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Measurement of Co-Circulation of Currencies

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Abstract

"Co-circulation" involves the regular use of two or more currencies within an economy. This paper examines methodologies to measure the extent to which foreign currencies are circulated within an economy. Ample anecdotal evidence exists that the U.S. dollar, DM, and other currencies are widely used outside their home countries, as general mediums of exchange, as speculative instruments, or as means of saving. Co-circulation is rarely estimated, which can result in serious errors in statistical estimates of international capital flows and monetary aggregates. We examine a variety of measurement techniques that might be used in various situations. However, estimation remains difficult or impossible in some settings. Limited evidence available suggests that co-circulation is widespread and large scale in some countries. In the final section, we discuss some policy implications of co-circulation regarding seigniorage, inflation control, and the partial integration of monetary systems that accompanies co-circulation. An appendix by Roman Zyttek discusses possible sampling biases in measuring co-circulation due to segmentation in markets.

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Readers are cautioned that much of the statistical material in this paper is potentially subject to a wide range of error. The possibility of such errors, and its potential implications, should be kept in mind whenever using data on cocirculation and associated balance of payments flows. We remain responsible for any errors in the text.

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### Summary

"Co-circulation" involves the regular use of two or more currencies within a country. This paper covers measurement and policy issues associated with the physical movement of currencies between countries and use of multiple currencies within a single economy. Co-circulation is common in Latin America and Eastern and Central Europe, and it also occurs in several Middle Eastern, East Asian, and African countries. Co-circulation causes statistical measurement problems in the balance of payments and money stock estimates.

The paper reviews a number of methods used to measure co-circulation. Some current research indicates that US\$200 billion or more may be in use outside the United States, and large amounts of other currencies may also be involved. In general, better techniques are available to measure currencies that leave their country of issue than to estimate the amount of foreign currencies circulating within an economy.

The penultimate section of the paper reviews some implications of co-circulation for statistical measurement and economic policy. Co-circulation is found to result in a loss of seigniorage to the host country, affect monetary policy control, and create foreign currency exposures within a country. Moreover, statistical errors may be created that could affect policy decisions.

An appendix discusses changes in demand for foreign currency that may occur when a country permits free circulation of foreign currency. A second appendix, contributed by Roman Zyteck, discusses how market segmentation might affect statistical estimates of co-circulation.



## Measurement of Co-Circulation of Currencies

by

Russell Krueger and Jiming Ha

### Introduction

"Co-circulation" involves regular use of two or more currencies within a country. <sup>1/</sup> A cocirculating currency can be used as a medium of exchange, serve as a means of saving by households, or act as a store of value in preference to the domestic currency.

This paper covers measurement and policy issues associated with the physical movement of currencies between countries and the use of multiple currencies within a single economy. Currency is a fixed nominal value bearer instrument, issued by national monetary authorities, that can be freely exchanged within a country or between countries. This paper is not concerned with use of noncurrency financial instruments denominated in foreign currencies, such as bank deposits or securities. Cocirculation often occurs in situations of inflation and economic distress, where international movements of a foreign currency result in substitution for the domestic currency. It also applies to regional monetary arrangements in which currencies of individual countries circulate throughout the union. Cocirculation also occurs as a matter of convenience where the economies of countries are closely integrated.

Cocirculation involves movement of physical currency from one country to another, which affects the size of the effective money stock in both countries. An informal survey of country experts revealed evidence of significant cocirculation (for example, 20-percent or more of the currency stock within a country) in about three dozen countries, including some of the largest. Cocirculation is legal in a small number of countries, tacitly sanctioned in a number of countries, but it also occurs in countries where it is discouraged or illegal. It is common in Latin America and Eastern and Central Europe; it also occurs in several Middle Eastern, East Asian, and African countries. Over one-third, and perhaps more than one-half, of the world's population lives in countries with cocirculation. The cross-border movement of currencies issued by the United States, Germany, Japan, South Africa, and others reduces the effective medium of exchange within those countries, but creates unmeasured monetary assets in the countries into which the currencies move. The balance of payments statistics of both sets of countries usually fail to capture the currency movements.

We use the word "cocirculation" to refer to all uses of a foreign currency by the general public because it relates to the statistical task of

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<sup>1/</sup> From this point, we will drop the hyphen in "cocirculation."

measuring the total outstanding stock of foreign currency. However, we have some feeling that the particular use and motivation for holding foreign currency are important variables for both statistical estimates and policy analysis. We can detect at least five different reasons for using a foreign currency; convenience in international transactions, general use in domestic transactions, use as a medium of saving, speculation against exchange rate changes, and as a store of value under inflationary conditions. This paper focusses on estimation of total flows, but information on specific uses may also need to be developed to enhance measurement techniques and to better specify policy implications.

Cocirculating currencies are virtually never reported in national estimates of the money stock, nor in estimates of international capital flows <sup>1/</sup>, although the amounts involved can be quite large. In many cases, the existence of cocirculating currencies is not acknowledged, or is ignored in monetary, financial, or balance of payments policy. We argue that estimates of cocirculation, even if they are fairly rough, are needed for balance of payments and monetary policy purposes and to accurately assess national monetary and financial conditions. At minimum, authorities need a qualitative understanding of the approximate magnitude and economic uses of the cocirculating currency.

This paper discusses a number of issues cocirculation raises regarding measurement of the money supply and the balance of payments, the accuracy of the data used by analysts and policy authorities, monetary control and policy, and government fiscal policy. These issues are important in economic stabilization situations.

Section I describes international flows associated with cocirculation and the resulting statistical discrepancies in the balance of payments and monetary accounts of many nations.

Section II reviews methods that have been suggested or are in use to measure international currency movements; some methods focus on the measurement of the volume of outward flows of currency, which provides an idea of the extent of the activity worldwide; others methods use direct measurement or econometric techniques to measure foreign currencies cocirculating within an economy.

Section III discusses remaining problems in measuring cocirculation, including some cocirculating situations that are not well handled by the techniques developed to date.

Section IV highlights several implications of circulation on fiscal and monetary policy.

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<sup>1/</sup> The exception is the German balance of payments, which includes data on currency shipments derived from bank reports and several surveys.

Section V summarizes conclusions.

Appendix I discusses some implications of a transition from an unrecognized or illegal cocirculation situation to one in which use of the foreign currency is tolerated or sanctioned. Appendix II discusses some sampling biases that may affect estimates of cocirculation.

#### I. Statistical discrepancies caused by cocirculation

Cocirculation involves the regular use of a foreign currency in everyday commerce, as a means of saving, or as a store of value. The country in which multiple currencies circulate is called the "User". The foreign currency is a liability of the central bank of another country, the "Issuer".

Cocirculation implies capital outflows from the User, and capital inflows to the Issuer. The physical "export" of the currency increases Issuer's international liabilities, which is a capital inflow in the balance of payments. Conversely, User increases its international claims, which is a capital outflow. Nearly all such international capital flows are missed in international and national statistical compilations. Given what we suspect about the size and nature of these gross flows during the past decade and one-half, cocirculation has resulted in large capital inflows into a few high-income countries, and outflows from developing countries, middle-income Latin American countries, transitional countries in Eastern Europe and Central Asia, and some of the remaining centrally planned economies.

The offset to movements of physical currency can take various forms. In a simple case, User pays for the physical currency from a foreign-currency deposit account in a bank located in Issuer. The reduction in the bank account reduces Issuer's international liabilities (which is a capital outflow for Issuer and a capital inflow for User). If the offset to the change in the bank account (the movement of physical currency) is missing from balance of payments statistics, a statistical discrepancy results in the accounts of both countries. <sup>1/</sup> We believe that such discrepancies exist in the international accounts of virtually every country that experiences cocirculation.

However, many other channels for the movement of physical currency exist, with a variety of offsets. Some of the channels cited most often are;

- transport of currency across national borders by tourists, airplane and ship crews, and business travelers,

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<sup>1/</sup> The likelihood of such discrepancies was cited in the Report of the Working Party on the Capital Account Discrepancy. (IMF, 1992).

- build-up of working balances in foreign currencies in financial institutions, businesses, and governments,
- use of foreign currency holdings as a means of capital flight or currency speculation,
- unrecorded diversion of currency into private holdings due to underinvoicing of exports, overstatement of import costs, or diversion from official exchange markets,
- payments of cash to pay for smuggling of drugs, weapons, or other items, and
- remittances of workers in foreign economies and emigrants back to their families in their home countries, etc..

The causes of cocirculation are often unique to each country and it is not possible to ascribe its causes solely to illegal operations, specific types of distortion in markets, or policy errors. In the press, international transfers of currencies are often associated with illegal activities, such as drug smuggling. Such activity undoubtedly occurs, but it must be emphasized that there are many legal channels through which currency can move. Legal channels may be the most important in many cases.

However, the multiplicity of channels and the poor documentation and statistical reporting of many of them, can create serious statistical problems. We discuss direct methods to measure some of these flows, but also discuss indirect statistical or econometric methods.

## II. Methods of measuring cocirculation

Several methods have been suggested or are in use to estimate cocirculation. In all the cases discussed below, the focus is on physical currency; foreign-currency denominated deposits and financial instruments are not discussed although they may also be present in cocirculating situations. 1/

This section addresses statistical and econometric measurement techniques. A variety of methods are discussed, from which tools relevant to a particular country's situation can be selected. In general, better

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1/ Noncurrency instruments denominated in a foreign currency include travelers checks, foreign-currency cashiers' checks, and foreign exchange certificates. Some of these may circulate freely and have many monetary characteristics. Several cases are known where such instruments are in circulation as if they were a currency. The analysis for currency may also apply to some of these instruments.



methods seem to be available for estimating the amount of currency leaving a country for use abroad, than for measuring the amount of foreign currency within an economy, based on the applicable statistical methods and the statistical resources that are likely to be available. Although data that can be developed may be weighted to the currency exporter's side, those data are important in establishing the overall magnitude of the phenomenon and providing some sense of the impact on world financial flows.

1. Comparison of per capita holdings of national currency. (Wilson, 1992)

A background paper by John Wilson in the 1992 IMF study, Report on the Measurement of International Capital Flows, is one of the first efforts to quantify the extent of some flows of physical currency. 1/ Wilson provided some very broad and rough techniques that might give some indication of the broad patterns of currency flows.

Wilson looked at real per capita currency balances, translated into U.S. dollar equivalents, in eight countries over the period 1970 to 1990. The eight were considered to be likely candidates to have substantial currency outflows to other countries. Wilson recognized that no single level of currency usage is appropriate for all countries because of differences in national customs and financial institutions and because the recorded stocks reflect changes in exchange rates. A table provided on per capita balances in 1985 showed that four countries had balances between \$325 and \$525 per person. Four countries, however, had notably higher per capita balances. Wilson implies that some of the currency issued by those countries may be in excess of "normal" requirements and are in use in other economies. 2/

Wilson argued that financial innovations, such as checking accounts, credit cards, and electronic payments, etc., would over the 20-year span normally provide means to conserve usage of currency, which does not earn interest income and is potentially subject to loss. Wilson began with the outstanding level of currency in 1970, and assumed that currency could be used 10 percent more efficiently by 1990. The difference between the actual level in 1990 and the adjusted real level from 1970 was considered to be "unexplained currency growth", which was interpreted as an upper-bound estimate of cumulative capital flows over the period. The data do not

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1/ Although the study cited the possibility of large scale international flows of currency, it stated that it could not address currency movements due to a lack of systematic data on the subject. The background paper by Wilson was intended to provide a quick rough estimate of the possible extent of the currency flows.

2/ Per capita real currency balances in U.S. dollar equivalents in 1985 were; U.K. \$325, Canada \$404, Italy \$482, France \$529, Germany \$691, United States \$710, Japan \$948, and Switzerland \$2,100.

provide an estimate of total currency cocirculating because balances abroad prior to 1970 were not included and because the calculation was affected by exchange rate changes. However, the data provide a possible indication of the cumulative flows. Although Wilson did not calculate a total, his data show that "unexpected currency growth" from 1970 to 1990 was about \$279 billion, with over half the growth in Japan (\$148 billion) and the balance due mostly to the United States (\$65 billion) and Germany (\$53 billion). Italy and Canada had smaller amounts.

The data provided by Wilson are rough and can only provide broad indications of possible trends. Some analysts have argued that the excess growth of currency might represent means of payment for use in underground or unrecorded transactions. Moreover, it cannot be assumed that per capita usage of currency was flat or declined over the period: for example, rising per capita incomes over the long span might permit the public to hold higher *nonincome earning balances for contingencies*. However, his results are suggestive of possible large currency flows.

The method of comparison of *per capita* balances continues to be used, either in formal tables of comparison between countries, or informally, such as in Porter (1993), which appeals to the experience of readers that total issuance of U.S. currency greatly exceeds amounts circulating domestically.

## 2. Constructed estimates of flows. (Krueger 1992; and German research)

In some countries, statistical estimates of international flows of currency are most likely to be constructed through netting of gross outflows and inflows of flows associated with particular types of balance of payments transactions. That is, gross outflows associated with tourism, immigrants' remittances, and all other channels, are netted against gross inflows through tourism, bank reflows, and all other channels. Wide variations may exist in the quality of these estimates depending on (1) the importance of types of flows (for example, capital flight presents larger statistical problems than tourism, which in turn is more difficult to monitor than bank transactions), and (2) the statistical resources and institutional arrangements within each country. Although the piecing together of bits of information about currency flows to construct a picture of total flows is time consuming and capable of producing only rough estimates, it may well be the best available method in many countries.

This section first discusses some early research by Krueger to construct a picture of flows of U.S. dollars based on compilation of data on specific balance of payments flows. The second part refers to efforts by German authorities to measure flows of German marks. Some of the techniques used may be applicable in other countries. One important observation is that the nature of dollar and mark flows appears to be very different, and therefore different techniques may be needed.

### A. Ad hoc estimates of U.S. dollar flows.

In early 1992, Krueger made an *ad hoc*, unpublished review of some of the data that might be used to measure outward shipments of U.S. dollars. No estimates were made following this method. Data on shipments of U.S. dollars are especially important because the dollar is regarded as the largest cocirculating currency. 1/

The goal of the method was to measure net flows of currency in the U.S. balance of payments, which when accumulated would provide estimates of the stock of U.S. currency abroad. However, accumulation of the balance of payments flows does not provide information on the distribution of the dollar stock abroad because of subsequent shipments between countries; for example, balance of payments data might identify large flows to Switzerland, but subsequent flows from Switzerland into Eastern Europe are missed. However, use of currency flows reporting systems in other countries could track cross-country flows and might result in rough estimates of the *location of stocks of dollars*.

Capturing data of large flows of currency passing through national banking systems is a critical and relatively easy first step in measuring cocirculation. In the United States, two reporting systems might be used. The Currency and Monetary Instruments Reports (CMIR), which is a formal customs-type system that requires reporting of large shipments, was not used due to some statistical problems. 2/ The second system consists of voluntary reports submitted to the Federal Reserve by several major money

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1/ U.S. currency outside banks increased \$99 billion between yearend 1989 and yearend 1993, a 43 percent increase. Most of that increase may have gone abroad, which would indicate a substantial increase in cocirculation of U.S. dollars during that period. Large currency exports would result in substantial seigniorage earned by the U.S. government.

2/ The CMIR requires reporting of exports and imports of U.S. currency in amounts of \$10,000 or more. The report is designed for law enforcement purposes rather than for statistical data collection. Numerous small transactions that might have a large cumulative impact are not reported. Illegal transactions are missing and many potential reporters may underreport or evade reporting. However, records of very large transactions, such as shipments reported by banks for Argentina (cited in the Kamin and Ericsson study below) can be considered accurate.

Due to possible statistical problems, a decision was made not to rely on the CMIR as a primary source of data on international flows of currency. However, with an increased commitment of resources and possible redesign, the CMIR might produce statistically reliable information.

It should be noted that Edgar Feige, who has examined CMIR data closely, believes that it provides a great deal of useful information.

shipping banks for about the past seven years. <sup>1/</sup> Because shipping physical currency is a specialized service provided only by a few banks, these data potentially can be obtained easily and quickly. Major problems with this approach are the shortness of the time series, the need to preserve confidentiality about transactions of individual banks, and the voluntary basis. In other countries, reporting systems on bank transactions might be established to cover both inward and outward shipments of currency.

Data on large shipments through banks can be supplemented by data derived from indicator series that would cover small value shipments:

1. Data on tourist and business traveler visits could provide information on the distribution of currency flows. Estimates of dollars taken and spent abroad can be found by multiplying the number of visitors by an estimate of the amount spent by each visitor. The estimate of average expenditures will be inexact, but presumably changes little each quarter. This method should track expenditures trends as a function of the number of visitors and the trend in their average expenditures, but the level of expenditure would be imprecise.
2. Estimates should also include data on remittances of immigrants to their home countries. Research undertaken by the U.S. balance of payments division indicated that new immigrants send large portions of their income to their home countries. Most transfers were in clothing, appliances, or other goods, or in noncurrency financial instruments such as bank checks, travelers' checks, or money orders. Slightly less than 1/5th of the transfers were found to be in physical currency. (These ratios might be very different in other countries.) These data would permit rough estimates of currency transfers trends by immigrants, but levels would be imprecise. The research also found that the portion of income remitted dropped off steadily the longer the immigrant was in the United States, which would have to be built into the estimation process. Similar methods can probably be used in other countries.

The research also suggested a perpetual inventory to cover reflows of dollars back to the United States. Given the absence of solid information on dollar reflows, it was suggested that reflows be calculated as a percentage of the estimated currency stock abroad, with the percentage amount of reflow correlated to countries' proximity to the United States. That is, the cumulative stock of dollars in each foreign country would be calculated as the sum of outflows from the United States over time, less a portion each calendar quarter which is considered reshipped to the United

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<sup>1/</sup> Currency shipments data are often closely correlated with publicly available data on issuance of currency by the New York Federal Reserve Bank, which might provide a nonconfidential means of acquiring rough information on total shipments, without detail on destination.

States. Initially, the percentage reflow would be chosen arbitrarily, but the data could be refined by examining differences in behavior between countries or by conducting experiments about the rate of return of dollars to the United States. In other countries, reshipment data might be based on reflows to the domestic banking system.

The research undertaken by Krueger at best would produce rough estimates for both inflows and outflows of dollars and some data on country distribution. The method cannot handle shifts of dollars between foreign countries given current data sources. However, rough estimates could be developed if other countries establish systems to measure large currency shipments.

#### B. Estimates of German mark flows.

German authorities have diligently examined the major channels for international flows of marks. They have examined flows related to specific current-account transactions, such as tourism, and capital flows through the banking system and by immigrant workers. These sources generally indicate that there is usually a rapid turn-around in mark flows; many marks return a few days or weeks after they leave Germany, and a large portion of the marks that reside in other countries for a period return on a seasonal basis. On occasion it has been possible to identify cases where flows through banks accumulate in a foreign country in response to political or economic uncertainties. Identification of the location of stocks in foreign countries is complicated because reflows are often rechanneled through banking centers. Flows outside of formal banking systems and stocks held by nonbank nonresidents are considered to be problematic, and may cast doubt on the accuracy of the published data. Research by German authorities is ongoing.

#### 3. Surveys of portfolios

It is theoretically possible to survey businesses and households regarding their holdings of foreign currencies and other financial instruments. For example, data on currency holdings of U.S. households were collected in a 1986 survey <sup>1/</sup> taken by the U.S. Federal Reserve Board. The survey, supplemented with estimates for currency holdings by other sectors of the U.S. economy, could account for only about one-third of total currency issued, which implies large holdings in other countries.

As a practical matter, however, such surveys can be very difficult, expensive, and potentially subject to large error. Major problems include (1) unwillingness of respondents to provide accurate information, (2) difficulty in sampling to cover situations where a small percentage of respondents may hold a large portion of assets, (3) the need to compile data on complete financial balance sheets in order to put data on currency

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<sup>1/</sup> Survey of Currency and Transaction Account Usage (SCATU).

holdings in perspective, (4) the cost and delays involved in conducting the survey, and (5) possible inability of most surveys of assets to identify cyclical movements in the data.

Portfolio surveys are useful for compiling broad accounts of financial assets and net worth of sectors, but they are probably not practical for many countries, including most developing countries.

#### 4. Currency tracking.

A potentially important method of measuring cocirculation and international currency movements is to track actual flows. In many currencies, each bill is unique, with a serial number. Alternatively, some countries have codes for regional banks, or supranational banks code currency based on its release location, etc. If a cataloging technique is available, the flow of bills can be documented and statistical measures prepared of the volume and speed of flows.

Key information that can be obtained through direct measurement include transfers to foreign countries, reflows from foreign countries back to the parent country, the size denomination of bills in each country, shifts between foreign countries, the speed of various movements, evidence of the amount of bills that drop out of circulation and presumably are held in hoards, and evidence of transactions within undocumented domestic markets versus transactions within foreign economies.

The critical factor is to have cataloging mechanisms in place in locations that are likely to verify or disprove hypotheses about currency flows. For example, an estimate of transfers from the United States to Central America or from Germany to Russia can be developed by finding evidence of bills in the recipient countries that were known to have been circulating in the issuer country. Reflows can also be measured by finding bills at home that were once found abroad. Unfortunately, some important flows may be outside of formal institutions where cataloging procedures can easily be implemented. It may be necessary to use controlled experiments to deal with such situations, such as releasing cataloged bills into informal markets then tracing and timing their return to formal markets. It may be difficult to construct statistically valid experiments, but this is a fertile area for research.

Automated means of tracking currencies are needed to make these methods feasible. Machines are available to scan bills at very high speeds, at a relatively low cost. These machines can be used by monetary authorities to gather basic information on currency demand and replacement and deterioration of bills. The examination of bills may also be a necessary part of efforts to staunch counterfeiting. Specialized research on international currency movements can probably be done as an offshoot to those projects.

Identification items on bills other than serial numbers might also be used depending on the specific situation. These could include date of issuance, location of issuance, bank of issuance, mint, etc. Changes in the design of bills might provide a basis for monitoring flows, such as in the new design U.S. \$100 bills that will be introduced in the next two years or so. Coding of information that can facilitate statistical estimates of currency flows might be considered whenever currencies are redesigned. 1/

At present, two U.S. researchers are attempting to apply tracking methods to estimate dollars abroad, but it is too early to report results. Edgar Feige is developing a model of the life cycle and location of currency. He hopes that a real-time currency census system can be implemented which ultimately can provide information on the country distribution of dollars. Richard Porter is using a sampling technique that uses new issue U.S. bills as markers within an unknown total population, similar to a method used at fish hatcheries to measure fish populations.

5. Seasonal adjustment techniques. (Porter 1993)

Richard Porter has used estimates of the amplitude of seasonal factors for the demand for currency to prepare estimates of U.S. currency in circulation in foreign countries. The technique was originally used by Sumner in 1990 to estimate U.S. currency hoarded within the United States. Sumner assumed that currency that is hoarded is not subject to seasonal fluctuation, but does increase the outstanding stock of currency, which has the effect of reducing the amplitude of seasonal fluctuation (in a multiplicative moving-average seasonal adjustment model) due to transactions.

Porter used the same technique, on a more formal basis than Sumner, in order to estimate U.S. currency that might be held abroad. He assumed that balances abroad do not reflow to the United States with any consistent seasonal pattern due to distance and cost of reshipment. 2/ He argued plausibly that the seasonal transactions demand for currency in Canada is close to that in the United States and can be used as a proxy for the true U.S. seasonal demand. Given these conditions, the difference between the amplitudes of the estimated true U.S. seasonal factors and the seasonal pattern in the U.S. observed by the U.S. monetary authorities can provide an estimate of currency held abroad (as described in detail below). His method

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1/ In light of serious difficulties that have been experienced during the breakup of nations or regional currency arrangements, it seems prudent to embed on bills information on date and location of issuance, and issuing authorities.

2/ The lack of a seasonal pattern in international flows of U.S. currency may be a unique situation. The mark, for example, has a strong seasonal pattern.

shows that during the 1980's and early 1990's the portion of U.S. currency held abroad grew steadily to equal 60 percent or more of U.S. currency. That is, \$200 billion or more circulates outside the United States. By implication, nearly all of the increase in U.S. currency issued between 1989 and 1993 went abroad. If the amount abroad is that large, or even if it is substantially less, U.S. currency used outside the United States constitutes an important portion of the total currency in use worldwide. 1/

Porter's estimate is subject to several possible sources of error:

- Foreign holdings of U.S. dollars might be subject to seasonal reshipment back to the U.S., for example by tourists or reflows across the Mexican or Canadian borders.
- Amounts hoarded within the United States would also reduce the amplitude of the seasonal factors and lead to overestimates of international flows of currency, and
- The Canadian proxy might not actually correspond to U.S. transactions money demand.

#### Estimating outflows of currency

This section provides a simple symbolic statement of Porter's method to measure changes to seasonal amplitudes that can be caused by international currency movements. The method can be used in both issuer and user countries whenever certain assumptions hold.

In a multiplicative seasonal adjustment model, the observed value,  $O$ , equals the trend,  $T$ , times the seasonal,  $S$ ; or  $O = T \times S$ .

If some dollars are in country  $U$  (User), then the observed value:

$$O = T \times S = T^I S^I + T^U S^U$$

where  $I$  indicates the issuer and  $U$  is the user.

Let  $\beta = T^I / T =$  Portion remaining in Issuer

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1/ Cocirculating Deutschmarks, South African rand, Japanese yen, Russian rubles, and other currencies should be added to the estimate of U.S. currency used abroad to obtain an estimate of the total portion of world currency involved in cocirculation. If Porter's estimate for U.S. dollars is broadly correct, perhaps as much as one-quarter to one-third of the world's currency is involved with cocirculation. (Of course, the specific percentage may vary considerably depending on the exchange rate of the numeraire currency at the time of measurement: by convention, it may be best to calculate this ratio from SDR equivalents.)



$$1 - \beta = T^U / T = \text{Portion in User}$$

Thus,  $TS = \beta TS^I + (1 - \beta)TS^U$

or  $S = \beta S^I + (1 - \beta)S^U$

Assume no seasonal movement in the User country; that is,  $S^U = 1$

then,  $S = \beta S^I + (1 - \beta)$

$$S - 1 = \beta S^I - \beta$$

$$S - 1 = \beta(S^I - 1)$$

$$\frac{S - 1}{S^I - 1} = \beta$$

That is,  $\beta$ , the portion of currency remaining in the issuer country, is a function of two seasonal factors.

Note that  $S$  (the seasonal of total currency issued) can be measured directly from balance sheets of the monetary authorities of the issuer country, but  $S^I$  is unknown.

However, if a value for  $S^I$  can be found,  $\beta$  can be calculated. Sumner used seasonality of small-denomination bills as an indicator series for  $S^I$ , Porter used Canadian demand. Retail sales is a likely indicator series in many countries.

*For the issuing country, the observed seasonal factors for the demand for the issuer's currency have a smaller amplitude than the true seasonal factors.*

*This method can be used for all outflows of currency, regardless of the reason that it is held by foreigners.*

#### Estimating inflows of currency

The same technique can be used for user countries when the cocirculating currency is used for transactions, but the effect is opposite of that in issuing countries. The foreign currency substitutes for a portion of the domestic currency that otherwise would have been issued, which affects the observed seasonality of the domestic currency in the user country.

*For the user country, the observed seasonal factors for demand for the national currency have greater variance than the true seasonal factors, when the foreign currency is used for transactions purposes.*

However, when the foreign currency is hoarded or used as savings, the seasonal adjustment method does not work. 1/

6. Econometric money demand model. (Kamin and Ericsson 1993)

Kamin and Ericsson (1993) estimated dollarization in Argentina using a money demand function. The central idea is to include two sets of variables in the money demand function to explain separately the observed demand for peso-denominated money and the unobservable demand for U.S. dollar-denominated money.

Suppose  $M$  denotes the observed nominal peso-denominated money balances;  $M^*$  denotes the nominal peso- and dollar-denominated money balances, of which the dollar-denominated money balances are unobservable. The authors assume that the demand for peso-denominated money would have been equal to  $M^*$  in the absence of substitution of dollars for pesos in Argentine economy. The demand for  $M^*$  in real terms is specified as a standard money demand function in log-linear form:

$$\log\left(\frac{M^*}{P}\right) = \alpha' X, \quad (1)$$

where  $P$  is the price level;  $\alpha$  is a vector of coefficients;  $X$  is a vector of explanatory variables which typically include income, interest rates, expected inflation rates, and a constant term.

The difference between the demands for  $M^*$  and  $M$ --the demand for dollar-denominated money in peso terms -- depends on vector  $Y$  which includes, *inter alia*, variables measuring expected inertia of hyperinflation and expected devaluation of the peso,

$$\log\left(\frac{M^*}{P}\right) - \log\left(\frac{M}{P}\right) = \beta' Y, \quad (2)$$

where  $\beta$  is a vector of coefficients, which are positive by intuition.

Substituting equations (1) into (2),

$$\log\left(\frac{M}{P}\right) = \alpha' X - \beta' Y \quad (3)$$

The authors obtained  $\hat{\alpha}$  and  $\hat{\beta}$ , the estimates of coefficients  $\alpha$  and  $\beta$ , using linear regression.

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1/ Information on whether cocirculating currencies are used in general circulation or for other purposes might, in theory, be deduced depending on whether the seasonal demand for the domestic currency is affected by the presence of a second currency.

By definition,  $M^* = M + eQ$ , where  $e$  is the nominal exchange rate (peso/dollar), and  $Q$  is the balance of dollar-denominated money in dollar term. Substituting this expression into equation (2) and using the estimated coefficients  $\hat{\beta}$ , the authors derived an estimate of dollar-denominated money in Argentina,

$$\hat{Q} = \frac{M}{e} [\exp(\hat{\beta}' Y) - 1] \quad (4)$$

*Applying Argentine data to the model, the authors concluded that U.S. dollar currency in circulation in Argentina during 1990 comprised the largest portion of the entire money stock--U.S. dollar currency holdings were about 9 times as large as U.S. dollar deposits and about 4.5 times as large as peso circulation.*

7. Maximum likelihood money demand model. (Ha 1994)

In a 1994 internal report, Jiming Ha used maximum likelihood methods to measure circulation of South African rand in Swaziland. Swaziland has a formal arrangement with South Africa that permits legal use of rand at a fixed exchange rate of the rand per lilangeni, the local currency of Swaziland.

Ha estimated the rand circulation in Swaziland using a conventional money demand function, in which the quantity of money demanded depends on income and variables measuring opportunity costs of holding money--interest rate and expected inflation rate. Given his income, a representative agent chooses his spending on consumption goods, on holdings of money, and on holdings of interest bearing financial instruments. The real return on money is the negative of expected inflation rate, and the real return on interest-bearing financial instruments is real interest rate. Assuming money and interest-bearing financial instruments are gross substitutes, the demand for money would be expected to depend positively on income and negatively on inflation and real interest rates. The money demand function in log-linear form may be specified as:

$$\log(M^*/P) = \alpha_0 + \alpha_1 \log(Y/P) + \alpha_2 \pi + \alpha_3 r \quad (5)$$

$$\alpha_1 > 0, \alpha_2 < 0, \alpha_3 < 0,$$

where  $M^*$  is the demand for narrow money ( $M1$ ) in nominal terms,  $P$  is the price level,  $Y$  is nominal income,  $\pi$  is the expected inflation rate, and  $r$  is the real interest rate.

However, the demand for nominal money,  $M^*$ , includes the unobservable demand for the South African rand notes, and the observed nominal balance ( $M$ ) which includes local currency (lilangeni) and demand deposits. Letting  $\theta$  denote the ratio of the rand notes to the lilangeni notes that are

circulating in Swaziland, a linkage between the unobservable and the observable money balances is established:

$$M^* = \theta CU + M \quad (6)$$

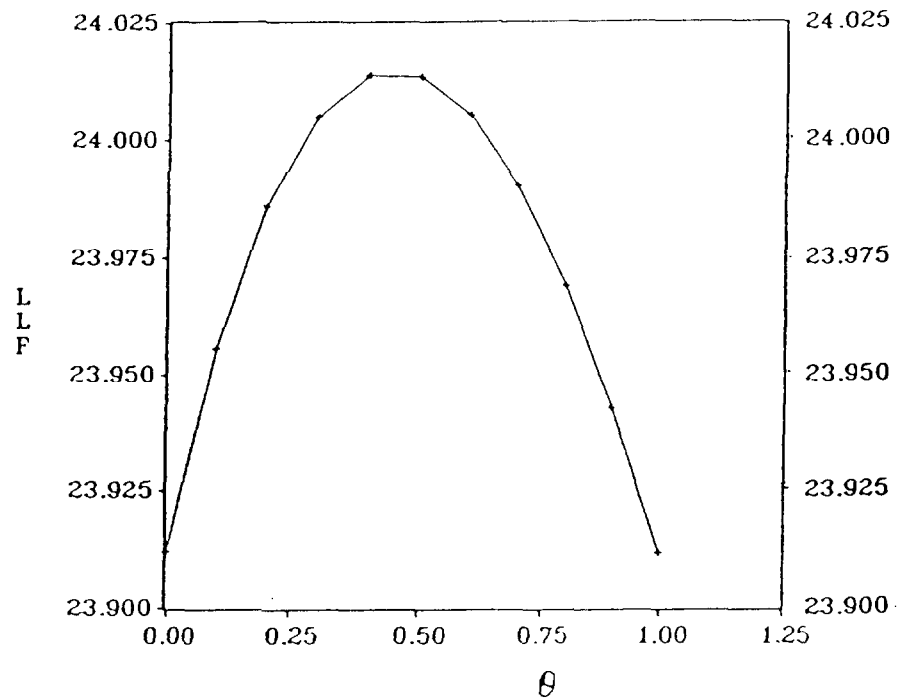
where  $CU$  is the lilangeni in circulation. For example, if  $\theta = 0.1$ , then rand circulation in Swaziland is equal to 10 percent of the nominal amount of local currency outstanding.

Ha estimated  $\theta$  as well as the parameters in equation (1) using the 1974-92 annual data published in *International Financial Statistics (IFS)*. Given  $\theta = 0$ , equation (1) was estimated and the value of the log-likelihood function was recorded. The process is repeated using successively large values of  $\theta$  (using 0.1 increments in  $\theta$ ), and the value of the log-likelihood function was recorded for each estimation. The log-likelihood function attained its maximum when  $\theta = 0.4$ , indicating rand circulation in Swaziland amounted to 40 percent of the local currency in circulation.

Chart 1 shows the log-likelihood function at various values of  $\theta$ .

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Chart 1. Log-likelihood Function at Various Values of  $\theta$



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The estimates of the money demand equation are shown in Table 1. All the estimated parameters have the expected signs and are statistically significant, and the goodness-of-fit is satisfactory.

Table 1  
Estimates of Money Demand Function

Parameters	$\alpha_0$	$\alpha_1$	$\alpha_2$	$\alpha_3$	$\bar{R}^2$
Estimates	-0.439	0.337	-0.023	-0.237	0.731
t-stat.	(-1.98)	(4.01)	(-3.33)	(-2.62)	

8. Qualitative estimates

We recognize that in some countries quantitative estimates of foreign currencies will not be feasible. Some compilers may refuse to publish data that they consider unreliable or misleading.

In this situation, we recommend that compilers provide a qualitative description of the types of uses of foreign currency within their countries. Rough estimates of the degree of usage can be made for each type of use. Although this will not provide information suitable for quantitative research, it may focus policy makers and researchers to the existence of cocirculation. The classification of type of use also may allow comparison on experiences across countries as an aid to policy development. Moreover, currency behavior may differ depending on use -- for example, foreign currency held for currency speculation purposes may leave the country quickly after stabilization, but foreign currency that is well integrated into domestic transactions may leave the economy only slowly.

The table below suggests how qualitative data on foreign currency usage might be organized.

Use of Foreign Currencies					
Reason for using foreign currency	Degree of Use				
	None	Limited	Moderate	Heavy	Very Heavy
Domestic Transactions					
Tourism and border transactions					
Savings and capital transactions					
Inflation hedge					
Exchange rate hedge					

9. Use of foreign currency bank deposits as a proxy.

In the absence of solid data on cocirculation, some researchers may be tempted to use data drawn from foreign currency deposits in banks as a proxy for cocirculating currency. *We strongly advise against this method in the absence of specific information that foreign currency deposits and cocirculating currencies move closely together:*

- Some of the motivations for transacting in a foreign currency stem from distrust of the formal financial sector or to maintain anonymity.
- Cocirculation can occur despite prohibitions or restrictions on use of foreign currency deposits.
- Interest rates on foreign currency deposits may differ from those available in informal or international markets.
- Cocirculation and foreign currency deposits can move inversely depending on factors such as stabilization programs, financial condition of the banking system, and changes in currency regulations, etc.
- Foreign currencies used for hoards or long-term savings will not respond to the same economic stimuli as will foreign-currency bank deposits used for transactions.
- Foreign-currency deposits may be largely associated with foreign commerce, with foreign-controlled banks, with nonresidents, or with remittances from foreign workers, and thus may not behave similarly to a broadly used currency.

## II. Unresolved measurement difficulties

The range of techniques described above do not handle some cocirculation situations, including some that may be important for policy.

-- One important problem is that time series data may be too short to produce statistically reliable seasonal adjustment and econometric parameter estimates. Rarely will it be possible to use time series less than six years long, and many series may need to be substantially longer depending on the type of analysis performed. Thus, application of seasonal adjustment and econometric techniques may be limited to special situations.

-- Statistical estimates may be unstable or unreliable because of structural changes.

-- The amount of cocirculation may change rapidly due to sudden economic or political changes, speculation on exchange rate changes, or success or failure of economic programs, etc..

-- The break-up of countries may require data on currency held by the general public in each country in order to redeem currency liabilities or make other transfers. These situations may require direct accounting or surveys of transactions and the stock of foreign currency. Indirect statistical techniques may prove unsuitable in these situations.

-- A reporting problem may occur where use of foreign currencies is not sanctioned or is illegal. Statistical reports on cocirculation may focus attention on a phenomenon which authorities wish to minimize or which may contradict government statements.

-- Standard currency demand models that are based on transactions motives for demanding currency may prove inadequate when foreign currencies are held for savings or as speculative instruments.

-- Finally, observations regarding the extent of cocirculation may be unrepresentative: use of foreign currencies in cosmopolitan national capital cities, along borders, or at tourism sites may overestimate the use of foreign currencies nationwide.

Above all, researchers must not give an impression of precision in their estimates of cocirculation and must be willing to admit that major statistical problems are embedded in estimates. With rare exceptions, the range of error in estimates of cocirculation will be large, which opens them up to second-guessing and dispute. Although statisticians may be unwilling to publish estimates that may mislead the public, they have an obligation (1) to make clear that cocirculation exists, and (2) to provide at least a rough indication of magnitude and trends. The goal may be to establish a



baseline estimate that can provide some basis for estimating the impact of policy or macroeconomic changes.

In some cases, statistical problems may be insurmountable. It may only be possible to describe cocirculation conditions qualitatively by identifying the sectors using a foreign currency, making a rough estimate of magnitude, and identifying the common uses of the currency. In particular, it may be important to distinguish between uses of a foreign currency;

- (1) as a general medium of exchange,
- (2) as a convenience in tourism and trade at borders,
- (3) as a medium for saving or for use in capital transactions,
- (4) and (5) as an instrument used in capital flight or to speculate or hedge against exchange rate changes or inflation.

Qualitative descriptions of uses of foreign currency provide guidance in policy decisions because the policy options may differ in each case. Qualitative statements also establish a context for interpretation of data on the domestic currency.

Data on cocirculation are important to develop accurate monetary and balance of payments statistics in both user and issuer countries. Accurate statistics are important to avoid analytical or policy errors. These concerns remain important, regardless of the legal status of cocirculation (legal, sanctioned, officially discouraged, or illegal).

### III. Implications for statistical measurement and economic policy

#### Cocirculation as a Monetary/Exchange Rate Regime

Cocirculation can be viewed as a specific form of monetary/exchange rate regime, a "cocurrency regime", which appears to have some unique properties. Within a cocurrency regime, two polar policy environments can exist depending on whether the foreign currency cocirculates independently of the formal banking system or is incorporated into the formal system.

This section, compares cocurrency regimes to standard models of fixed or floating exchange rates. It is generally implicitly assumed that under both floating and fixed exchange rate regimes transactions within an economy must use the national currency, and that all currency in circulation is under the policy control of domestic authorities. Consequently, changes in exchange rates or movements in international reserves have a monetary impact on the economy as a whole, on the aggregate supply of money, on the overall rate of inflation, etc. These assumptions do not hold in cocurrency situations.

#### A. Floating Exchange Rate Regimes

Under a floating exchange rate regime, a national currency is issued by national authorities. The price of the currency against other currencies is allowed to vary. The price is determined by the currency's demand and supply. For example, with the supply of the domestic currency fixed, appreciation of a currency can be caused when accumulations of foreign currency due to a current-account surplus are converted into the domestic currency: that is, the current-account surplus increases the demand for the domestic currency and raises the exchange rate. The supply of the domestic currency is fully controlled by national authorities, who earn seigniorage on the currency issued.

#### B. Fixed Exchange Rate Regimes

Under a fixed exchange rate regime, a national currency is issued by national authorities, but the price is fixed against a foreign currency or a basket of foreign currencies. National authorities maintain the fixed market price by various types of intervention, which can include sales or purchases of official holdings of foreign exchange.

National authorities earn seigniorage on currency issued, but are limited by the requirement of maintaining parity with the foreign currency. Thus, seigniorage may effectively be limited to the inflation rate in the foreign currency. Seigniorage may be negative if the foreign country is experiencing deflation.

#### C. Cocurrency Regimes

In contrast to the assumptions above, numerous cases exist in which two or more currencies are used for transactions within a country. The exchange

rate between the cocirculating currencies can either float or be fixed. Several key differences exist between cocurrency regimes and traditional fixed or floating rate regimes:

(1) The degree of control by the domestic authorities can vary. At one extreme, the cocurrency can be entirely independent of the formal financial system or from any effective regulation by national authorities. Alternatively, the cocurrency could be fully integrated into the formal financial situation and subject to regulation and reserving by national authorities. 1/ The two extremes, and the variations in between, may involve different policy responses.

(2) Seigniorage is not captured by domestic authorities, but by the foreign currency issuing country. The amounts involved can be substantial and can have a major impact on the government fiscal situation in both the issuer and user countries. 2/ 3/

(3) Currency exposures and mismatches are endemic *within* the domestic economy 4/; in contrast, in the fixed and floating rate models such exposures exist only vis-a-vis the rest of the world. For example, an enterprise in a cocirculation situation may have an exposure because it sells its product to a domestic customer in the foreign currency, but may incur tax and wage obligations in the domestic currency.

Such exposures can have multiple effects, including generating large implicit transfers between enterprises and sectors due to exchange rate changes, inducing shifts between domestic-currency and foreign-currency denominated instruments within portfolios, or increasing the fragility of the financial system.

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1/ In addition to use of foreign currency, in *formal* cocurrency regimes a variety of noncurrency foreign-currency-denominated instruments can be used, which can include (1) foreign-currency demand deposits and credit instruments, and (2) foreign exchange certificates, which are bills put into (sometimes limited) circulation against deposits of foreign currency. Some of the analysis in this article applies to these instruments. Beckerman (1987) provides an interesting discussion of more general use of foreign-currency instruments.

2/ Fischer (1982) provides some estimates of the amount of seignorage affected. The amounts are impressively large in some countries.

3/ With a preexisting cocirculation situation, the government of the recipient country has strong fiscal incentives to move toward a single domestic-currency regime in order to recapture the seignorage.

4/ See Beckerman (1987) for a closely related discussion.

These exposures may enhance the strength of inflationary feed-back: any acceleration in domestic-currency inflation is apt to cause (1) losses to domestic-currency creditors that have foreign currency obligations, which may result in the government or monetary authorities absorbing some of the risk in the form of exchange rate guarantees or increased (including emergency) liquidity support, especially if financial institutions are affected, (2) continuing infusions of domestic-currency credit to domestic-currency borrowers and wage payers in order to refinance their increased net domestic-currency borrowing and other obligations, and (3) shifts to foreign-currency assets, which further increases exchange rate pressures. These actions potentially constitute positive feed-back, domestic-currency inflationary responses.

Moreover, the government may also find that the real value of domestic-currency tax receipts is reduced, which may lead to increased issuance of the domestic currency or monetization of a fiscal deficit. 1/ Once an inflationary process is underway, the existence of a cocirculating currency may exert increased (and perhaps accelerating) pressures on the domestic currency, which may prove hard to control.

(4) In principle, national measures of inflation and changes in purchasing power should be measured based on the weighted average of transactions that take place in each currency, and not just based on the changes in the purchasing power of the domestic currency.

(5) The external adjustment mechanism can be muted. Changes in the current account may be only partially reflected as changes in the demand for the domestic currency. The overall rate of adjustment to external changes may be drawn out to the extent that changes in the domestic monetary and inflation situations are slower.

(6) Exchange rate conversion costs vis-a-vis the rest of the world are reduced to the extent that international transactions are executed in the foreign currency; in contrast, conversion costs are incurred in some

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1/ The government fiscal situation may depend critically on whether it has developed arrangements to tax or otherwise capture a portion of the cocirculating currency flow. Failure to capture revenues in the cocirculating currency potentially results in diminution of the government's command over real resources, which may force it to undertake inflationary actions. Methods that might be used to capture foreign currency revenues include mandatory deposits of (or taxes on) foreign currency export earnings, mandatory foreign-currency reserves from the banking system, foreign-exchange certificates, and duties on exchange transactions. The ability to tap foreign-currency revenue sources is enhanced the more fully the cocirculating currency is integrated into the formal financial and fiscal environment.

domestic transactions. The overall impact of this is uncertain, but (a) might accelerate integration of the national economy into the world economy or (b) create a bifurcated economy.

(7) Cocirculation is typically a second best option. Rational economic agents strive to minimize transaction costs and may shift to transacting business in foreign currencies if the domestic money becomes an unreliable medium of exchange or store of value. A second best optimum emerges where transactions occur because agents can make use of a foreign currency. Banning the use of foreign money without changing the quality of domestic money may result in further increases in transaction costs and deterioration in the level of economic activity. 1/

(8) The national monetary systems of the issuing and using countries are partially integrated, to varying degrees. The next section discusses how this might affect some of their financial relations.

#### Dealing with partially integrated monetary systems

Long-term cocirculation results in partial integration of the monetary systems of the issuer and user countries, which may generate a number of problems or areas of mutual interest. This section enumerates several areas where the partial integration of national monetary systems that accompanies cocirculation may lead to working arrangements or formal agreements between countries. The specific arrangements, of course, depend on whether cocirculation is acknowledged, sanctioned, or discouraged in the user country, and the degree to which it is integrated into the formal financial system. Of course, it is not at all certain that any arrangements will be made between the countries involved.

The perception of authorities in many user countries may be that the issuer countries have unilaterally benefitted from the seigniorage created by cocirculation and that corrective steps may be needed. In contrast, issuer governments may argue that users have received services from use of a more stable and useful currency and therefore no actions are needed. Issuers may also feel that users are stepping into policy areas where they have no right to be involved. Thus, negotiations may not always be cordial.

(1) Control of counterfeiting is important to the currency issuing country. Opportunities to counterfeit are increased when currency circulates abroad because users are unfamiliar with the currency and anti-counterfeiting control mechanisms are absent. Technical assistance may be offered to user country authorities in order to identify and control counterfeiting, and legal arrangements may also be needed. Technology that can identify counterfeit bills might also be used to

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1/ We are indebted to Roman Zyttek for this point.

track currency flows and improve estimates of the amount of cocirculation. <sup>1/</sup>

(2) Payments from the issuer to the user might be made in recognition of the loss of seigniorage income by the user and its receipt by the issuer. Payments might be made either as one-time transfers equal to the estimated net change in the cocirculating currency (less expenses of issuing the currency), or as continuing payments that represent the interest earnings on the stock of cocirculating currency that would have been earned by the user government. Such payments are formerly made between South Africa and Swaziland, for example. Accurate estimates of the amount of cocirculating currency are needed for this purpose.

(3) Users may seek prior consultation in decisions of the issuer countries regarding the rate of issuance or which affect the physical form of the cocirculating currency.

(4) Users may become partially integrated into the monetary and capital markets of the issuer country and may seek guarantees regarding access to those markets, removal of restrictions on transfers, a voice regarding determination of interest rate policy, access to emergency liquidity assistance, access to currency clearing facilities, application of exchange controls, etc. Some of these issues are obviously sensitive to both governments.

(5) User countries may choose to operate a cocurrency regime, in order to cut capital flight, stabilize economic activity, or enforce discipline on the domestic currency, etc. Such countries may have specially strong arguments for assistance from the issuer country.

(6) Lender of last resort assistance from the Issuer could be important. Cocirculation reduces the resources available to the user government to intervene and regulate markets, and thus they may need to rely on assistance from the issuer-country authorities or international financial agencies.

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<sup>1/</sup> Counterfeiting is not uncommon in cocirculation situations due to the public's lack of familiarity with the foreign currency, the volume of transactions outside of formal financial institutions, and lack of a legal enforcement mechanism. Counterfeiting can either involve production of fake bills, which is facilitated by development of modern color copying technology, or altering bills to raise their value, such as adding a zero to produce false 50,000 yen notes from real 5,000 yen notes. A recent news article suggested that \$6 billion in U.S. currency is in circulation in Moscow, but about 1/5th is counterfeit. ("Not-so-funny money," in The Economist, July 30, 1994, p.68) Counterfeiting in foreign countries has received heightened attention by monetary authorities.

### Policy relevance

The policy choices of how to deal with a cocirculating currency are being faced at present in a number of countries. Within the past year, Russia, Viet Nam, Belarus, and Azerbaijan have restricted use of foreign currencies. The United States took steps to deny Cuba access to U.S. dollars that could be used within the Cuban economy. Such actions are of major policy importance and it is important that systematic analysis take place of how to implement policy in a cocirculation environment.

### IV. Conclusion

Cocirculation of foreign currencies within an economy raises many questions regarding statistical measurement and economic policy. Cocirculation has been largely ignored in both statistics and policy, but the limited data that are available indicate that cocirculation is substantial. The magnitude of cocirculation suggests that it should now be explicitly placed on the agenda of monetary and balance of payments statisticians and economic policy authorities.

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Appendix I: Transition from informal to formal cocurrency regimes

It is instructive to consider the impacts of a shift from an informal cocirculation situation to a formal environment.

Informal cocirculation is characterized by use of foreign currencies by businesses or the general public independent of the formal banking system. In a number of cocurrency countries, use of foreign currencies is discouraged or outlawed, or banks are not permitted to establish foreign currency facilities.

Formal cocirculation permits unrestricted use of foreign currencies and the organized banking sector may establish foreign currency deposit and credit facilities. The issue facing policy authorities in a number of countries is what will be the implications of moving from an informal cocirculation environment to a formal one. The demand for foreign currency may change. Measurement of the money stock may also be affected.

Initially, formalization of use of a foreign currency will bring a portion of the cocirculating currency into the formal banking system where it can be measured. The amount of foreign currency within the country does not change, although the amount in general circulation is reduced by the amount of foreign currency deposits.

Subsequently, the bank will extend foreign currency credit by creating a demand deposit account in the name of the borrower, which the borrower will draw on for transactions or other purposes. Thus, the formalization of cocirculation initially results in some substitution of demand deposits for currency for transactions purposes. Both foreign currency outside the banks and the demand deposits should be included in estimates of the total money stock.

Foreign currency credits used for domestic transactions are likely to result in further expansion of foreign currency deposits and credits, due to operation of a fractional reserve system. Thus, there is likely to be a general expansion in credit, which can have impacts on prices and nominal economic activity. (Certain foreign-currency credits are leakages from the system and do not result in deposit and credit expansion; credits to nonresidents, those used to purchase imports, and those subject to 100-percent reserves requirements.)

Formalization of foreign-currency transactions might increase the amount of foreign currency in use. Formalization may increase the ease of use of foreign currency and broaden the range of transactions for which it can be used, which could result in an increased demand for the physical currency, which will be met by currency inflows. Also, banks and other financial intermediaries will build up foreign currency working balances for use as reserves, for clearing purposes, and to meet transactions demands.

In contrast, formalization may decrease the stock of foreign currency because of substitution of deposits for transactions purposes. Free convertibility with the domestic currency may permit the public to economize on its holdings of foreign currency. Also, formalization may be part of a stabilization program or restructuring process that might act to increase confidence in the national currency and financial system and thus reduce demand for the foreign currency.

A key question is whether the transition to a formal cocurrency regime increases or decreases the net demand for the foreign currency because balance of payments flows and the exchange rate may be affected.

A comprehensive statistical system should shed light on the economic effects of transition to a formal cocirculation regime. Unfortunately, spotty statistical coverage of holdings of foreign currency or balance of payments flows of currency may result in a biased picture. Above all, there is the possibility of interpreting increases in holdings of foreign currency within the formal banking sector as evidence of capital inflows rather than as a shift in the location of currency already within the country.

Appendix II: Functions of money, market segmentation, and measuring co-circulation of foreign currencies, prepared by Roman Zytek.

This appendix examines whether measurement of co-circulation of foreign currencies is affected by segmentation of markets, with differing degrees of usage of foreign currencies in different markets. It is hypothesized that the ways in which foreign currencies circulate in different market segments may depend on the specific economic functions they perform in each market, specifically as a measure of value, medium of exchange, or store of value. Measurement techniques may need to be adjusted to deal with market segmentation and identification of the specific functions performed by foreign currencies in different markets.

This note concludes that the validity of the Gresham-Copernicus' law can be extended in modern times to co-circulation of two currencies. According to the original Gresham-Copernicus' law, when two coins are equal in debt-paying value but unequal in intrinsic value, the one having the lesser intrinsic value tends to remain in circulation and the other is hoarded. The extension of this law to currencies without intrinsic value would suggest that, if agents can choose between two currencies and one of the currencies is perceived to be inferior, the agents will choose to spend the inferior money and hoard the superior. It is postulated that the law also applies to the physical quality of bills in a single currency. The working of the Gresham-Copernicus' law may bias estimates of co-circulation: the average note in a statistical sample of currency would be older and in worse physical condition than the true average for the entire stock of co-circulating foreign currencies. This result would be reinforced by periodic redesigns of the co-circulating foreign notes. Finally, the above extension to the Gresham-Copernicus' law suggests that different currencies should not be expected to co-circulate in individual markets. It is likely that in some markets foreign currencies dominate the market, while the use of foreign currencies in other segments remains negligible.

1. Functions of money and co-circulation

Money, including notes and coins, whether domestic or foreign, performs three functions: it is a measure of value, medium of exchange, and store of value. Economic agents may resort to using foreign currency notes and coins for domestic transactions if the domestic legal tender fails to perform one or more of these functions, or if foreign notes are at least as efficient as the domestic legal tender in performing at least one of these three functions. Co-circulation may take place within a market segment irrespective of the general economic situation of the country and it does not necessarily imply that the domestic legal tender is broadly rejected by the public.

For example, co-circulation may be efficient in otherwise stable economies, as illustrated by tourists and small traders from one country who do not bother to change currencies when visiting border areas of a neighboring country. Local traders in such border areas routinely transact

business in both domestic and foreign currencies, and carry little additional cost compared with transactions in the domestic legal tender. 1/

On the other hand, co-circulation may spread beyond border areas when domestic legal tender fails to be a good measure of value, medium of exchange, or store of value. In an effort to reduce transaction costs or compensate for risk and uncertainty related to the domestic legal tender, economic agents will search for other currencies that can efficiently perform one or more of the three functions of money.

The domestic legal tender may fail as a measure of value if economic agents find quoting prices (or even thinking about the value of goods and services offered) in terms of foreign currency units to be preferable to quoting them in the domestic currency units. 2/ For this reason economic agents will either denominate prices directly in foreign currency or convert the foreign currency price into domestic currency using current exchange rate.

The domestic legal tender may be rejected by economic agents as a suitable medium of exchange. This will happen when the recipient of payment (seller) finds it preferable to accept foreign currency instead of the domestic legal tender, or when the buyer prefers to effect payments using foreign currency. Although, one could argue that the seller could be induced by the buyer to accept the domestic legal tender, such an inducement may be too expensive to the buyer. 3/

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1/ The term "border area" refers to any area with a relatively high presence of foreign tourists or traders. Border areas represent, for example, tourist resort regions or towns with many foreign businesspeople.

2/ Sellers may price goods or services in terms of foreign currency units. For example, hotel rooms in Turkey are often priced in U.S. dollars, but the actual payment is effected in Turkish lira. It is common to see prices for products frequently purchased by foreign visitors denominated in foreign currencies: In Poland, throughout 1970s and 1980s, tutoring services provided by college faculty, apartment prices, and other big ticket items were valued in U.S. dollar terms, although the actual payment for tutoring was made in Polish currency, while payments for apartments and other big ticket items were in U.S. dollars, other foreign convertible currencies, and Polish zloty.

3/ There are many possible reasons why foreign currency notes may be preferable to the domestic legal tender. For example, the seller wants to use the proceeds to buy property sold only for foreign currency, the seller wants to take the proceeds out of the country, or the foreign currency notes are in preferable, usually higher, denominations.

Finally, the domestic legal tender may be considered unsuitable as a store of value because it loses value measured in terms of its purchasing power faster than other available stores of value, such as commodities or foreign currencies.

The failures of the domestic legal tender are rarely complete, i.e., lead to a complete replacement of the domestic legal tender by foreign units of measurement, and the actual foreign notes and coins. In practice, the domestic legal tender may continue to be used in some markets to measure relative values for goods and services, while foreign units of measurement dominate in other markets. <sup>1/</sup> At any time, save store value in both the domestic legal tender and in foreign currency, depending on the purpose of savings, geographic location, and the availability of alternative saving vehicles.

This process of substituting relatively bad money for good money in open circulation became known as the Gresham-Copernicus' law. This law stated that when two coins are equal in debt-paying value but unequal in intrinsic value, the one having the lesser intrinsic value tends to remain in circulation and the other to be hoarded. In the period of commodity money, currency substitution meant hoarding the more reliable commodity, and paying as much as possible using the less reliable commodity. In the period when coins were made of precious metals, economic agents hoarded coins with higher intrinsic value (made of more expensive precious metal, or made by honest mints). In modern times, economic agents can simply turn to foreign legal tenders which better perform the functions of money. As a result of the working of the Gresham-Copernicus' law, undesirable, "bad" money remains in general circulation while desirable, "good" money is pushed out of general circulation, or at least out of the markets where the "bad" money is still acceptable. The "good" money, usually foreign currencies, is hoarded and used in markets where goods and services are valued in and exchanged for these foreign currencies.

The above reasons for resorting to the use of foreign currency in any country are often interrelated. For example, a service is valued in U.S. dollars because the seller of the service intends to save for a specific big ticket item which is priced and sold only in exchange for U.S. dollars. In this example, foreign currency is preferred to domestic currency in all of the three functions of money: measure of value, medium of exchange, and the store of value.

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<sup>1/</sup> The term market represents here a specific geographic location, type of commodity or service traded in that location, and time at which the trade takes place.

## 2. Sampling and systematic errors: background for measuring co-circulation

Statistics textbooks list three standard types of samples: convenience samples, judgment samples, and random samples.

When expediency is the primary consideration and only the most easily accessible units are chosen for observation, the resultant subset of an associated population constitutes a convenience sample. It is unlikely that valid inferences can be drawn from a convenience sample about the underlying population. The specific danger in estimating co-circulation is that the convenient method of sampling relies on currency flows through formal banking systems, which may lead to bias because (1) co-circulation in some market segments is largely independent of the formal system, (2) the formal system is distrusted, or (3) the Gresham-Copernicus' law suggests that older, worn bills are recycled through the system but newer bills are held.

In the case of a judgment sample, an "expert" uses personal judgment, presumably based on prior experience, to select elementary units for observation. Making such a judgment can be next to impossible, however, especially when the elementary units are heterogenous and when the desired sample is small. When the "expert judgment" is wrong, as is easily possible, the sample is unrepresentative of the whole. At present, systematic knowledge of co-circulation is so limited that judgments may lead to a distorted picture of market segments affected and the degree of co-circulation.

Random samples (also called probability samples) avoid the problem of unrepresentativeness, because they are chosen by a random process that gives each unit of the associated population a known positive (but not necessarily equal) chance to be selected. If properly executed, the random sample selection process allows no discretion to the investigator as to which particular units in the population enter the sample. 1/

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1/ Four major types of random samples exist: (1) a simple random sample is a subset of an associated population, chosen in such a fashion that every possible subset of like size has an equal chance of being selected; (2) a systematic random sample, is a subset of an associated population, chosen by randomly selecting one of the first k elements and then including every k-th element thereafter; (3) a stratified random sample, is a subset of an associated population, chosen by taking separate (simple or systematic) random samples from every stratum in the population, often in such a way that the sizes of the separate samples vary with the importance of the different strata; and (4) a clustered random sample, which is a subset of an associated population, chosen by taking separate censuses in a randomly chosen subset of geographically distinct clusters.

Sampling is subject to biases. Biases can enter sampling procedures at the planning stage, during the data-collection stage, or during processing.

(continued...)

Some of the proposed methods of measuring co-circulation appear to rely on an implicit assumption that markets are integrated and that some form of random sampling can be used to derive valid estimates of the underlying population. These are strong assumptions under distressed economic conditions when co-circulation often exists: co-circulation appears to occur when market segmentation of markets is likely and the Gresham-Copernicus' law may affect results.

### 3. Measuring co-circulation

In order to measure the extent of foreign currency co-circulation in any country one is tempted to use simple sampling techniques to measure the value of GDP transacted in foreign currencies and the value of foreign currencies circulating in any economy. The problem is that to provide any meaningful information about the sampled population (value of foreign currencies in circulation, and the value of transactions in foreign currencies) a sample should be drawn from the entire population, unless one can prove that any subset of the whole (the entire population) is very representative of the whole. But as was hinted in section 1, markets where foreign currencies are used are hardly homogenous. It may prove difficult to collect samples from all markets with potentially heavy use of foreign currencies. Also, it remains to be proven whether markets where foreign currencies are used are integrated. 1/

Therefore, attempts to measure co-circulation of foreign currencies in any country run into a risk of committing sampling errors discussed in section 2 above. First, one can be persuaded to sample only from the easily accessible markets where foreign currencies circulate. Such a convenience sample may hardly represent anything more than fringes of the entire population of foreign currency in stock in any given country. Second, one can try to apply personal judgments about the uses of foreign currency and then try to sample accordingly. The judgment samples that would result are

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#### 1/ (...continued)

In the planning stage, systematic biases, such as selection bias, response bias, and nonresponse bias, can be built into the design of the sample. Similarly, the three types of biases may enter the survey at the survey's collection stage. A selection bias, is a systematic tendency to favor the inclusion in a sample or survey of selected elementary units with particular characteristics, while excluding other units with different characteristics. A response bias, is a tendency for answers to survey questions to be wrong in some systematic way. And finally a nonresponse bias, is a systematic tendency for some elementary units with particular characteristics not to contribute data in a survey.

1/ Central banks often examine the age and condition of notes returning from foreign countries for clues regarding circulation abroad. The Gresham-Copernicus' law suggests that this sample is unrepresentative.

bound to prove little more than the correctness of the "expert," who pre-determined the markets where foreign currencies are used. Random sampling poses another problem: samples to be truly random should be drawn from the entire population. But defining the potential population involved in co-circulation involves subjective judgments.

#### 4. Potential biases in samples of foreign currencies

Assuming that the Gresham-Copernicus' law is valid, one should expect to find a sample of foreign currencies collected from any market (1) to overstate the age and wear of the general population of foreign notes and coins in circulation, (2) to be heavily influenced by periodic efforts of major industrial countries, issuers of the co-circulating foreign currencies, to alter their national currencies to make them more difficult to counterfeit, and (3) to overstate or understate the total stock of foreign currencies in circulation depending on whether the sample is drawn from markets where foreign currencies dominate in circulation or from markets where the domestic legal tender is still broadly used.

All three biases are a direct result of the workings of the Gresham-Copernicus' law: individuals should be expected to hoard (i.e., take out of circulation) new money in any place where the market value of notes and coins may differ from the stated face value according to their age and wear. <sup>1/</sup> Also, changes in notes to protect them from counterfeiting create a natural demand for new, safer (and therefore more valuable) notes at the expense of the old notes. And finally, as long as the domestic legal tender is issued and used for payments it will be accepted in some markets. But, because "bad" money pushes out of circulation "good" money, the weaker the national tender is, relative to foreign currencies, the more of it (relative to its total issue) will circulate in markets where it is still accepted. The more desirable foreign notes are hoarded, and used only in markets where the domestic legal tender is mostly rejected.

The third bias has important implications for economic policy analysis. It suggests, that it is not the general velocity of circulation that increases when the domestic legal tender is gradually rejected and substituted by foreign currencies, but rather the number of markets served by the domestic legal tender declines and the velocity of transactions in

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<sup>1/</sup> In many countries, worn notes (i.e., more risky notes) are exchanged at a discount from their face value by privately operated currency exchange offices.



those markets increases. 1/ To measure velocity properly one needs to include the correct value of the foreign currency component in money supply.

5. Suggested research needed before measuring co-circulation

Before foreign currency co-circulation can be measured in any economy, one should call for a clear identification of the markets where co-circulation takes place. Institutional research is called for as the first step. To identify markets with co-circulation one could build a multidimensional matrix, that would attempt to define each potential market where foreign currencies co-circulate with the domestic legal tender.

For the purpose of measuring co-circulation it is recommended that compilers roughly estimate for key markets (1) the extent to which foreign currencies are used as a measure of value and medium of exchange, and (2) the extent to which foreign currencies are used as a store of value.

1. Because co-circulating foreign currencies can be used as both measure of value and medium of exchange we define each market where foreign currencies are suspected by a set of parameters  $a$ ,  $b$ , and  $t$ , where

$a = [v, e]$  and  $v$  - measure of value,  $e$  - medium of exchange,

$b$  is a set of individual market characteristics, for example,  $b_1$  - geographic location (name of town, region),  $b_2$  - group of products or services (or a single product or service), and

$t$  represents time.

Parameters  $v$  and  $e$  can take values from 0 to 1. For example,  $[v, e] = [0.7, 0.9]$  would mean that 70 percent of prices quoted in a given market are quoted in foreign currencies and 90 percent of transactions in that market are concluded in foreign currencies. In practice, less precise estimates such as quintiles might be used.

2. To measure the extent to which foreign currencies are used as a store of value we have to identify first why economic agents store value in foreign currencies. Economic agents diversify their savings into foreign currencies (a) to protect their wealth against the expected loss of purchasing power of the domestic legal tender (both domestically and

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1/ This creates an inflationary velocity spike with the domestic currency segments. The market segments in which the domestic legal tender continues to circulate, such as market for foodstuffs, are likely to be the markets that are sampled to determine changes in the consumer price index. This may create an upward bias in measured inflation.

internationally), 1/ and (b) to circumvent potential currency exchange restrictions and ensure the availability of foreign currency for future transactions, both domestic and international.

After identifying markets with potential co-circulation and asset diversification into foreign currencies, an attempt should be made to measure the extent of co-circulation in each market and in each type of portfolio using sampling techniques or conducting controlled experiments.

Measuring foreign currency component of savings portfolios will be undoubtedly very difficult. One can expect, however, that the use of foreign currencies as a measure of value and medium of exchange should indicate the extent to which foreign currencies are used as a store of value. For example, heavy use of foreign currencies to intermediate transactions in real estate and durable goods would indicate that economic agents planning to purchase these assets would save in foreign currencies.

#### References

Kohler, Heinz, Statistics for Business and Economics, (Glenview, Illinois: Scott, Foresman and Company, 1985)

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1/ This also includes holding foreign currencies as a precaution against expropriation if the domestic legal tender is replaced with a new tender without equitable compensation to holders of the replaced tender, or if some currency denominations are invalidated.