the industry structure and modifies the behavior of the different banks towards reducing slack and improving managerial practices.

As far as the Central Bank is concerned, we envision a world with the primacy of the prudential regulation and supervision tools over the traditional short-term monetary policy instruments as the most effective ways to ensure a convergence of the best-practices in the local banking industry towards the international benchmarks.

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Juan Carlos Castañeda

Competing monies in Guatemala: what should we expect?

I. INTRODUCTION

On December 2000, the National Congress of Guatemala enacted a bill named "Ley de Libre Negociación de Divisas", which makes it legal to trade in any foreign currency, eliminates the legal tender feature of the "quetzal" (the Guatemalan national currency), and allows the domestic banking sector to engage in financial intermediation operations denominated in any foreign currency. This law is to be effective on May 1, 2001.[1]

As a matter of fact, the US dollar has been used for several years in Guatemala as a unit of account, deposit of value, and/or medium of exchange in a limited but important subset of eco-

[1] Congreso de la República de Guatemala (2000).

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nomic transactions. Nevertheless, the enactment of the new law has caused a lively discussion in Guatemala regarding its possible immediate effects on the main macroeconomic and monetary variables. The basic premise in the discussion seems to be that the new law will encourage the process of currency substitution (the US dollar replacing the Guatemalan quetzal) to an extent greater than what is already observed.[2]

This paper develops a model intended to analyze the effects of the new law on the Guatemalan economy. The model shows that, in the most plausible scenario, we should not expect to observe very important macroeconomic or foreign-exchange effects at the time when the new law becomes effective.

We will now comment on the main features of the analytical framework used in the paper. We develop a dynamic, perfect-foresight, general equilibrium model of a small-open economy with imperfect capital mobility.[3] There are four sectors in the model: the households, the domestic banking sector, the offshore banking sector, and the government.

There is a continuum of identical households, each of which is endowed with a constant amount of the unique consumption good per period and with initial stocks of six different types of monetary assets: quetzal-denominated currency, dollar-denominated currency, quetzal-deposits, dollar-deposits in the domestic banking sector, dollar-deposits in the offshore banking sector, and foreign deposits. The representative household gets utility from consumption and from holding stocks of the monetary assets mentioned above. These monetary assets produce liquidity services and are imperfect substitutes for one another. The household makes a consumption/investment decision each period in order to maximize the present value of its utility; it also decides how to allocate its wealth among the different monetary assets.

It is important to notice that the household cannot have a short position in any asset (either domestic or foreign). This restrictive assumption is introduced to make it possible for the domestic in-

[2] See, for example, CIEN (2001), Facultad de Ciencias Económicas (2001), and Sosa (2001).

[3] In essence, we present a portfolio-allocation model for analyzing currency substitution, in the tradition of Calvo (1996a) and other references therein. However, the way we model the imperfect capital mobility feature is different from the most usual approaches that can be found in the relevant literature (as will become clear below.)

terest rate to be permanently influenced by the central bank (an apparent feature of the Guatemalan economy).[4] [5]

The domestic banking sector is perfectly competitive. It gets funds on deposit from the households and invests those funds on public bonds, bar a reserve requirement. Both deposits and bonds can be denominated in either quetzals or dollars. The offshore banking sector is also perfectly competitive. It also gets funds on deposit from the households and invests those funds on public bonds, but it operates in dollar-denominated assets only. The offshore banking sector is not subject to a legal reserve requirement, but it voluntarily holds a fraction of its deposits in the form of liquid foreign assets. The offshore banking sector is included in the model because its importance is acknowledged (though not quantified) in the Guatemalan financial market.[6] Again, both the domestic banking sector and the offshore one are precluded from borrowing from abroad in order to preserve the 'imperfect capital mobility' feature of the model.

The public sector includes a fiscal authority and a monetary authority. The fiscal authority gives lump-sum transfers to the households or exacts lump-sum taxes from them. There is no public expenditure or public investment in the model, and there are no distortionary taxes (other than inflation). The monetary authority or central bank issues currency denominated in quetzals, gets funds on deposit from the domestic banking sector as reserve requirement (in both quetzals and dollars), and issues bonds (in quetzals and dollars). It devotes the proceeds to foreign-asset accumulation (international reserves) or to transfers to the fiscal authority.

The policy regime in the model is such that the central bank predetermines the exchange rate and fixes the domestic interest rate, while the fiscal authority's transfers to the households equal

[4] Since the model is a perfect foresight one, it has no room for 'country risk' (or for any kind of risk.)

[5] If this assumption were relaxed and the household could borrow from abroad, then the domestic interest rate would be necessarily equal (in real terms) to the international one. Even if borrowing from abroad were precluded but the household were allowed to borrow from the domestic credit market, then the domestic real interest rate in steady state could not be different from the subjective discount rate and, hence, could not be an independent policy variable.

[6] See, for example, International Monetary Fund and The World Bank (2000).

exactly the central bank's net interest revenue. This is a particular case of monetary dominance and fiscal accommodation that guarantees that the consolidated government's intertemporal budget constraint holds. In this regime, the central bank's international reserves and the monetary aggregates are endogenously determined in equilibrium. Although the model's policy setup does not literally represent the Guatemalan actual fiscal/monetary policy combination, it is a simplification that underscores the disposition of both the monetary and the fiscal authority to preserve the macroeconomic stability (in particular, the exchange rate and the financial stability) at the time when the new law is to become effective.

The 'monetary-dominance/fiscal-accommodation' feature distinguishes this model from others that also deal with currency substitution. Most of the theoretical literature on currency substitution assumes that seigniorage is a key element in fiscal deficit's financing; moreover, most of the empirical literature deals with historical experiences in which that seems to be the case.[7] However, the law under analysis will become effective in Guatemala in an environment in which the inflation rate has been moderate for ten years: less than 15% a year in the 1991-2000 period, and less than 10% a year in the 1997-2000 period.[8] In addition, the central bank has a historically high level of international reserves (for the country's standards)[9] and has shown a predisposition to use them in order to substantially reduce the exchange rate's volatility.[10]

In the model, the effect of the new law in question is to cause an increase in the share parameter in the utility function corresponding to dollar-deposits in the domestic banking sector and a decrease by the same amount of the share parameter corresponding to quetzal-deposits.[11] These changes in parameter values are announced four periods before they are materialized (one period representing one month).[12] The nature of the analytical experi-

[7] See, for example, Calvo (1996), Calvo and Vegh (1992), ILADES (1992), and references therein.

[8] Banco de Guatemala (2001).

[9] See Banco de Guatemala (2000).

[10] See Edwards (2000).

[11] The strategy of modeling an increase in one country's level of currency substitution as a change in parameter values of dynamic, general equilibrium models has antecedents in the currency substitution literature; it is used, for instance, in Bufman and Leiderman (1992) and in McNeils and Asilis (1992).

[12] The new law ("Ley de Libre Negociación de Divisas") was enacted on December 2000 and expected to be effective four months later, on May 1, 2001.

ment is the following: the artificial economy is at the original steady state before period 0. On period 0, it is announced that from period 4 on, a new set of parameter values will be effective. The problem is to find the original steady state of the artificial economy, as well as the new steady state and the transition paths for all relevant variables. The analysis focuses on the two relevant steady states and the transition paths between them because it tries to isolate the permanent effects of the new law from the day-to-day operation of the economy. This is also why the model was designed as a perfect-foresight one, and the policy setup was modeled as invariant to the changes implied by the new law.

The remainder of this paper is organized as follows: the second part presents the model and its calibration in detail; the third part presents the solution technique applied and the results obtained; and the last part contains a conclusion that wraps up the main ideas in the paper.

II. THE MODEL

The following perfect-foresight model corresponds to a deterministic, endowment, monetary, small-open economy. There are four sectors: the households, the domestic banking sector, the offshore banking sector, and the government. We now proceed to examine the model's features in detail.

1. Some definitions and conventions

In what follows, the variable c_t represents consumption; m_t is the household's nominal domestic currency balance, $m_{\$,t}$ is its nominal foreign currency balance, d_t represents nominal domestic quetzal-denominated deposits, $d_{\$,t}$ represents nominal domestic dollar-denominated deposits; $d_{\$off,t}$ represents nominal offshore dollar-denominated deposits, $d^*_{\$,t}$ represents nominal foreign dollar-denominated deposits, and f_t is a nominal quetzal-denominated lump-sum transfer from the government which, in principle, can be positive, negative, or zero).

The symbol $i_{d,t}$ denotes the nominal interest rate on domestic quetzal-denominated deposits, $i_{d\$,t}$ is the nominal interest rate on domestic dollar-denominated deposits, $i_{d\$off,t}$ is the nominal interest rate on offshore dollar-denominated deposits, and i^*_t is the nominal interest rate on all foreign assets (including deposits); P_t is the price (measured in quetzals) of one unit of the good in pe-

riod *t*, and E_t is the nominal exchange rate (the price of one dollar in terms of quetzals).

In period *t*, the household chooses the *t* value of each asset, taking the *t* -1 value of each asset as given.

Interest rates indexed *t* -1 clear the financial assets markets in period *t* -1 and must be paid in period *t*, and those indexed *t* clear the markets in period *t* and must be paid in period *t* +1.

Lower case variables correspond to the individual household, while capital case variables are aggregate per capita averages.

We assume that the law of one price holds in this economy:

$$P_t = E_t \cdot P_t^*, \forall t \tag{1}$$

where P_t^* is the foreign price level. Hence, in terms of rates of growth, the following equation holds:

$$1+\pi_t = (1+\varepsilon_t)\cdot(1+\pi_t^*), \forall_t \tag{2}$$

where:

$$1+\pi_t \equiv \frac{P_t}{P_{t-1}} \tag{3}$$

$$1+\varepsilon_t \equiv \frac{E_t}{E_{t-1}} \tag{4}$$

$$1+\pi_t^* \equiv \frac{P_t^*}{P_{t-1}^*} \tag{5}$$

Moreover, we assume that the foreign inflation rate is always zero:

$$\pi_t^* = \pi^* = 0, \forall t \tag{6}$$

Therefore, it must be the case that in this economy the inflation rate is always equal to the rate of devaluation:

$$\pi_t = \varepsilon_t, \forall t \tag{7}$$

Besides, for normalization purposes, we assume that:

$$P_t^* = 1, \forall t \tag{8}$$

and, hence:

$$P_t = E_t, \forall t \tag{9}$$

We also assume that the foreign interest rate is constant and smaller than the subjective discount rate of the household:

$$i^*_{\$,t} = i^*_{\$} \in \left(0, \frac{1}{\beta} - 1\right), \forall t \tag{10}$$

In addition, in order to simplify the notation, we define the following variables:

$$\hat{m}_t \equiv \frac{m_t}{P_t} \tag{11}$$

$$\hat{m}_{\$,t} \equiv \frac{E_t \cdot m_{\$,t}}{P_t} \tag{12}$$

$$\hat{d}_t \equiv \frac{d_t}{P_t} \tag{13}$$

$$\hat{d}_{\$,t} \equiv \frac{E_t \cdot d_{\$,t}}{P_t} \tag{14}$$

$$\hat{d}_{\$off,t} \equiv \frac{E_t \cdot d_{\$off,t}}{P_t} \tag{15}$$

$$\hat{d}^*_{\$,t} \equiv \frac{E_t \cdot d^*_{t\ \$,t}}{P_t} \tag{16}$$

$$\hat{f}_t \equiv \frac{f_t}{P_t} \tag{17}$$

and, in general, a 'hat variable' is the corresponding nominal variable measured in real terms (i.e., measured in units of the consumption good).

2. The household

There is a continuum of infinitely-lived households. Each household has a fixed endowment of *y* units per period of the unique, perishable consumption good. The household also has initial stocks of the following financial assets: domestic currency $m_{\$,-1}$; foreign currency $m_{\$,-1}$; domestic, quetzal-denominated deposits d_{-1}; domestic, dollar-denominated deposits $d_{\$,-1}$; offshore,

dollar-denominated deposits $d_{\$off,-1}$; and foreign, dollar-denominated deposits $d^*_{\$,-1}$. The household also gets a nominal (quetzal-denominated) transfer f_t per period from the government. Each period, the household decides how to allocate its wealth between consumption and asset accumulation, and how to divide its wealth among the different financial assets.

The household maximizes an intertemporal, time-separable utility function, which adds up the discounted utility flow of each period. The arguments of the period-utility function are the quantity consumed of the unique good during the period, and the real values of the stocks of the monetary assets (currencies and deposits). The latter belong to the utility function because of the liquidity services that they provide to the household. The household has no access to any form of credit, either domestic or foreign.

a) Household's problem

The household solves the following problem:

$$\max_{\left[c_t, \hat{m}_t, \hat{m}_{\$,t}, \hat{d}_t, \hat{d}_{\$,t}, \hat{d}_{\$off,t}, \hat{d}^*_{\$,t}\right]}$$

$$U = \sum_{t=0}^{\infty} \beta^t \cdot u\left(c_t, \hat{m}_t, \hat{m}_{\$,t}, \hat{d}_t, \hat{d}_{\$,t}, \hat{d}_{\$off,t}, \hat{d}^*_{\$,t}\right) \tag{18}$$

subject to:

$$c_t + \hat{m}_t + \hat{m}_{\$,t} + \hat{d}_t + \hat{d}_{\$,t} + \hat{d}_{\$off,t} + \hat{d}^*_{\$,t} =$$
$$y + \frac{\hat{m}_{t-1}}{(1+\pi_t)} + \hat{m}_{\$,t-1} + \frac{(1+i_{d,t-1})\cdot \hat{d}_{t-1}}{(1+\pi_t)} +$$
$$(1+i_{d\$,t-1})\cdot \hat{d}_{\$,t-1} + (1+i_{d\$off,t-1})\cdot \hat{d}_{\$off,t-1} +$$
$$(1+i^*_{\$,t-1})\cdot \hat{d}^*_{\$,t-1} + \hat{f}_t; \tag{19}$$

and

$$c_t, \hat{m}_{t-1}, \hat{m}_{\$,t-1}, \hat{d}_{t-1}, \hat{d}_{\$,t-1}, \hat{d}_{\$off,t-1}, \hat{d}^*_{\$,t-1} \geq 0, \forall t \tag{20}$$

where:

$$u\left(c_t, \hat{m}_t, \hat{m}_{\$,t}, \hat{d}_t, \hat{d}_{\$,t}, \hat{d}_{\$off,t}, \hat{d}^*_{\$,t}\right) =$$

$$\left[\alpha_1 log\left(c_t\right)+\alpha_2\, log\left(\hat{m}_t\right)+\alpha_3\, log\left(\hat{m}_{\$,t}\right)+\alpha_4\, log\left(\hat{d}_t\right)\right.$$
$$\left.+\alpha_5\, log\left(\hat{d}_{\$,t}\right)+\alpha_6\, log\left(\hat{d}_{\$off,t}\right)+\alpha_7\, log\left(\hat{d}^*_{\$,t}\right)\right] \quad (21)$$

$$\alpha_1,\alpha_2,...,\alpha_7 \in (0,1) \quad (22)$$

$$\sum_{j=1}^{7}\alpha_j = 1 \quad (23)$$

$i_{d,-1}, i_{d\$,-1}, i_{d\$off,-1}, i^*_{\$,-1}, i_{-1}, i_{\$,-1}$ are given; current and future prices are known and taken as given.

In the problem above, equation (19) is the period budget constraint. In addition, prevention of Ponzi schemes is guaranteed by the fact that the household is not allowed to hold short positions in any financial asset (inequality (20)).

b) First order conditions

The following six equations are the first order conditions of utility maximization for the household with respect to the variables $m_t, m_{\$,t}, d_t, d_{\$,t}, d_{\$off,t}, d^*_{\$,t}$ respectively:

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_2\cdot\frac{1}{\hat{m}_t}=\beta\cdot\alpha_1\cdot\frac{1}{1+\varepsilon_{t+1}}\cdot\frac{1}{c_{t+1}} \quad (24)$$

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_3\cdot\frac{1}{\hat{m}_{\$,t}}=\beta\cdot\alpha_1\cdot\frac{1}{c_{t+1}} \quad (25)$$

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_4\cdot\frac{1}{\hat{d}_t}=\beta\cdot\alpha_1\cdot\frac{1}{1+\varepsilon_{t+1}}\cdot\left(1+i_{d,t}\right)\cdot\frac{1}{c_{t+1}} \quad (26)$$

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_5\cdot\frac{1}{\hat{d}_{\$,t}}=\beta\cdot\alpha_1\cdot\left(1+i_{d\$,t}\right)\cdot\frac{1}{c_{t+1}} \quad (27)$$

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_6\cdot\frac{1}{\hat{d}_{\$off,t}}=\beta\cdot\alpha_1\cdot\left(1+i_{d\$off,t}\right)\cdot\frac{1}{c_{t+1}} \quad (28)$$

$$\alpha_1\cdot\frac{1}{c_t}-\alpha_7\cdot\frac{1}{\hat{d}^*_{\$,t}}=\beta\cdot\alpha_1\cdot\left(1+i^*_{\$,t}\right)\cdot\frac{1}{c_{t+1}} \quad (29)$$

3. The domestic banking sector

There is a generally available, constant-returns-to-scale, domestic banking technology in the artificial economy. Because of the constant-returns-to-scale feature, there are zero profits in this banking sector and, without loss of generality, we can assume that there is only one domestic banking firm that behaves competitively.

The balance sheet of the domestic banking firm is the following:

$$\frac{R_{b,t}}{E_t} + R_{\$b,t} + \frac{B_{b,t}}{E_t} + B_{\$b,t} = \frac{D_t}{E_t} + D_{\$,t} \tag{30}$$

In the left-hand-side, $R_{b,t}$ represents quetzal-denominated reserves, $R_{\$b,t}$ represents dollar-denominated reserves, $B_{b,t}$ is quetzal-denominated bonds, and $B_{\$b,t}$ is dollar-denominated bonds. In the right-hand-side, D_t represents quetzal-denominated deposits, and $D_{\$,t}$ represents dollar-denominated deposits (all variables in nominal and per capita terms). We assume that the domestic bank does not have access to the international capital market at all, and does not have any net worth.

The bank does not use real resources to operate; however, it is subject to a reserve requirement: it needs to hold a fraction $\tau_1 \in (0,1)$ of its deposits in the form of deposits at the central bank. That is:

$$R_{b,t} = \tau_1 \cdot D_t \tag{31}$$

$$R_{\$b,t} = \tau_1 \cdot D_{\$,t} \tag{32}$$

and, hence:

$$\frac{B_{b,t}}{E_t} + B_{\$b,t} = (1-\tau_1) \cdot \left(\frac{D_t}{E_t} + D_{\$,t} \right) \tag{33}$$

Since the bank is assumed to have zero net worth, the zero-profits condition implies that total nominal revenue equals total nominal cost each period:

$$\frac{R_{b,t}}{E_{t+1}} + R_{\$b,t} + (1+i_t) \cdot \left(\frac{B_{b,t}}{E_{t+1}} \right) + (1+i_{\$,t}) \cdot B_{\$b,t} = (1+i_{d,t}) \cdot \left(\frac{D_t}{E_{t+1}} \right) + (1+i_{d\$,t}) \cdot D_{\$,t} \tag{34}$$

where i_t is the nominal interest rate on domestic, quetzal-denominated bonds, and $i_{\$,t}$ is the nominal interest rate on domestic, dollar-denominated bonds.

Moreover, because of the constant-returns-to-scale feature prevailing in the banking technology, it must be the case that there are zero profits in each possible banking operation.[13] This statement implies that the following four conditions must hold:

$$\tau_1 \cdot D_t + (1 + i_t) \cdot [(1 - \tau_1) \cdot D_t] = (1 + i_{d,t}) \cdot D_t \tag{35}$$

$$\tau_1 \cdot D_{\$,t} + (1 + i_{\$,t}) \cdot \{(1 - \tau_1) \cdot D_{\$,t}\} = (1 + i_{d\$,t}) \cdot D_{\$,t} \tag{36}$$

$$\tau_1 \cdot D_{\$,t} + (1 + i_t) \cdot [(1 - \tau_1) \cdot D_{\$,t} \cdot E_t] \cdot \left(\frac{1}{E_{t+1}} \right) = (1 + i_{d\$,t}) \cdot D_{\$,t} \tag{37}$$

$$\tau_1 \cdot D_t + (1 + i_{\$,t}) \cdot \left[\frac{(1 - \tau_1) \cdot D_t}{E_t} \right] \cdot E_{t+1} = (1 + i_{dt}) \cdot D_t \tag{38}$$

Equation (35) corresponds to quetzal-denominated investments financed with quetzal-denominated deposits; (36) corresponds to dollar-denominated investments financed with dollar-denominated deposits; (37) corresponds to quetzal-denominated investments financed with dollar-denominated deposits; and (38) corresponds to dollar-denominated investments financed with quetzal-denominated deposits. Equations (35) to (38) imply the following conditions:

$$i_{d,t} = (1 - \tau_1) \cdot i_t \tag{39}$$

$$i_{d\$,t} = (1 - \tau_1) \cdot i_{\$,t} \tag{40}$$

$$i_{d\$,t} = \tau_1 + (1 - \tau_1) \cdot (1 + i_t) \cdot \left(\frac{1}{1 + \varepsilon_{t+1}} \right) - 1 \tag{41}$$

$$i_{d,t} = \tau_1 + (1 - \tau_1) \cdot (1 + i_{\$,t}) \cdot (1 + \varepsilon_{t+1}) - 1 \tag{42}$$

In addition, combining equations (39) and (42) we get:

$$i_t = (1 + i_{\$,t}) \cdot (1 + \varepsilon_{t+1}) - 1 \tag{43}$$

And combining (39) and (43) we obtain:

[13] For example, prices cannot be such that there are losses in quetzal-denominated intermediation, even if they are offset by profits in dollar-denominated intermediation. The reason is that a new bank could be established to operate in dollar-intermediation only with unlimited profits at such prices. Of course, that situation could not possibly characterize an equilibrium.

$$i_{d,t} = (1-\tau)\cdot\left\{\left(1+i_{\$,t}\right)\left(1+\varepsilon_{t+1}\right)\right\}-1 \tag{44}$$

These results imply that if one the four interest rates $(i_t, i_{\$,t}, i_{d,t}, i_{d\$,t})$ is given, the other three are automatically determined in equilibrium. In particular, if $i_{\$,t}$ is known, then $i_{d\$,t}, i_t$, and $i_{d,t}$ are determined by equations (40), (43), and (44), respectively. Besides, equation (43) implies that the interest rate on quetzal-bonds is equal in real terms to the interest rate on domestic dollar-bonds.

4. The offshore banking sector

There is also a generally available, constant-returns-to-scale, offshore banking technology. We also assume that there is only one offshore bank that behaves competitively.

The balance sheet of the offshore banking firm is the following (all variables in nominal and per capita terms):

$$R^*_{\$off,t} + B_{\$off,t} = D_{\$off,t} \tag{45}$$

In the left-hand-side, $R^*_{\$off,t}$ represents dollar reserves held by the offshore bank in the international capital market, and $B_{\$off,t}$ represents dollar-denominated bonds held by the offshore bank in the Guatemalan domestic credit market. In the right-hand-side, $D_{\$off,t}$ represents dollar-denominated deposits. We assume that the offshore bank cannot borrow in the international capital market, but it can hold international assets that yield the international interest rate $i^*_{\$,t}$.

As the domestic bank, the offshore bank does not use real resources to operate. Moreover, and unlike the domestic one, the offshore bank is not subject to a legal reserve requirement. Nevertheless, we assume that in order to operate the offshore bank needs to hold a fraction $\tau_2 \in (0,1)$ of its deposits in the form of liquid assets $R^*_{\$off,t}$ at the international capital market:

$$R^*_{\$off,t} = \tau_2 \cdot D_{\$,t} \tag{46}$$

and, hence:

$$B_{\$off,t} = (1-\tau_2)\cdot D_{\$off,t} \tag{47}$$

It is also the case that for this bank the zero-profits condition implies that total nominal revenue equals total nominal cost each period:

$$\left(1+i^{*}_{\$,t}\right)\cdot R^{*}_{\$off,t}+\left(1+i_{\$,t}\right)\cdot B_{\$off,t}=\left(1+i_{d\$off,t}\right)\cdot D_{\$off,t} \tag{48}$$

where $i_{d\$off,t}$ is the nominal interest rate on offshore dollar-denominated deposits, and $i^{*}_{\$,t}$ and $i_{\$,t}$ are as previously defined. Since the offshore bank invests a fraction τ_2 of its assets in internationally liquid reserves, then the zero-profits condition requires that:

$$\left(1+i^{*}_{\$,t}\right)\cdot\left[\tau_2\cdot D_{\$off,t}\right]+\left(1+i_{\$,t}\right)\cdot\left[\left(1-\tau_2\right)\cdot D_{\$off,t}\right]=\left(1+i_{d\$off,t}\right)\cdot D_{\$off,t} \tag{49}$$

Hence, in equilibrium, the offshore nominal interest rate on deposits is completely determined by the international nominal interest rate $i^{*}_{\$,t}$; the nominal interest rate on domestic, dollar-denominated bonds $i_{\$,t}$; and the offshore reserve parameter τ_2:

$$i_{d\$off,t}=\tau_2\cdot\left(1+i^{*}_{\$,t}\right)+\left(1-\tau_2\right)\cdot\left(1+i_{\$,t}\right)-1 \tag{50}$$

5. The government

a) Budget constraint

The period budget constraint of the government (in nominal and per capita terms) is the following:[14]

$$\frac{F_t}{E_t}+\frac{\left(1+i_{t-1}\right)B_{t-1}}{E_t}+\left(1+i_{\$,t-1}\right)B_{\$,t-1}+R^{*}_{\$,t}=$$
$$\frac{\left(M0_t-M0_{t-1}\right)}{E_t}+\left(R_{\$b,t}-R_{\$b,t-1}\right)+\frac{B_t}{E_t}+B_{\$,t}+\left(1+i^{*}_{\$,t-1}\right)R^{*}_{\$,t-1} \tag{51}$$

In equation (51), F_t represents the primary fiscal deficit (lump-sum transfers to the household minus lump-sum taxes);[15] B_{t-1} is the domestic, nominal (quetzal-denominated) public debt issued on period $t-1$ that must be paid (along with the corresponding interest) on period t; $B_{\$,t-1}$ is the domestic, nominal (dollar-denominated) public debt issued on period $t-1$ that must be paid in period t; $R^{*}_{\$,t-1}$ is the stock of foreign, nominal (dollar-denominated) public net assets[16] determined on period $t-1$ that matures (and yields interest at the rate $i^{*}_{\$,t-1}$) on period t; $R_{\$b,t-1}$ is the stock of dollar-denominated bank reserves determined on

[14] This budget constraint corresponds to the 'consolidated' government (i.e., the fiscal and monetary branches of government taken together.)

[15] There are no public expenditures in the model.

[16] That is, international reserves minus public external debt.

$t-1$ and taken as given on t; $M0_{t-1}$ is the nominal (quetzal-denominated) monetary base determined on period $t-1$ and taken as given on period *t*. The monetary base is, in turn, equal to the sum of quetzal-denominated currency and quetzal-denominated bank reserves:

$$M0_t = M_t + R_{b,t} \tag{52}$$

where M_t is quetzal-denominated currency in the public's hands and $R_{b,t}$ is the stock of quetzal-denominated bank reserves, both determined on *t*.

Prevention of Ponzi schemes and a full use of resources on the part of the government are guaranteed by the following conditions:

$$\frac{B_t}{P_t}, \frac{E_t \cdot B_{\$,t}}{P_t}, \frac{E_t \cdot R^*_{\$,t}}{P_t} \in (-\Gamma, \Gamma), \forall t \tag{53}$$

where Γ is a very big (but finite) number.

b) Fiscal and monetary branches

The government is divided in two branches: the fiscal branch and the monetary one. The fiscal branch is in charge of disbursing lump-sum transfers to the households (or exacting lump-sum taxes from them, when the transfers have a negative sign). The fiscal branch does not accumulate assets or liabilities at all, but it can get transfers form the monetary branch.

The monetary branch (or central bank) issues high-powered money and public debt, and holds international reserves. The central bank's balance sheet is as follows (in dollars per capita):

$$R^*_{\$,t} = \frac{M0_t}{E_t} + R_{\$b,t} + \frac{B_t}{E_t} + B_{\$,t} + NW_t \tag{54}$$

where NW_t is the net worth of the central bank on period *t* and all other variables are as previously defined.

In addition, we can measure central bank's profits using the following formula:

$$\Pi_{\$,t} = (1 + i^*_{\$,t-1}) \cdot R^*_{\$,t-1} - \frac{M0_{t-1}}{E_t} - R_{\$b,t-1} - (1 + i_{t-1}) \cdot \frac{B_{t-1}}{E_t} - (1 + i_{\$,t-1}) \cdot B_{\$,t-1} - \frac{T_t}{E_t} \tag{55}$$

where $\Pi_{\$,t}$ stands for nominal profits (measured in dollars) determined on period *t*; and T_t represents nominal, per capita,

quetzal-denominated transfers from the central bank to the fiscal branch. In real terms, the formula for central bank's profits is:

$$\hat{\Pi}_{\$,t} = \left(1 + i^*_{\$,t-1}\right) \cdot \hat{R}^*_{\$,t-1} - \left(\frac{1}{1+\varepsilon}\right) \cdot \hat{M}0_{t-1} - \hat{R}_{\$b,t} - \left(1 + i_{t-1}\right) \cdot \left(\frac{1}{1+\varepsilon}\right) \cdot \hat{B}_{t-1} - \left(1 + i_{\$,t-1}\right) \cdot \hat{B}_{\$,t-1} - \hat{T}_t \quad (56)$$

c) Public policy

We will explore the behavior of the model under a particular policy regime. Under this regime, the government predetermines the exchange rate and fixes the interest rate. That is, the government sets the value of the following variables:

$$E_0 = \overline{E}_0 \in (0, \infty) \quad (57)$$

$$\varepsilon_t = \varepsilon \in [0, \infty), \forall t > 0 \quad (58)$$

$$i_{\$,t} = i_\$ \in \left(i^*_\$, \frac{1}{\beta} - 1\right), \forall t > 0 \quad (59)$$

$$\hat{F}_t = \hat{T}_t \quad (60)$$

$$\hat{T}_t = \left(1 + i^*_{\$,t-1}\right) \cdot \hat{R}^*_{\$,t-1} - \left(\frac{1}{1+\varepsilon}\right) \cdot \hat{M}0_{t-1} - \hat{R}_{\$b,t} - \left(1 + i_{t-1}\right) \cdot \left(\frac{1}{1+\varepsilon}\right) \cdot \hat{B}_{t-1} - \left(1 + i_{\$,t-1}\right) \cdot \hat{B}_{\$,t-1} \quad (61)$$

In words, the government sets the path for the exchange rate and the devaluation rate (equations (57) and (58)). Since the law of one price prevails and foreign inflation is zero, this means that the government also sets the path for the price level and the inflation rate.

Equation (59) implies that the government also exogenously determines the domestic interest rate on dollar-denominated bonds. This rate is restricted to be greater than the international interest rate for the model to deliver relevant results for the Guatemalan economy. It is also restricted to be less than the household's subjective discount rate to make sure that interest rate on offshore deposits is always low enough for a stationary equilibrium to exist.[17]

[17] Otherwise, if $i_\$$ could be greater than $\frac{1}{\beta} - 1$, it would be possible that the interest rate on offshore deposits were greater than the subjective discount rate. In that case, the household would choose an ever increasing per capita consumption path that would be infeasible.

Equation (60) indicates that the fiscal primary deficit is equal to the transfer that the fiscal authority gets from the central bank, and equation (61) implies that such transfer is equal to the amount of net financial revenue of the central bank. This is a special case of fiscal/monetary coordination in which monetary policy is dominant and fiscal policy accommodates in order to satisfy the requirements of the government's intertemporal budget constraint. Combining equations (51), (56), (60), and (61) we get the following expression for the level of international reserves:

$$\hat{R}^{*}_{\$,t} = \hat{M}0_t + \hat{R}_{\$b,t} + \hat{B}_t + \hat{B}_{\$,t} \tag{62}$$

6. Market clearing conditions

In equilibrium, the following market clearing conditions must hold every period:

Goods market:[18]

$$y + \hat{m}_{\$,t-1} + (1 + i^{*}_{\$,t-1}) \cdot \left[\hat{d}^{*}_{\$,t-1} + \hat{R}^{*}_{\$,t-1} + \hat{R}^{*}_{\$off,t-1}\right] = c_t + \hat{m}_{\$,t} + \hat{d}^{*}_{\$,t} + \hat{R}^{*}_{\$off,t} \tag{63}$$

Dollar-denominated currency:

$$m_{\$,t} = M_{\$,t} \tag{64}$$

Quetzal-denominated deposits:

$$d_t = D_t \tag{65}$$

Domestic dollar-denominated deposits:

$$d_{\$,t} = D_{\$,t} \tag{66}$$

Offshore dollar-denominated deposits:

$$d_{\$off,t} = D_{\$off,t} \tag{67}$$

Foreign dollar-denominated deposits:

$$d^{*}_{\$,t} = D^{*}_{\$,t} \tag{68}$$

Banks' bonds:

[18] This is the relevant per capita resource constraint for this small open economy.

$$\frac{B_t}{E_t} + B_{\$,t} = (1-\tau_1)\cdot\left(\frac{D_t}{E_t} + D_{\$,t}\right) + (1-\tau_2)\cdot D_{\$off,t} \tag{69}$$

Quetzal-denominated currency:

$$m_t = M0_t - \tau_1 \cdot D_t \tag{70}$$

Quetzal-denominated domestic-bank' s reserves:

$$R_{b,t} = \tau_1 \cdot D_t \tag{71}$$

Dollar-denominated domestic-bank's reserves:

$$R_{\$b,t} = \tau_1 \cdot D_{\$,t} \tag{72}$$

Offshore bank's reserves:

$$R^*_{\$off,t} = \tau_2 \cdot D_{\$off,t} \tag{73}$$

Primary fiscal deficit:

$$f_t = F_t \tag{74}$$

7. Calibration

There are fifteen parameters in this model. They were calibrated to the Guatemalan economy for monthly data. We will briefly comment on the strategy followed for calibrating each parameter.

There are eight parameters in the household's utility function: the discount factor parameter and the share parameters of the seven arguments of the period-utility function. The strategy for calibrating these parameters was to get their values from the first order conditions for the household's utility maximization in steady state, using for that purpose some relevant information from the Guatemalan data. However, the assumption that the household has no access to any sort of borrowing implied that the discount factor parameter β was not uniquely determined. Hence, an arbitrary value was assigned to β, such that the implied discount rate was slightly greater than the highest interest rate at which the household could invest. The values for the share parameters $\alpha_1, \alpha_2, \alpha_4, \alpha_5, \alpha_6$ and α_7 were determined from the first order conditions in steady state, as functions of some parameters $(\beta, i^*_\$, i, i_\$, i_d, i_{d\$}, i_{d\$off}, \tau_1, \varepsilon)$ and some average values from the data:

$$\overline{\left(\frac{M0}{c}\right)}, \overline{\left(\frac{D}{c}\right)}, \overline{\left(\frac{D_{\$}}{c}\right)}, \overline{\left(\frac{D_{\$off}}{c}\right)}$$

The value of the parameter α_3 was arbitrarily set to be equal to one tenth of α_2, since there are no data available about the amount of dollar-currency held by Guatemalan residents.

The values for the parameters i, τ_1, and ε were taken from the Guatemalan data. The i parameter was equated to the average lending rate of the Guatemalan banking system during the period 1991-2000 (using monthly data). The ε parameter was equated to the average monthly rate of change of the exchange rate (the price of one US dollar in terms of Guatemalan quetzals) for the same period. The τ_1 parameter was equated to the current (as of April 2001) legal reserve requirement for Guatemalan banks. The values for $i_{\$}, i_d, i_{d\$}$ were determined using equations (40), (43), and (44), as functions of i and τ_1.

The foreign interest rate parameter $i^*_{\$}$ was equated to the average rate on certificates of deposit reported by the US Federal Reserve Board for the period 1965:12-2001:03 (monthly data). The offshore interest rate parameter $i_{d\$off}$ was set arbitrarily (since there are no official data for that variable) at some point between the interest rate on dollar-deposits at the domestic banking sector and the discount rate.

The average ratios $\overline{\left(\frac{M0}{c}\right)}, \overline{\left(\frac{D}{c}\right)}, \overline{\left(\frac{D_{\$}}{c}\right)}$ were computed from the Guatemalan data.[19] Since there are no data for $D_{\$off,t}$ available, the $\overline{\left(\frac{D_{\$off}}{c}\right)}$ ratio was arbitrarily estimated to be half the size of the $\left(\frac{D}{c}\right)$ ratio.[20]

The reserve ratio for the offshore banking sector τ_2 was determined from equation (50), given the values of $i_{\$}, i_{d\$off}$, and $i^*_{\$}$.

Lastly, the monthly consumption-good endowment was normalized to be equal to one.

The values for all the parameters are given below:

[19] The monthly series for consumption was obtained by a cubic interpolation of the corresponding annual series divided by twelve.

[20] This figure is consistent with the gross assessment contained in International Monetary Fund and The World Bank (2000).

$$y = 1$$
$$\alpha_1 = 0.89076$$
$$\alpha_2 = 0.010849$$
$$\alpha_3 = 0.0010849$$
$$\alpha_4 = 0.0057825$$
$$\alpha_5 = 1.0681 \times 10^{-5}$$
$$\alpha_6 = 0.0015186$$
$$\alpha_7 = 0.089995$$
$$\beta = 1 / 1.015$$
$$\tau_1 = 0.14$$
$$\tau_2 = 0.095661$$
$$\varepsilon = 0.003202$$
$$i = 0.017519$$
$$i_{d\$off} = 0.013333$$
$$i_{\$}^{*} = 0.004462$$

And the average ratios used in the calibration are the following:

$$\overline{\left(\frac{M0}{c}\right)} = 0.970228$$

$$\overline{\left(\frac{D}{c}\right)} = 2.076500$$

$$\overline{\left(\frac{D_{\$}}{c}\right)} = 0.004464$$

$$\overline{\left(\frac{D_{\$odd}}{c}\right)} = 1.0382$$

III. SOLUTION

1. Equilibrium definition

"Equilibrium" in this economy is a set of sequences for con-

sumption allocations, asset stocks, and prices, such that each household solves its utility maximization problem, the domestic bank solves its profit maximization problem, the offshore bank also solves its profit maximization problem, the government's period and intertemporal budget constraints hold, the equations that characterize the policy regime hold, and all markets clear. In other words, in equilibrium equations (24)-(29) hold (household maximization); as well as equations (39)-(44) (domestic bank's maximization), equation (50) (offshore bank maximization), equations (51) and (56) and condition (53) (government's constraints and central bank's profits), equations (57)-(62) (policy-regime equations), and the market clearing conditions (63)-(74).

2. Equilibrium dynamical system

After substituting equations (39)-(44), (50), (51), (56), (57)-(62), and (64)-(74), into equations (63) and (24)-(29), we get the following nonlinear system of seven first-order difference equations in seven variables $\left(c, \hat{M}0, \hat{M}_{\$}, \hat{D}, \hat{D}_{\$}, \hat{D}_{\$off}, \text{and } \hat{D}_{\$}\right)$ that represents the equilibrium dynamical system:

$$y + \hat{M}_{\$,t-1} + \left(1 + i^*_{\$}\right) \cdot \left[\hat{D}^*_{\$,t-1} + \hat{M}0_{t-1} + \left(1 - \tau_1\right) \cdot \hat{D}_{t-1} + \hat{D}_{\$,t-1} + \hat{D}_{\$off,t-1}\right] =$$

$$= c_t + \hat{M}_{\$,t} + \hat{D}^*_{\$,t-1} + \hat{M}0_t + \left(1 - \tau_1\right) \cdot \hat{D}_t + \hat{D}_{\$,t} + \hat{D}_{\$off,t} \quad (75)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_2 \cdot \frac{1}{\left(\hat{M}0_t - \tau_1 \cdot \hat{D}_t\right)} = \beta \cdot \alpha_1 \cdot \frac{1}{1+\varepsilon} \cdot \frac{1}{c_{t+1}} \quad (76)$$

$$\alpha_1 \frac{1}{c_t} - \alpha_3 \cdot \frac{1}{\hat{M}_{\$,t}} = \beta \cdot \alpha_1 \cdot \frac{1}{c_{t+1}} \quad (77)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_4 \cdot \frac{1}{\hat{D}_t} = \beta \cdot \alpha_1 \cdot \frac{1}{1+\varepsilon} \cdot \left(1 + i_d\right) \cdot \frac{1}{c_{t+1}} \cdot \quad (78)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_5 \cdot \frac{1}{\hat{D}_{\$,t}} = \beta \cdot \alpha_1 \cdot \left(1 + i_{d\$}\right) \cdot \frac{1}{c_{t+1}} \quad (79)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_6 \cdot \frac{1}{\hat{D}_{\$off,t}} = \beta \cdot \alpha_1 \cdot \left(1 + i_{d\$off}\right) \cdot \frac{1}{c_{t+1}} \quad (80)$$

$$\alpha_1 \cdot \frac{1}{c_t} - \alpha_7 \cdot \frac{1}{\hat{D}^*_{\$,t}} = \beta \cdot \alpha_1 \cdot \left(1 + i^*_{\$}\right) \cdot \frac{1}{c_{t+1}} \tag{81}$$

where:

$$\left(1 + i_d\right) = \left\{1 + \left(1 - \tau_1\right) \cdot \left[\left(1 + i_{\$}\right) \cdot \left(1 + \varepsilon\right) - 1\right]\right\} \tag{82}$$

$$\left(1 + i_{d\$}\right) = \left[1 + \left(1 - \tau_1\right) \cdot i_{\$}\right] \tag{83}$$

$$\left(1 + i_{d\$off}\right) = \left[\tau_2 \cdot \left(1 + i^*_{\$}\right) + \left(1 - \tau_2\right) \cdot \left(1 + i_{\$}\right)\right] \tag{84}$$

3. The experiment

The new law ("Ley de Libre Negociación de Divisas") was enacted on December 2000 and expected to be effective on May 1, 2001. In the model, the effect of the new law is to cause an increase in α_5 (the share parameter in the utility function corresponding to dollar-deposits in the domestic banking sector) and a decrease by the same amount of α_4 (the share parameter corresponding to quetzal-deposits). These changes in parameter values occur in period 4, but they are announced in period 0 (one period representing one month).

The nature of the analytical experiment is the following: the artificial economy is at the original steady state before period 0. On period 0, it is announced that from period 4 on, a new set of parameter values will be effective. In particular, α_4 and α_5 will change from $\alpha_{4,0}$ and $\alpha_{5,0}$ to $\alpha_{4,1}$ and $\alpha_{5,1}$, respectively, subject to the following restrictions:

$$\alpha_{4,0}, \alpha_{5,0}, \alpha_{4,1}, \alpha_{5,1} \in (0,1) \tag{85}$$

$$\left(\alpha_{5,1} - \alpha_{5,0}\right) + \left(\alpha_{4,1} - \alpha_{4,0}\right) = 0 \tag{86}$$

$$\alpha_{5,1} > \alpha_{5,0} \tag{87}$$

Actually, the following parameter values were used:[21]

$$\alpha_{4.0} = 0.0057825; \qquad \alpha_{4,1} = \frac{\alpha_{4.0} + \alpha_{5,0}}{2}$$

[21] The choice of the values used for $\alpha_{4,0}$ and $\alpha_{5,0}$ is explained in the Calibration section of this paper. The arbitrary values chosen for $\alpha_{4,1}$ and $\alpha_{5,1}$ imply that both quetzal- and dollar-deposits have the same weight in the representative household's utility function after the new law becomes effective.

$$\alpha_{5,0} = 1.0681 \times 10^{-5}; \qquad \alpha_{5,1} = \frac{\alpha_{4,0} + \alpha_{5,0}}{2}$$

The problem is to find the original steady state of the artificial economy, as well as the new steady state and the transition paths for all relevant variables.

4. Solution method

Both steady states of the economy were found by evaluating the fixed point of the equilibrium dynamical system (75)-(81) at each of the two sets of parameter values. The dynamical system was linearized around both steady states, and it was verified that the system displayed saddle-path stability at both points. Then, the linearized version of the saddle-path around the new steady state was derived.[22]

In order to solve for the transition paths, the following idea was pursued: after a large number of periods *T*, the dynamical system is close enough to the new steady state so that the linearized version of the saddle-path is a good approximation to the true saddle-path. Consequently, an approximate solution for the transition paths would be a set of trajectories (one for each of relevant variable) such that:

(i) the initial conditions for the predetermined variables[23] of the system (provided by the original steady state) are satisfied on period 0;

(ii) the laws of motion of all variables (provided by the nonlinear, equilibrium dynamical system (75)-(81)) hold from period 0 to period *T* (taking into account that two parameter values change on period 4); and

(iii) the linearized version of the saddle-path around the new steady state holds from period *T* on.

The value for *T* was chosen so that a further increase in *T* caused only a negligible change in c_0 (the value for consumption

[22] The general methodology for linearizing a nonlinear dynamical system of difference equations around the relevant steady state is explained in Farmer (1999).

[23] The definition of 'predetermined variable' that we are using can be found in Farmer (1999, Ch. 3.) In our system, the predetermined variables are the following: $\hat{M}0_{t-1}$, $\hat{M}_{\$,t-1}$, $\hat{D}_{t-1}$, $\hat{D}_{\$,t-1}$, $\hat{D}_{\$off,t-1}$, and $\hat{D}^{*}_{\$,t-1}$

on the period of the announcement of the new law). Using $T = 119$ guaranteed that result.

5. Results

The macroeconomic effects of the analyzed experiment are rather mild. In what follows, we discuss those effects in detail. The model's solution for the relevant variables can be observed in Figures 1 and 2. Figures 1.1, 1.2, and 1.3 show the behavior of exogenous variables that remain constant along the experiment. The main and obvious effect of the experiment is the conversion of a fraction of quetzal-deposits into dollar-deposits at the domestic banking sector on period 4, when the values of the corresponding preference parameters change (see Figures 2.1 and 2.2). Other variables do not seem to be affected in Figures 1 and 2, except for a slight increase in the level of international reserves (Figure 2.6). However, as will be clear soon, there are marginal effects in all variables that become apparent when the scales on the vertical axes are suitably modified.

It might look puzzling that the significant shift from quetzal-deposits to dollar-deposits in the domestic banking sector on period 4 causes only very mild macroeconomic effects. In particular, the greater demand for dollar-deposits does not cause a drop in international reserves; quite on the contrary, international reserves increase slightly as a result. The explanation rests on the fact that, under the prevailing assumptions, that shift from quetzal-deposits to dollar-deposits does not directly affect the foreign exchange market, since it is accomplished by a simple change in the unit of account of the corresponding deposits at the domestic bank.[24] [25] In other words, the currency substitution process that we are modeling here is not one in which domestic currency is replaced by foreign assets, but rather one in which domestic currency is replaced by domestic assets denominated in a foreign unit of account.

Now let us look at the marginal effects in operation. The key to

[24] At the same time, there is a change in the unit of account of a fraction of the reserve requirement, but, again, the net demand of foreign exchange is not affected at all.

[25] An important assumption here is that the domestic bank does not invest abroad, so the increased amount of dollar-deposits is still offset by domestic bonds (either quetzal- or dollar-denominated), in addition to the reserve requirement.

FIGURE 1

Figure 1.1. Devaluation Rate (%)

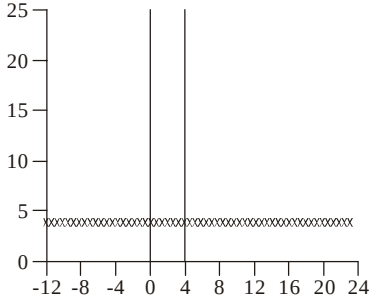


Figure 1.2. Dollar Interest Rate (%)

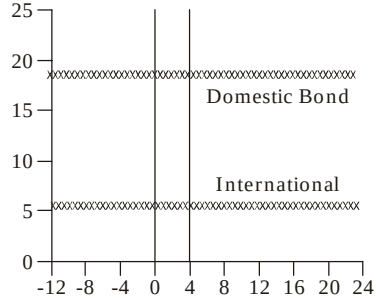


Figure 1.3. Fractional Reserve (%)

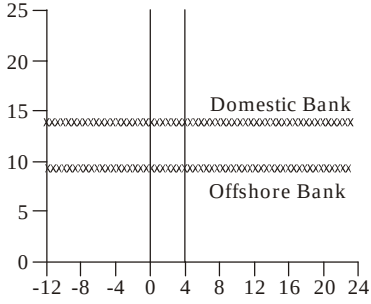


Figure 1.4. Quetzal Interest Rate (%)

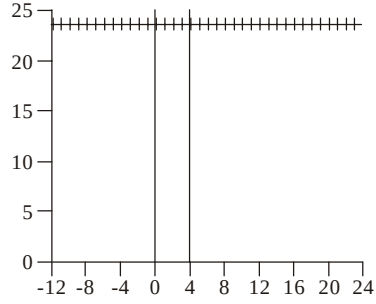


Figure 1.5. Interest Rate on Deposits (%)

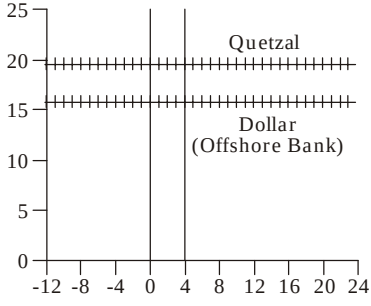


Figure 1.6. Consumption

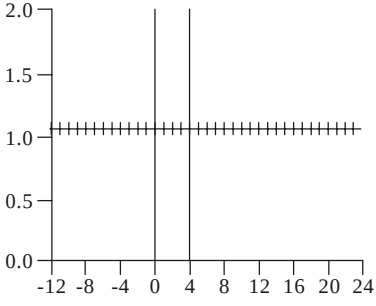


Figure 1.7. Quetzal-Currency

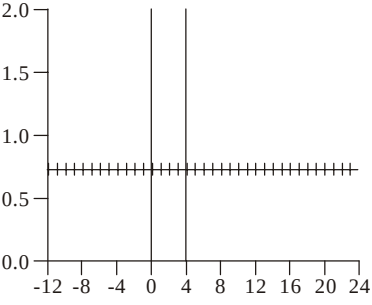


Figure 1.8. Dollar-Currency

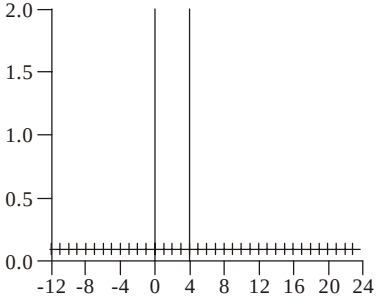


FIGURE 2

Figure 2.1. Quetzal-deposists

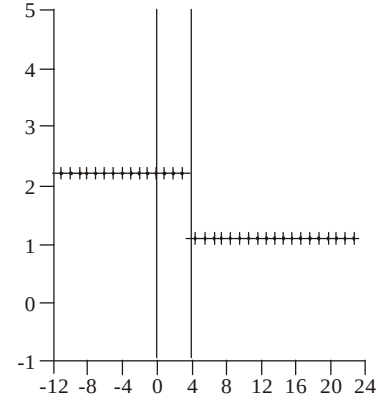


Figure 2.2. Domestic Dollar-Deposists

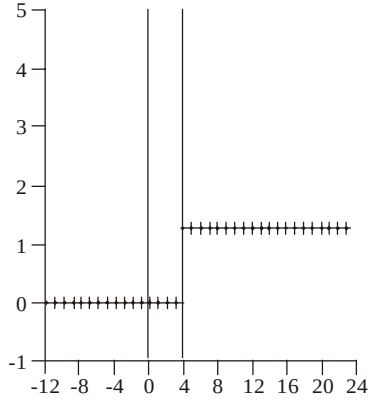


Figure 2.3. Offshore Deposits

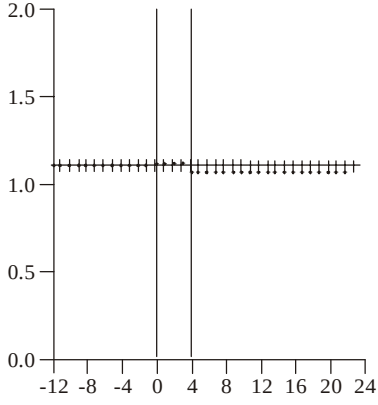


Figure 2.4. Foreing Deposits

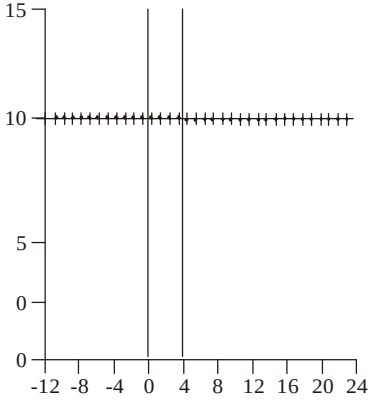


Figure 2.5. Primary Fiscal Deficit

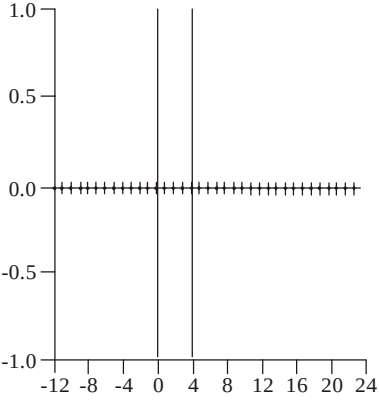
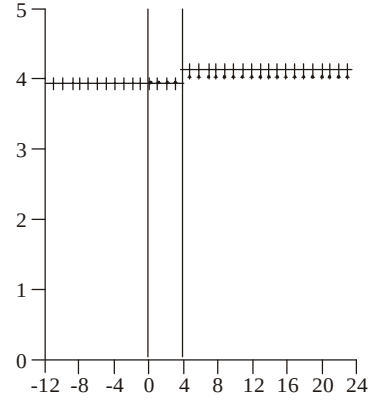
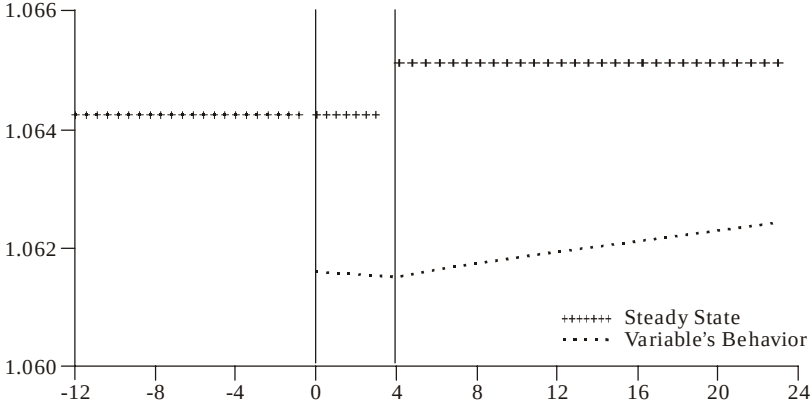


Figure 2.6. International Reserves



understanding these effects can be found in Figure 3, where we can appreciate the behavior of consumption. Let us notice first that the steady state value of consumption increases from period 4 on (i.e., after the parameter change). We can also observe that the current consumption level drops on impact on period 0 (when the new law is announced) and remains lower than the original steady state level from period 0 to period 4; then, it engages in a path that converges to the new (higher) steady state value. In other words, the representative family increases its savings for a while in order to increase the value of its portfolio and achieve a permanently higher level of consumption. In turn, this behavior of consumption is explained by the behavior of the domestic banking sector, to which we turn our attention now.

FIGURE 3. CONSUMPTION



Dollar-deposits at the domestic banking sector yield a higher interest rate (in real terms) than quetzal-deposits. This is so because under perfect competition total revenue must be equal to total cost in both quetzal and dollar operations. While both quetzal- and dollar-bonds yield the same interest rates in real terms, the dollar-banking reserves yield a higher real-interest rate than the quetzal-reserves.[26] Hence, the quetzal-deposits interest rate must be less than the dollar-deposits rate if the domestic bank is to operate in both currencies.

When it is announced that there will be a shift in preferences

[26] Both types of reserves yield zero nominal interest rate, but quetzal-reserves are affected by the devaluation rate.

from quetzal-deposits to domestic dollar-deposits, it becomes clear that a fraction of the former will be converted into the latter. This, in turn, means that the marginal yield on the whole household's portfolio will increase. However, in steady state the sum of the marginal yield and the marginal utility of the portfolio must be equal to the subjective discount rate. If the marginal yield of the portfolio increases, the marginal cost of saving becomes less than the marginal benefit, so the representative family saves more. As the family saves more, the value of the portfolio increases and its marginal utility decreases. Eventually, the marginal utility of any asset is low enough so that the sum of the marginal yield and the marginal utility of the portfolio is just equal to the subjective discount rate; at that point, a new steady state is reached in which the consumption level is permanently higher than before. This chain of results explains the behavior of consumption in Figure 3.

In Figure 4 we can observe the behavior of the offshore deposits. As we can see, the new steady state level (from period 4 on) is higher than the original one. In addition, from period 0 to period 3, the level of offshore deposits is increasing and higher than the original steady state; this is what we would expect since the savings level increases at that time. However, on period 4 the level of offshore deposits drops, and then it increases gradually until it gets to its new (higher) steady state level. The drop on period 4 is explained by the increased convenience of using dollar-deposits at the domestic bank from that period on.

Figures 5, 6, and 7 show the workings of foreign deposits, dol-

FIGURE 4. OFFSHORE DEPOSITS

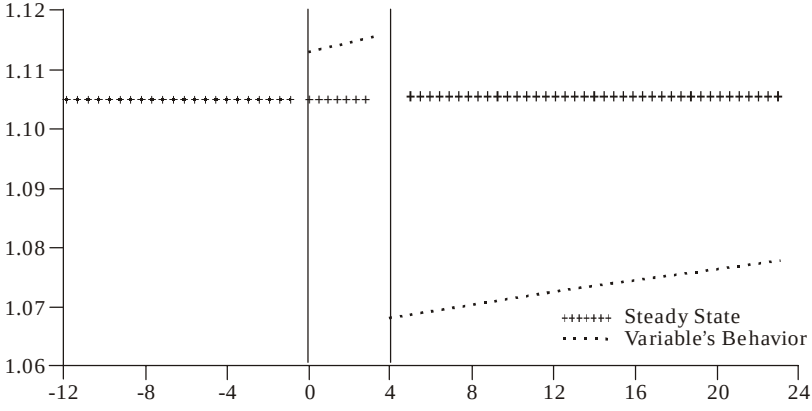
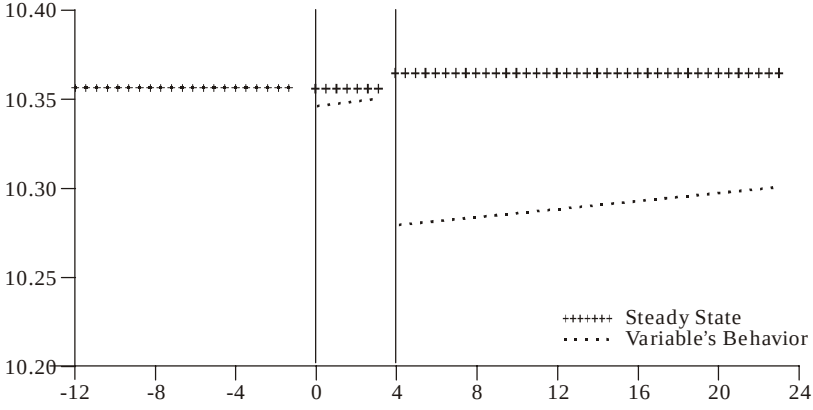


FIGURE 5. FOREIGN DEPOSITS



lar-currency, and quetzal-currency, respectively. In all cases, the new steady state is higher than the original one. As in the case of the offshore deposits, the levels of these variables increase from period 0 to period 3, drop in period 4, and increase gradually from period 4 on, approaching the new steady state. However, unlike the case of the offshore deposits, these variables drop slightly on impact on period 0. The cause for this drop is the low interest rate that these assets yield (as compared to the subjective discount rate); it turns out to be optimal to concentrate the saving effort in the high-return assets (like the offshore deposits and the deposits at the domestic bank).

FIGURE 6. DOLLAR-CURRENCY

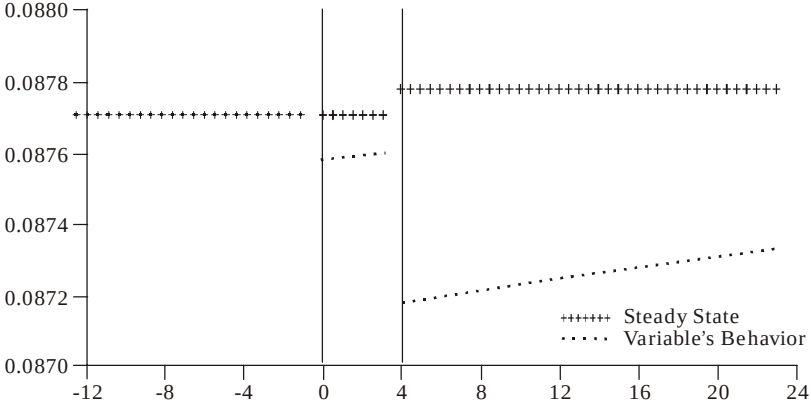
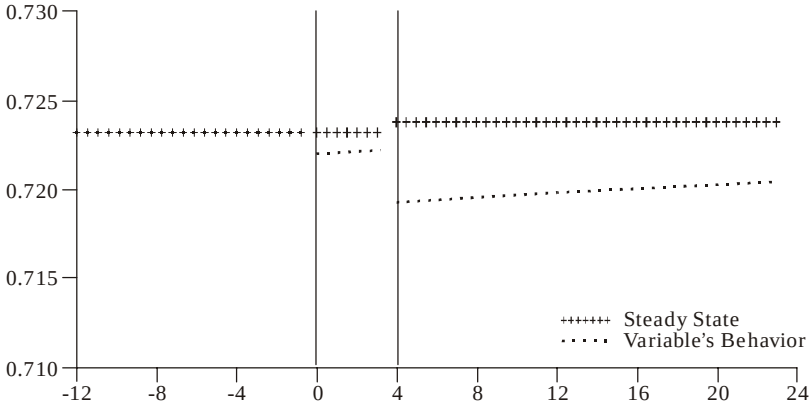
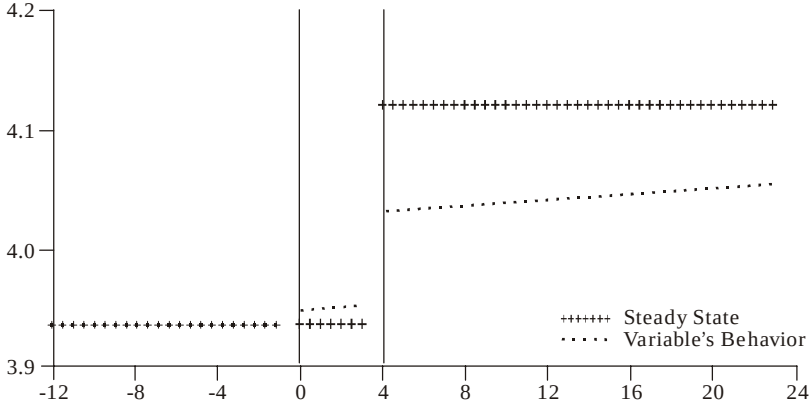


FIGURE 7. QUETZAL-CURRENCY



The behavior of the international reserves can be observed in Figure 8. Again, the steady state level increases from period 4 on. The saving effort is reflected in the increase observed from period 0 to period 3 and from period 4 on. On period 4, the variable undergoes a sudden increase caused by the conversion of small fractions of the stocks of dollar-currency, foreign deposits, and offshore deposits into domestic dollar-deposits (as was explained above). It is important to notice that while the conversion of a fraction of the stock of quetzal-deposits into domestic dollar-deposits is a direct consequence of the assumed change in preferences, the conversion of some parts of the stocks of other dollar-

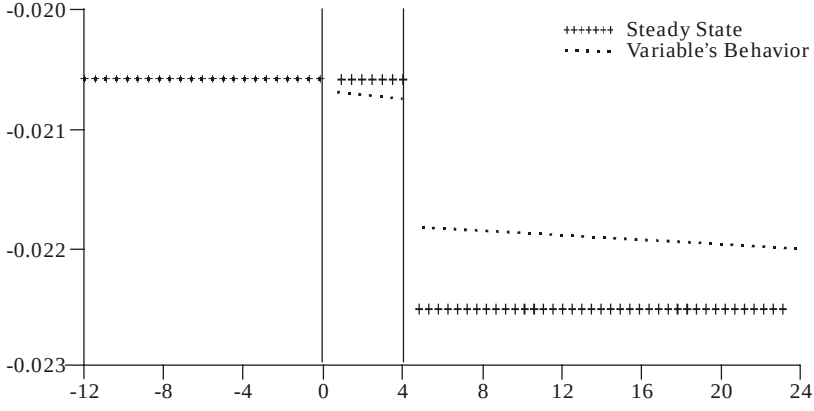
FIGURE 8. INTERNATIONAL RESERVES



denominated assets into domestic dollar-deposits is rather an optimal response of the representative family to the parameter change.

Figure 9 shows how the primary fiscal deficit needs to be reduced (or the primary fiscal surplus needs to be increased) in order to keep both the devaluation rate and the domestic interest rate constant. The reduction in the deficit is caused by an equal reduction in the central bank's net interest revenue for two reasons: (i) the central bank issues more bonds and at the same time accumulates more international reserves, but the former yield an interest rate greater than the latter; and (ii) the quetzal-denominated reserve requirement decreases while the dollar-denominated one increases (but the latter yields a real interest rate greater than the former).

FIGURE 9. PRIMARY FISCAL DEFICIT



IV. CONCLUSION

This paper develops a model intended to analyze the currency-substitution effects of a new law ("Ley de Libre Negociación de Divisas") on the Guatemalan economy. In particular, a dynamic, perfect-foresight, general equilibrium model of a small-open economy with imperfect capital mobility is solved. The change in the legal regime is modeled as a change in some preference parameters: it is assumed that the share parameter in the utility function corresponding to the quetzal-denominated deposits decreases when the new law becomes effective, while that corre-

sponding to the domestic, dollar-denominated deposits increases by the same magnitude.

The model shows that, in the most plausible scenario, we should not expect to observe very important macroeconomic or foreign-exchange effects at the time when the new law becomes effective. Such a scenario would involve the following elements: (i) the new law increases the Guatemalan residents' preference for holding domestic assets denominated in a foreign unit of account; (ii) however, the new law does not increase the Guatemalan residents' preference for holding foreign assets; (iii) both monetary and fiscal policies support macroeconomic stability; and (iv) Guatemalan banks use only domestic assets (either dollar- or quetzal-denominated) to offset their dollar-deposit liabilities.

The main cause for this result is the fact that the conversion of quetzal-denominated deposits into dollar-denominated deposits at the domestic banking sector can be accomplished just by performing the adequate accounting operations, so the conversion itself does not affect the net demand of foreign exchange.

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Index 2002

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