# Currency Substitution, Unofficial Dollarization and Estimates of Foreign Currency Held Abroad: The Case of Croatia

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*Paper prepared for the Sixth Dubrovnik Economic Conference*

Dubrovnik, 28 - 29 June 2000

*Forthcoming in Mario Blejer and Marko Skreb (eds), Financial Vulnerability and the Exchange Rate Regime, MIT Press.*

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# Introduction

Monetary and fiscal policies, the choice of exchange rate regime and interventions in foreign exchange markets are often undertaken in economies that experience "unofficial" or "*de facto*" dollarization, that is, where individuals and firms choose to use a foreign currency as a substitute for some of the monetary services of the domestic currency. The existence of a typically unknown amount of foreign currency in circulation (FCC) makes the outcome of domestic monetary policy uncertain. The effective money supply may be much larger than the domestic money supply and is subject to endogenous behavioral responses reflecting currency substitution on the part of the public. Hausmann et al (1999) suggest that under such circumstances, expansionary monetary policy can have pro-cyclical instead of counter-cyclical consequences and Eichengreen and Hausmann (1999) note that the market for domestic government debt may be completely missing in dollarized countries, with adverse consequences for economic growth (Fry, 1997). On the other hand, unofficial dollarization will tend to dampen government efforts to employ inflationary finance to impose implicit taxes on domestic monetary assets.

Co-circulating foreign currency holdings reflect both currency substitution and asset substitution, and the two may have different economic consequences, making the implications of unofficial dollarization for macroeconomic decisions more difficult to predict. The greater the extent and variability of dollarization, the weaker is the central bank's knowledge and control over the effective money supply. Growing unofficial dollarization reduces the ability of the monetary authority to earn seigniorage from its own currency issue. Unofficial dollarization reflects citizen's perceptions of the stability of the domestic monetary regime, the credibility of monetary policies and the perceived stability of the domestic banking system.

Unofficial dollarization not only makes the outcomes of monetary policy less certain, it also has fiscal consequences. Foreign cash transactions rarely leave a paper trail. They therefore reduce the costs of tax evasion and increase the size of the unreported (unofficial) economy. This weakens the government's fiscal ability to command real resources from the private sector and deepens fiscal deficits. The shifting of economic activity toward the underground economy distorts macroeconomic information systems (Feige 1990, 1997), thereby adding to the difficulty of formulating macroeconomic policy. By obscuring financial transactions,

unofficial dollarization also reduces the cost of enterprise theft, and may facilitate greater corruption and rent seeking. Given these extensive ramifications, informed policy decision-making requires better knowledge of the nature, extent, causes and consequences of unofficial dollarization as well as the specific effects of its components, currency substitution and asset substitution.

Despite the substantive importance of the issues cited, there is virtually no reliable empirical information concerning the actual extent of unofficial dollarization. In their review of the key issues concerning currency substitution, Calvo and Vegh (1992) observed:

*"In the final analysis, the relevance of currency substitution is an empirical issue…At the empirical level, the study of currency substitution faces a fundamental problem: there is usually no data available on foreign currency circulating in an economy. Therefore the importance of currency substitution is basically unobservable."*

This paper employs newly collected data (Feige, 1996, 1997) on the amount of foreign currency in circulation (FCC) in the form of US dollars, in various countries in the world. These new data enable us to finally circumvent the fundamental problem of "unobservability" that has plagued the currency substitution literature since its inception. Our estimates of FCC permit a refinement of definitions and empirical measures of the extent of currency substitution, asset substitution, unofficial dollarization and the credibility of domestic banking institutions.

Once the nature and extent of unofficial dollarization is empirically measurable, it becomes possible to examine the causes of de facto dollarization, and to examine the circumstances under which unofficial dollarization is likely to become irreversible.[2] Irreversibility will depend upon network externalities associated with the use of foreign currency (Feige, et al, 2001).

Much of the dollarization literature has focused on the experience of Latin America and those transition countries whose hyperinflationary episodes have induced a flight to dollars. With new estimates of the extent of dollar currency holdings in these countries, we set out to model the dollarization process. These models are then used to investigate a more complex issue, namely the use of other

non-dollar foreign currencies as substitutes for domestic monetary assets. In particular, the citizens of a number of Central and Eastern European (CEE) transition countries have chosen the Deutsche mark (DM) rather than the dollar as a substitute co-circulating currency. In addition to the aforementioned issues concerning the consequences of currency substitution, "unofficial Dmarkization" presents a special logistical problem of considerable urgency. On January 1, 2002, the Euro will be introduced as the common physical currency of the European Union (EU) and the DM will cease to be legal tender. At the end of 1999, there were 2.8 billion DM banknotes in circulation with an estimated value of 274 billion DM. Indirect estimates (Seitz, 1995; Doyle, 2000) suggest that between 30-69% of the total DM outstanding may be held outside of Germany. Anecdotal evidence suggests that "unofficial Dmarkization" has occurred in many of the Central and Eastern European countries, including Croatia. Unfortunately, no current estimates exist concerning the exact location of the estimated 82-189 billion DM held abroad. If there is to be a smooth transition from DM to the Euro in non-EU countries, it is important for the European Central Bank to have estimates of the amount of Euros that will be required to replace DM overseas. We therefore develop methodologies designed to obtain estimates of the use of non-dollar substitute currencies in foreign countries and present preliminary estimates of the extent of Dmarkization in Croatia.

The first section of the paper briefly reviews earlier efforts to measure dollarization by indirect means and defines several measures of unofficial dollarization that attempt to distinguish between currency and asset substitution. Currency substitution occurs when a foreign currency substitutes as a medium of exchange for the domestic currency, whereas asset substitution refers to the substitution of foreign denominated monetary assets for domestically denominated monetary assets. The following section presents new empirical estimates of the extent of dollarization and compares these estimates to earlier proxy measures employed by the International Monetary Fund (IMF). We find that earlier estimates of dollarization are highly correlated with our estimates of asset substitution but appear to be imprecise measures of currency substitution.

The following section introduces two methods for determining the unknown amount of a non-dollar foreign currency like the D Mark that may be in circulation in

[2] For an elaboration of the irreversibility problem see Guidotti and Rodriguez (1992) and Balino,

some of the CEE transition countries. The "denomination displacement method" is based on the hypothesis that foreign currency substitution often involves high denomination foreign notes that tend to replace the highest denomination notes of the domestic currency. By examining the observed denomination structure of the domestic currency, we hope to infer the extent of foreign currency usage. The second method employs estimates of the demand function for foreign currency in circulation (FCC) in countries known to be highly dollarized. The model's parameter estimates are then used to simulate the demand for non-dollar FCC holdings in countries that are believed to employ the DM as a substitute for the domestic currency. Empirical estimates for Croatia are used to illustrate the use of the two methods proposed for obtaining estimates of non-dollar holdings of foreign currency in circulation in transition countries.

# I Definitions

In an economy with unofficial dollarization, the effective broad money supply (EBM) consists of local currency (cash) in circulation outside the banking system (LCC), foreign currency (cash) in circulation outside the banking system (FCC), local checkable deposits (LCD), foreign currency deposits (FCD) held with domestic banks, and local currency time and savings deposits (LTD). Quasi money (QM) consists of FCD and LTD. Thus, the typical definition of broad money (BM) falls short of the EBM by the unknown amount of FCC. The narrow money supply (NM) is typically defined to include only LCC and LCD. However, in a dollarized economy, the effective narrow money supply (ENM) also includes FCC. [3] Thus,

(1) $EBM \equiv LCC + FCC + LCD + QM \equiv BM + FCC$, where:

(2) $QM \equiv FCD + LTD$

(3) $BM \equiv LCC + LCD + QM$

(4) $NM \equiv LCC + LCD$

(5) $ENM \equiv NM + FCC$

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Benett and Borensztein (1999).

[3] We ignore those rare institutional circumstances in which transfers between foreign currency deposits are employed for transaction purposes.

In a regime with unofficial dollarization, the recorded money supply falls short of the effective money supply largely due to the omission FCC, which is typically unknown and is not directly controllable by the local central bank.

Due to the data limitation on measuring the amount of foreign currency in circulation (FCC) cited by Calvo and Végh (1992), the entire literature on currency substitution has been forced to accept as a proxy for dollarization, the observable amount of foreign currency deposits (FCD). Studies of currency substitution often associated with the International Monetary Fund (IMF), [Sahay and Végh (1995); Ize and Levy-Yeyati (1998); Balino, Bennett and Borensztein (1999)] employ the ratio of FCD to broad money as the means of establishing the extent to which countries are dollarized.[4] We denote this common dollarization index:

(6) $(DI_{IMF}) \equiv FCD/BM.$

Unofficial dollarization, as studied in the context of Latin America was often a response to hyperinflation. Calvo and Végh (1992) point out that under such circumstances, a foreign currency may first serve as a unit of account and store of value and only later as a circulating medium of exchange. "Currency substitution" suggests that the foreign currency largely displaces the domestic currency as the medium of exchange. If one is primarily concerned with the extent to which a foreign nation's currency has substituted for local currency primarily as the medium of exchange, it is useful to define an explicit currency substitution index CSI. When the main impact of dollarization takes the form of asset substitution, it is useful to define an asset substitution index ASI. Finally, when both asset substitution and currency substitution take place, we define a broader unofficial dollarization index (UDI) that reflects the fraction of the broad effective money supply that is composed of foreign currency and foreign deposits. We use the following definitions throughout the paper:

*Definition 1*

[4] Balino, et. al. (1999) choose to define highly dollarized countries as those whose ratio of FCD/broad money exceeds 30%. The major shortcoming of this definition is that it takes no account of foreign cash in circulation. Further study is required to determine whether there exists a unique value of the dollarization index that represents a threshold effect at which point dollarization is likely to become irreversible because of network externalities. Mongardini and Meuller (1999) define the degree of currency substitution as measured by the ratio of FCD to total deposits.

**Currency substitution** occurs when foreign currency is partly or entirely used as a unit of account and medium of exchange. Currency substitution can be official or unofficial.[5] While official cases are rare, unofficial dollarization is widespread. Indeed recent studies (Feige, 1996, 1997; Porter and Judson, 1996) suggest that between 40 and 60 percent of the US currency supply ($192-$288 billion) may be held overseas. The most sensitive measure of currency substitution is represented by the currency substitution index (CSI), which shows the fraction of a nation's total currency supply made up of foreign currency.[6] Thus,

(7) CSI ≡ FCC/(FCC+LCC)

Since domestic transactions are typically settled by debiting and crediting local demand deposit (LDD) accounts, when institutional circumstances warrant, it may also be useful to modify the CSI and use instead, (CSIn) defined as the fraction of the effective narrow money supply made up of foreign currency.

(8) CSIn ≡ FCC/(ENM)

*Definition 2*

**Asset substitution** involves the use of foreign denominated monetary assets as substitutes for domestic ones, in their capacity as a store of value. It is measured by the asset substitution index (ASI), defined as the ratio of foreign denominated monetary assets to domestic denominated monetary assets excluding cash outside banks.[7]:

(9) ASI ≡ FCD/(LCD+QM)

[5] Officially dollarized independent countries include the Marshall Islands, Micronesia, Palau and Panama.

[6] In some countries foreign banknotes may simply be hoarded and treated purely as a store of value. When this part of FCC can be estimated, it should be treated in the capacity of money as the store of value and included in the asset substitution index.

[7] Again, a reader should keep in mind that the definition of ASI also depends upon the particular institutions of a nation. Its quality is high when the amount of FCD and LTD used for transactions purposes is low in comparison to the amount of those deposits used as income earning assets.

*Definition 3*

**Dollarization** is a summary measure of the use of foreign currency in its capacity to produce all types of money services in the domestic economy. It is measured by the unofficial dollarization index (UDI), which represents the fraction of a nation's broad effective money supply composed of foreign monetary assets. Thus:

(10) UDI ≡ (FCC+FCD)/EBM

*Definition 4*

**Bank Credibility:** The choices individuals make concerning the disposition of their monetary assets reflects their perceptions of the credibility of the domestic banking system. Since this perceived credibility might be an important factor affecting the ability of the monetary authority to pursue its macroeconomic objectives, it is useful to define a bank credibility index (BCI) reflecting the ratio of monetary assets held in the domestic banking system to assets held in the form of currency outside the banking system. Thus,

(11) BCI ≡ (LDC+FCD+LTD)/(LCC+FCC),

where LTD represents time and savings deposits in domestic banks.

Each of the foregoing indices depends upon a number of economic variables that reflect the relative incentives to hold the different assets described in both the denominator and numerator of each index. These incentives will include relative rates of return as reflected by interest rate differentials, inflation differentials and exchange rate depreciation as well as the relative costs associated with network externalities and risks of banking institutions.

With the notable exception of Kamin and Ericsson (1993) on Argentina, no other studies have employed direct estimates of foreign currency holdings to estimate the currency substitution process. Balino, Benett and Borensztein (1999) distinguish between currency and asset substitution and report some FCC data based on cross-

border US dollars flows, but they end up relying on the conventional IMF dollarization ratio ($DI_{IMF}$) used in the earlier literature (e.g. Sahay and Végh, 1995; Ize and Levy-Yeyati, 1998) to characterize the extent to which different countries are dollarized.

The IMF dollarization index will be an adequate proxy of overall dollarization when foreign currency holdings are of marginal importance, or when FCC and FCD are highly complementary. However, if significant amounts of foreign currency circulate for transaction purposes and if FCC and FCD are in fact substitutes, then the IMF dollarization measure is likely to perform poorly as an indicator of unofficial dollarization. Typically, the IMF dollarization index will understate the true extent of dollarization due to its omission of FCC holdings. Moreover, the IMF index does not permit one to distinguish between the currency substitution and asset substitution processes that our more refined indicators attempt to capture. In order to examine the adequacy of the IMF index, we now turn to a discussion of our efforts to obtain direct estimates of US currency holdings in different countries around the world.

# II Measurement

*Direct measurement of FCC*

There is now a growing body of evidence (Feige 1996, 1997; Porter and Judson, 1996) that US currency is widely used outside of the US. While the exact percentage of US currency held abroad is difficult to determine and still subject to debate, various estimates suggest that between 40 – 60 percent of all US currency in circulation is held overseas.[8] US currency (cash) has many desirable properties. It has a reputation as is a stable currency, and is therefore a reliable store of value. It is available in many countries, is widely accepted as a medium of exchange, and protects foreign users against the threat of bank failures, devaluation and inflation. US dollar usage preserves anonymity because it leaves no paper trail of the transaction for which it serves as the means of payment. Indeed the very characteristics that make the US dollar a popular medium of exchange also makes it difficult to determine the exact amount and location of US notes circulating abroad. Nevertheless, there is a direct source of information that can be used to determine the approximate amounts of US

[8] In 1999 some $480 billion dollars were in circulation, suggesting that $192 - $288 billion may in circulation overseas.

cash in circulation in different countries. Over the past two decades, the United States Customs Service has been mandated to collect systematic information on cross border flows of US currency. In October 1970, the Currency and Foreign Transactions Reporting Act (also known as the "Bank Secrecy Act") required persons or institutions importing or exporting currency or other monetary instruments in amounts exceeding $5,000, to file a Report of International Transportation of Currency or Monetary Instruments. The U.S. Customs Service has collected these reports, commonly known as Currency and Monetary Instrument Reports (CMIR) since 1977. In 1980, the required reporting limit was raised to $10,000. Although the CMIR data system was established with the aim of recording individual instances of cross border inflows and outflows of currency and monetary instruments, its micro records can be usefully aggregated to study the size, origin and destination of cross border currency flows. The CMIR data system consists of more than 2.5 million inbound filings and more than 300,000 outbound filings. With the cooperation of the U.S. Customs Service and the U.S. Treasury Department's Financial Crimes Enforcement Network, the information contained in the millions of accumulated confidential individual CMIR forms have been aggregated in order to preserve the confidentiality of individual filers. The aggregated data yield time series observations on the gross inflows and outflows of US currency to different destinations. We employ these aggregated data to analyse the approximate extent of informal dollarization throughout the world. Cross border currency flows are known to consist of several components, only some of which are recorded in systematic manner. The largest component of cross border currency flows is wholesale bulk shipments of US currency that is transported by large financial institutions that specialize in the international transport of currency. US dollars can be obtained in most countries through the local commercial banking system. In order to satisfy the overseas demand for US dollars, overseas banks typically order US currency from one of the large wholesale shippers who transport the bulk currency directly to commercial banks. The shipper is required to file an outgoing CMIR form that contains information on size, origin and destination of the shipment. Conversely, when an overseas financial institution finds itself with excess US currency, a wholesale bulk shipper is enlisted to transport the excess currency back to US and must legally file an incoming CMIR form.

The second component of cross border flows consists of retail currency shipments that exceed the $10,000 filing threshold. Currency retailers, firms and individuals physically transport this currency. These flows also require the filling of a CMIR form except when the transporting agent is a Federal Reserve Bank. The New York Federal Reserve Bank maintains records of its own direct cross border currency shipments, and all currency flows reported in this study have been adjusted to include direct dollar shipments to and from Federal Reserve Banks.

The third category of currency flows consists of currency transfers by individual travellers and remittance grantors that fall below the $10,000 filing threshold. These transactions represent smaller amounts of currency legitimately imported to or exported from the US, but these shipments do not require the filling of a CMIR report and are therefore not included in our data. Feige (1996, 1997) has estimated that the cumulative net outflows of currency arising from these sources between 1977 - 1994 is between $2.9 billion and 24.7 billion, a relatively small fraction of total estimated net outflows.[9] Moreover, most of these cross border flows involve Mexico and Canada, which have common borders with United States. A final category of cross border flows represents illegal currency transfers that evade or circumvent legal reporting requirements. These unrecorded international currency flows represent currency smuggled out of the US for the purpose of laundering cash proceeds from illegal activities, most notably the traffic in narcotics. Data are available on drug related monetary seizures, however the "extent of currency smuggling is subject to a great deal of conjecture."[10] The economics of criminal activity provides strong incentives to launder cash proceeds from illegal activities so that they cannot be traced. Often, this requires that large amounts of cash, in small and mid-sized denominations, be smuggled out of the country, laundered and then returned through legitimate and reported channels. The logistical problems of exporting the cash proceeds from drug related activities might be as great as the problem of importing the narcotics themselves.[11] This observation suggests that compliance rates for reported currency outflows from the United Sates are likely to be

[9] Estimates of travelers' expenditures and net remittances are obtained from the Bureau of Economic Analysis - Survey of Current Business - Balance of Payments Accounts.
[10] Financial Crimes Enforcement Network (1992).
[11] The street value of a kilogram of cocaine is approximately $20,000. If the proceeds from the sale of cocaine were equally divided between $10 and $20 bills, the weight of the cash to be exported would exceed the weight of the imported cocaine. Four hundred and fifty US bills weigh approximately one pound.

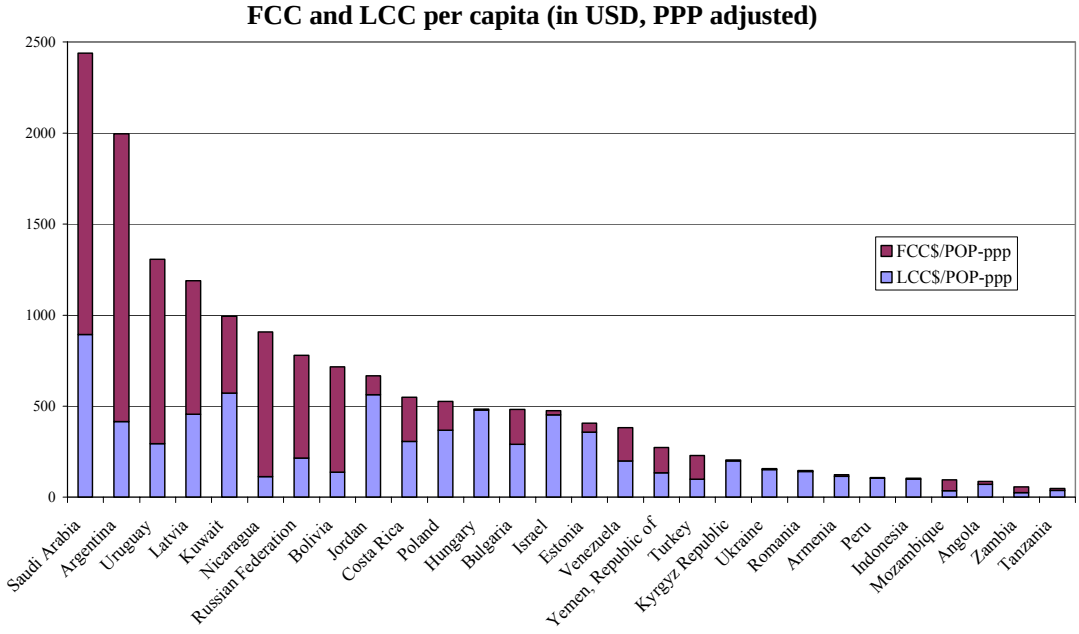
lower than the compliance rates for currency inflows. CMIR measures of net currency outflows by currency retailers, firms and individuals are therefore likely to understate the actual amounts of currency transferred abroad. The omitted flows are most likely to effect destination countries in Central and South America rather than flows to and from transition countries.

Given the adjusted CMIR data on gross inflows and outflows of US currency to different nations, it is possible to obtain an estimate of the stock of FCC in various countries and more precisely, an indication of how that stock has changed over time. In particular, the difference between gross outflows of US currency from the US to any nation, and gross inflows of US dollars from any nation is taken as a first order approximation of the growth of FCC in the respective country. Temporal aggregation of these net outflows of dollars yields an estimate of the stock of FCC in each country over time. The stock estimate is of course understated to the extent that local residents held stocks of US dollars prior to the beginning of the observation period in 1977. It is also understated to the extent that additional dollars have flowed into the country from other countries from illegal sources and legitimate sources such as tourist expenditures and remittances that fall below the reporting requirement. The estimate is overstated to the extent that unrecorded dollars have flowed out of each country via unreported cross border flows to pay for imports from third countries including tourist expenditures in other countries.

On the basis of available data, it is impossible to determine whether the adjusted CMIR based estimates of FCC are overestimates or underestimates of the true amount of dollars in circulation with the overseas public. Despite these limitations, CMIR currency flow data are the best available information source for determining the stocks of US dollars in particular countries abroad.

Figure 1 presents 1997 estimates of per capita holdings of domestic plus foreign currency in circulation for various countries. Among the most dollarized countries, as measured by per capita holdings of US dollars (PPP adjusted), are: Argentina, Saudi Arabia, Kuwait, Russia, Latvia, Uruguay, Bolivia and Nicaragua.

## Figure 1




Estimates of dollar FCC holdings are then used to calculate the asset substitution, bank credibility, currency substitution and dollarization indices described in section I. Table 1 displays the correlation matrix of these various indices of unofficial dollarization and the IMF dollarization index (DIIMF). The widely used IMF index is highly correlated with the indicator of asset substitution but appears to be an imprecise measure of currency substitution.

Table 2 displays a country-by-country comparison of the conventional IMF dollarization proxy (DIIMF) and our broader dollarization index (DI) that takes explicit account of the estimated amount of FCC in circulation in each nation. The

## Table 1

### Correlation Matrix Between Selected Dollarization Measures

| | ASI | BCI | CSI | CSIn | DI | $DI_{IMF}$ |
|---|---|---|---|---|---|---|
| **ASI** | 1.00 | -0.27 | 0.73 | 0.65 | 0.83 | 0.87 |
| **BCI** | -0.27 | 1.00 | -0.48 | -0.42 | -0.35 | -0.16 |
| **CSI** | 0.73 | -0.48 | 1.00 | 0.89 | 0.85 | 0.57 |
| **CSIn** | 0.65 | -0.42 | 0.89 | 1.00 | 0.73 | 0.47 |
| **DI** | 0.83 | -0.35 | 0.85 | 0.73 | 1.00 | 0.87 |
| **$DI_{IMF}$** | 0.87 | -0.16 | 0.57 | 0.47 | 0.87 | 1.00 |

**Table 2**

**Comparison of Different Dollarization Measures**

| Country | DI in % (1) | RANK for (1) (2) | $DI_{IMF}$ in % (3) | RANK for (3) (4) | Difference in perc. points (5=1-3) | IMF Study* in % (6) | RANK for (6) (7) |
|---|---|---|---|---|---|---|---|
| Angola | 6.3 | 26 | 1.3 | 25 | 5.0 | n.a. | |
| Argentina | 68.5 | 4 | 48.9 | 4 | 19.6 | 43.9 | 5 |
| Armenia | 36.1 | 12 | 33.6 | 8 | 2.5 | 20.4 | 15 |
| Bolivia | 83.5 | 1 | 78.8 | 1 | 4.7 | 82.3 | 1 |
| Bulgaria | 49.8 | 9 | 42.2 | 6 | 7.6 | 28.4 | 9 |
| Costa Rica | 40.8 | 11 | 35.5 | 7 | 5.4 | 31.0 | 8 |
| Estonia | 18.6 | 21 | 16.0 | 21 | 2.5 | 11.4 | 18 |
| Hungary | 26.7 | 15 | 26.6 | 13 | 0.1 | 26.6 | 11 |
| Indonesia | 20.9 | 18 | 20.7 | 16 | 0.2 | n.a. | |
| Israel | 18.0 | 23 | 17.9 | 19 | 0.2 | n.a. | |
| Jordan | 19.3 | 20 | 16.4 | 20 | 2.9 | 15.2 | 17 |
| Kuwait | 16.9 | 22 | 15.3 | 22 | 1.7 | n.a. | |
| Kyrgyzstan | 18.1 | 24 | 15.4 | 23 | 2.7 | n.a. | |
| Latvia | 56.8 | 5 | 31.1 | 9 | 25.7 | 31.1 | 7 |
| Mozambique | 45.5 | 10 | 29.1 | 11 | 16.4 | 32.6 | 6 |
| Nicaragua | 77.3 | 2 | 62.1 | 2 | 15.2 | 54.5 | 3 |
| Peru | 54.0 | 6 | 53.9 | 3 | 0.1 | 64.0 | 2 |
| Poland | 19.5 | 19 | 15.2 | 24 | 4.3 | 20.4 | 16 |
| Romania | 28.9 | 14 | 28.5 | 12 | 0.4 | 21.7 | 12 |
| Russia | 77.2 | 3 | 30.4 | 10 | 46.9 | 20.6 | 14 |
| Saudi Arabia | 36.0 | 13 | 17.9 | 18 | 18.1 | n.a. | |
| Tanzania | 50.0 | 17 | 46.4 | 17 | 3.6 | n.a. | |
| Turkey | 23.3 | 8 | 18.0 | 5 | 5.3 | 46.1 | 4 |
| Ukraine | 26.3 | 16 | 21.1 | 15 | 5.3 | 26.9 | 10 |
| Venezuela | 9.2 | 25 | 0.2 | 26 | 9.0 | n.a. | |
| Yemen | 50.7 | 7 | 25.8 | 14 | 24.9 | 20.9 | 13 |

* Balino, Bennet and Borzenstein (1999) data from their Table 1 are reported in column (6). Column (3) represents the same measure ($DI_{IMF}$) based on the data set independently gathered for the present study.

first column of Table 2 displays the value of our dollarization index (DI) for different countries and column 2 displays the corresponding ranking of each country according to the value of our dollarization index (DI). The third and fourth columns respectively display the same information based on our recalculation of the value of the IMF dollarization proxy IMF ($DI_{IMF}$) employed in most previous studies. Column 5 displays the percentage difference of the two indices. The final two columns respectively display the values of the IMF proxy and the corresponding country ranking as reported in (Balino, Bennett and Borensztein, 1999).

The Spearman rank correlation coefficient between the dollarization index DI (column 2) and IMF dollarization proxy based on our data set (column 4) is 0.91. Major differences in the magnitude of the dollarization indices appear in those countries that have a large share of observed dollar FCC net inflows, notably Russia, Latvia, Yemen, Argentina, Saudi Arabia, Mozambique and Nicaragua. The foregoing dollarization indices will understate the true amount of foreign currency in circulation in these countries to the extent that some countries also employ other foreign currencies as co-circulating currency

*Indirect Methods of Estimating Foreign Currency in Circulation*

Indirect estimates (Seitz, 1995; Doyle, 2000) suggest that between DM 84-193 billion DM are in circulation abroad. Although these studies are incapable of determining the location of these large estimated overseas holdings, anecdotal evidence suggests that many of the transition countries of Central and Eastern Europe employ the DM as a co-circulating currency. In Russia and the Baltic nations, dollars play the leading role of co-circulating currency, but in Bulgaria, the Czech Republic, Hungary, Slovakia, Slovenia, Croatia and Bosnia and Herzegovina[12], the DM is believed to be the dominant foreign currency in circulation. In Poland, and perhaps in some other transition countries, the situation is particularly complicated since dollars and DM are co-circulating and there is no direct means to measure DM FCC holdings directly for these countries.[13] We therefore require the development of indirect measures of DM FCC holdings.

The first indirect method of measurement we propose is the *denomination displacement method*. The hypothesis underlying the denomination displacement method is based on anecdotal evidence, which suggests that co-circulating currency is typically used for larger transactions such as the purchase of automobiles, consumer durables and real estate. In dollarized countries where people use US currency as means of exchange, it is well known that most transactions are affected with the largest denomination bills available, that is, with $100 US bills. Similarly, for those countries, which use non-dollar co-circulating currencies, many transactions are

[12] Bosnia and Herzegovina introduced currency board system, which issues "convertible mark" as a local currency.

[13] A carefully designed information system that tracks the exchange of DMs into Euros during the year 2002 conversion would enable central banks to obtain direct estimates of the amount of FCC in circulation.

carried out with larger denomination notes (such as 500 and 1000 DM bills). Our hypothesis is that countries that are heavily (unofficially) dollarized with large denomination foreign bills will have domestic currency (LCC) denomination structures that are unusually skewed away from higher denomination domestic bills. Denomination displacement occurs as higher denomination FCC bills substitute for the high denomination LCC bills.[14] As such, knowledge about the denomination structure can be used as an indicator of the extent of foreign currency in circulation.

The second method for estimating DM FCC is to investigate the demand for money in highly dollarized countries for which we have data on the actual amount of US dollar FCC. Our aim is to estimate an empirical demand function for dollar FCC that depends upon independent variables that can be readily measured in those countries for which the DM FCC is unknown. If we can find known dollarized countries that have behavioral and structural similarities to countries with unknown DM FCC, we can use the parameters obtained from estimated dollar FCC demand functions to simulate the unobserved demand for DM FCC in transition countries.

*Preliminary Findings Employing the Denomination Displacement Method: The Case of Croatia*

Before we make comparison of denomination structures of selected countries[15], it is useful to describe the denomination structure of Croatian currency. The Croatian currency consists of Kuna (HRK) notes, issued in denominations of 5,10,20,50,100,200,500 and 1000 bills, which have the same face value denominations as DM bills. Table 3 displays the nominal denominations of both Kuna and DM notes as well as the approximate Kuna value equivalent of DM notes. The circulation of the higher denomination DM notes (200,500 and 1000) will tend to primarily displace the 1000 and 500 Kuna notes.

[14] Rostowski and Shapiro (1992) analyze Russia's unique experiment of introducing a stable secondary currency during the period of hyperinflation that effectively replaced the primary currency. The primary currency that was devalued by the inflation was used only for small transactions and citizens demanded only small denominations of primary currency notes. On the other hand, the secondary currency, which was not affected by inflation, was used for large transactions and as a store of value, resulting in a demand for high denomination units of secondary currency notes.

[15] Denomination structures and values of local cash supply per denominations are usually not publicized, so we relied on direct data requests to the Central Banks of various nations. We obtained data from 10 countries from our sample: Armenia, Bulgaria, Estonia, Hungary, Israel, Latvia, Romania, Russia, Saudi Arabia and Venezuela.

**Table 3**

**Value Structure of Kuna and DM Notes**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kuna (HRK) | 5 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 |
| DM | 5 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 |
| Kuna Value Equivalent of DM bills ≈ | 20 | 40 | 80 | 200 | 400 | 800 | 2000 | 4000 |

The Kuna denomination structure is displayed in Figure 2 for the period 1994:6 – 1999:9. In September of 1999, 32.4% of the value of all HRK notes in circulation with the public were in the form of 100 HRK notes; 24.4% in 200 HRK notes, 19.3% in 500HRK notes and 11.8% in 1000 HRK notes with the remaining 12% in the smallest denomination notes.

**Figure 2**

**Denomination Structure of Kuna Notes in Circulation with the Public in Value Terms**

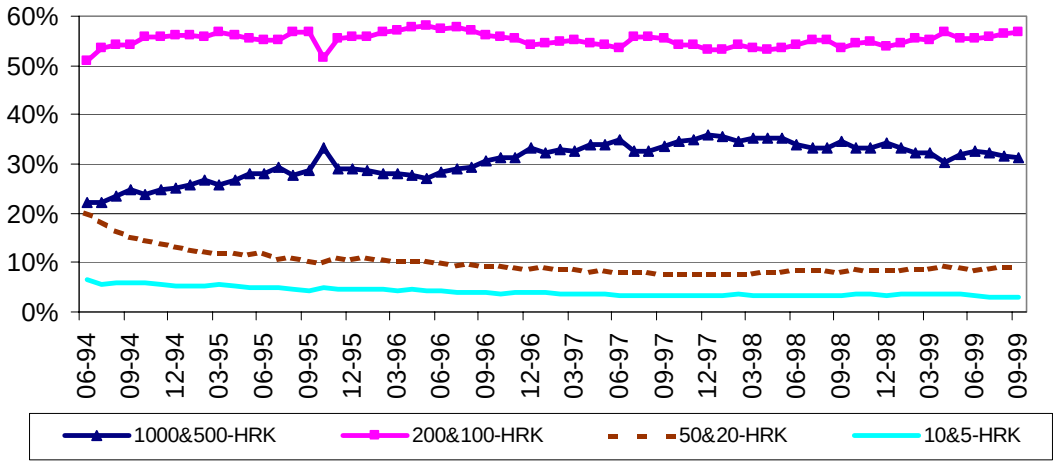


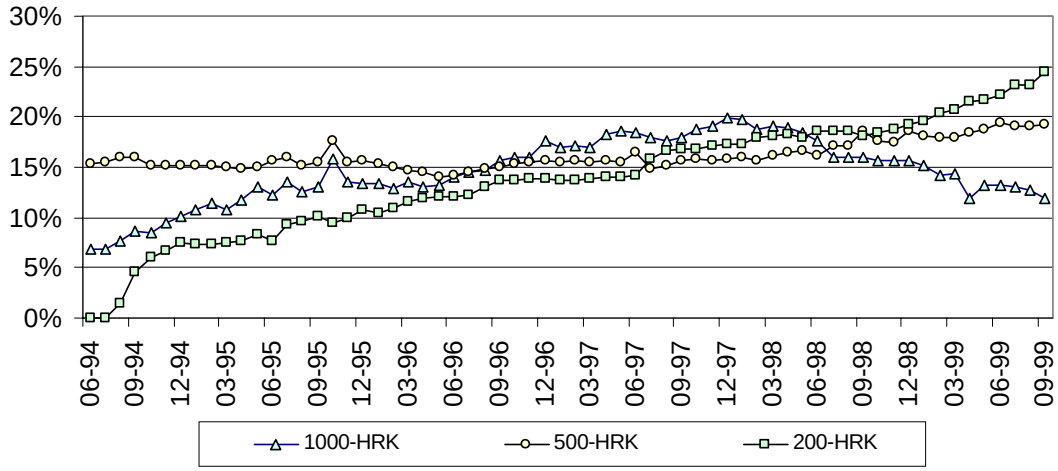

Figure 2 reveals that there have not been dramatic changes in the Kuna denomination structure during the observed period. Observations of denomination structures in other countries suggest that rising price levels that increase the average transaction size will induce an upward shift in the denomination structure. This tendency is predicted by models that assume transactors will attempt to economize on the number of bills used in any given transaction. As transaction size increases, economic actors will choose to hold a larger proportion of large denomination bills. A gradual shifting away from

lower denomination notes toward higher denomination notes is evident in the Croatia data.

Figure 3 displays greater detail on the temporal development of the largest denomination Kuna notes. The proportion of 200 HRK notes rise sharply as these notes appear to replace the 100 HRK note. The 500 HRK notes are roughly stable until the end of 1997 and thereafter reveal a gradual upward trend. The largest 1000K notes however reach a peak of roughly 20% of circulation at the end of 1997 and then decline to roughly 12% by September 1999. Therefore the dynamic denomination structure evidence suggests that whatever level of currency substitution had been achieved by mid 1994 was not significantly altered until the end of 1997. While there is evidence of denomination displacement in the highest denomination notes since the end of 1997, there is little evidence from these initial denomination structure data to support the notion that the extent of currency co-circulation changed dramatically between mid 1994 and the end of 1997.

**Figure 3**

**Percentage of Large Denomination Notes in Circulation**




We now turn to the denomination structure evidence concerning the extent of currency substitution in Croatia. Our aim here is to compare the denomination structure of Kuna notes with those of other countries. In particular, we are interested in examining the Croatian note denomination structure with those from other transition countries for which we have independent evidence of the extent of dollarization.

In order to make denomination structures comparable, we have defined three denomination categories in terms of US dollar values: small denomination notes having a value of $10 or less; mid-sized denomination notes having a value greater than $10 and less than $50 and large denomination notes having a value in excess of $50. The exchange rate is used to convert from local currencies to dollars. The percentage of notes in each size category is presented in Table 4, which reveals sizable differences between countries. The Slovak and Czech Republics appears to have a high percentage of large denomination notes compared to other countries, (Saudi Arabia being the exception) and a denomination structure not unlike that observed for Croatia. Hungary appears to have an unusually high percentage of medium denomination notes, while Romania appears to have only small denomination notes.

**Table 4**

**Denomination Structures for Selected Countries**

**Exchange Rate Conversion**

| Country | Year | Percent of Notes in Value Class | | |
|---|---|---|---|---|
| | | $0-$10 | >$10-$50 | >$50 |
| Russia | median 96,97 | 38.0% | 54.3% | 7.6% |
| Slovak R. | median 94-98 | 8.5% | 65.3% | 26.2% |
| Romania | median 93-98 | 100.0% | 0.0% | 0.0% |
| Hungary | median 93-98 | 17.8% | 82.2% | 0.0% |
| Bulgaria | median 97-98 | 44.8% | 55.2% | 0.0% |
| Latvia | median 95-98 | 19.3% | 57.5% | 22.1% |
| Estonia | median 95-98 | 31.5% | 68.5% | 0.0% |
| Czech | median 93-98 | 8.2% | 63.3% | 28.5% |
| Armenia | median 96-98 | 64.0% | 36.0% | 0.0% |
| Israel | median 95-98 | 7.6% | 69.2% | 23.2% |
| Venezuela | median 95-98 | 87.6% | 12.4% | 0.0% |
| Saudi Arabia | median 95-98 | 2.6% | 26.4% | 71.1% |
| Croatia | median 94-98 | 12.5% | 54.2% | 33.3% |

Since denomination structures will depend upon the size distributions of transactions, Table 5 displays the denomination structures employing the more appropriate purchasing power parity (PPP) index for converting local currencies into dollar values. The last column of Table 5 depicts two currency substitution indicators: per capita foreign currency holdings and the fraction of the effective M1 money

supply made up of foreign currency in circulation[16]. Table 5 also includes the denomination structure estimates for Germany and the Netherlands.[17]

Based on the purchasing power parity conversion, it appears that Hungary, Czech Republic and the Slovak Republic have denomination structures very similar to those of Germany and the Netherlands whereas the structures for Bulgaria, Croatia and Russia appear quite different.

**Table 5**

**Denomination Structures of Selected Countries**

**Purchasing Power Parity (PPP) Conversion**

| Country | Percent of Notes in Value Class Purchasing Power Parity Adjusted | | | Currency Substitution Indicators | |
|---|---|---|---|---|---|
| | $0-$10 | >$10-$50 | >$50 | $FCC/POP* | CSIn* |
| Russia | 9.4% | 83.0% | 7.6% | $374 | 63.0% |
| Slovak R. | 6.9% | 12.0% | 81.3% | n/a | n/a |
| Romania | 25.8% | 68.3% | 0.0% | $2 | 1.8% |
| Hungary | 3.3% | 13.7% | 82.2% | $2 | 0.3% |
| Bulgaria | 24.3% | 20.6% | 55.2% | $58 | 38.7% |
| Latvia | 0.0% | 49.7% | 50.3% | $354 | 50.7% |
| Estonia | 6.6% | 24.9% | 68.5% | $29 | 4.6% |
| Czech | 4.3% | 13.0% | 83.0% | n/a | n/a |
| Armenia | 29.0% | 35.0% | 36.0% | $1 | 5.3% |
| Israel | 4.0% | 66.0% | 30.0% | $24 | 2.3% |
| Venezuela | 57.2% | 42.8% | 0.0% | $74 | 15.8% |
| Saudi Arabia | 3.1% | 26.0% | 70.9% | $1096 | 36.5% |
| Croatia | 6.0% | 58.8% | 35.7% | n/a | n/a |
| Germany | 2.1% | 12.0% | 85.9% | - | - |
| Netherlands | 2.1% | 9.4% | 88.4% | - | - |

* Average values for the period 1996 - 1998

Figure 4 displays the simple observed relationship between the currency substitution index CSIn and the percent of high denomination notes for 8 out of 10 countries from table 4[18]. Consistent with the denomination displacement hypothesis,

[16] Our estimate of foreign currency in circulation is based on the direct measurements obtained from the Currency and Monetary Instrument Reports described before.

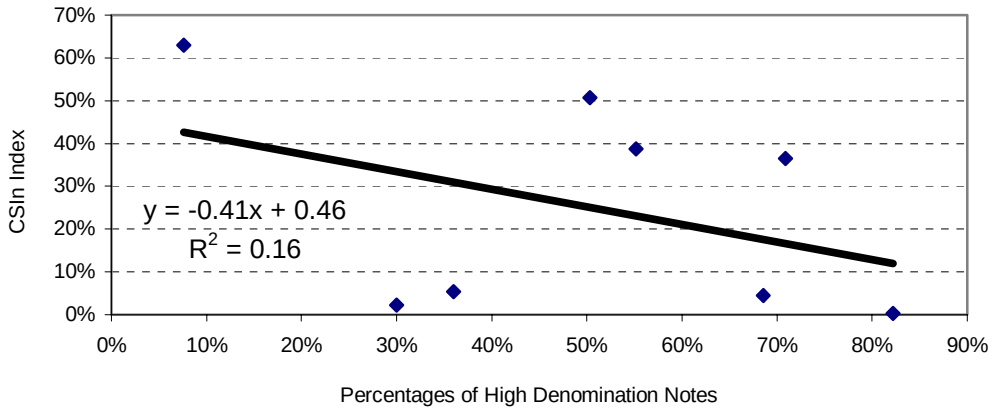
[17] The denomination structures for Germany and the Netherlands are based on median estimates for the period 1992-1996.

[18] Romania and Venezuela are outliers. We suspect that US dollarization is largely not relevant for Romania where DMs are believed to be the dominant competing foreign currency. In the case of Venezuela we suspect that the direct measures of dollar holdings may be biased as a result of money laundering associated with a common border with Colombia.

we note that Russia has the smallest percentage of high denomination bills (15.3%) and is also the most highly dollarized of the selected transition countries. Bulgaria is also quite highly dollarized but to a smaller extent than Russia and shows a higher proportion of notes in the large denomination range (59.6%). Hungary, which has the lowest currency substitution indicator, also has the highest percentage of domestic notes in the large denomination category (87.4). Croatia's denomination structure appears to lie somewhere between the two most dollarized countries. If Croatia, were assumed to lie on the simple regression line we would expect its narrow currency substitution index to be approximately 30%. Given the currency substitution index and the observed level of LCC and LCD, one could infer the unknown amount of FCC. However, it is impossible to draw any firm conclusion from these preliminary results because (i) some other explanatory variables are missing from the regression in Figure 4, (ii) CSIn for some countries in the sample is incompletely measured, because in countries like Bulgaria and Hungary the DM also plays the role of a competing foreign currency.

**Figure 4**

**Currency Substitution and Denomination Displacement**




In order to obtain a better estimate of the parameter linking the dollarization measure to the share of high denomination domestic notes, Table 6 presents the results of a regression model that employs the logarithmic transformation of the narrow currency substitution index (LCSIn) as the dependent variable and Denom (the value share of domestic currency in the highest denomination class); Privatcon (per capita household consumption expressed in US dollars corrected for PPP) and

Rom (a dummy variable for the Romania outlier) as independent variables. Given the regression presented in table 6, it is possible to obtain an estimate of the unknown amount of foreign currency in circulation in Croatia by substituting the known values of the independent variables for Croatia and solving the equation for the unknown quantity FCC.

**Table 6**

**Regression results**

**(t-tests in parenthesis, dependent variable LCSIn)**

| Ind. Variable | equation I |
|---|---|
| CONST | 1.7694<br>(1.9) |
| DENOM | -4.0447<br>(-3.6) |
| ROMANIA | -3.9804<br>(-4.3) |
| PRIVATCON | -0.0004<br>(-3.7) |
| R-squared | 0.47 |
| S.E. of regression | 1.59 |

Our estimate indicates that for the period 1994-1998, the average dollar value of the DM in circulation in Croatia was $402 US dollars per capita or a total of approximately 3.4 billion DM. This represents between 1.8 – 4.2 percent of the estimated total of DM believed to be circulating abroad.

We regard this preliminary estimate as an illustration of the denomination displacement method. A more reliable estimate will require a larger number of countries in our sample, refinement of the sample countries to exclude those believed to hold DM in addition to dollar FCC, and perhaps a more refined measure of the skewness of the denomination structure itself.

*Demand for Money Approach: Estimating Foreign Cash in Circulation from Currency Substitution Ratio Simulation Models*

In this section we attempt to estimate the unknown temporal path of FCC in Croatia by estimating a currency substitution ratio model for Argentina. Once we

have found a satisfactory model for Argentina, we use the parameters of the model to simulate the time path of the unknown amount of FCC held in Croatia. Argentina was chosen for this initial simulation effort because its history of hyperinflation followed by periods of stabilization is similar to that of Croatia. It is also a country about which we have obtained reliable estimates of the actual extent of dollarization based on the CMIR data. Unlike transition countries, data for Argentina span a period of two decades. Moreover, both countries also hold a surprisingly large fraction of broad money deposits in the form of foreign currency deposits. At the end of 1998, the FCD/broad money ratio was .697 for Argentina and .692 for Croatia.

Our first effort to model the currency substitution phenomenon employs a simple partial adjustment model[19] applied to the logarithmically transformed dollarization index LUDI so that the fitted dependent variables fall within the interval between 0 and 1.[20]

(12) LUDI = -Ln(1-UDI/UDI)

The explanatory variables of the dollarization process are those typically employed to explain the demand for money in situations where foreign currency and foreign currency deposits are available substitutes for domestic money. In particular, we employ as regressors the lagged value of the dependent variable, the expected depreciation of the exchange rate (dlex), a banking crisis variable (crisis)[21] and a ratchet variable (Ratchet) to capture the persistence effects that have been observed in dollarized countries (Kamin and Ericsson, 1993) when network externalities produce incentives for the continued use of a foreign currency even after inflation or exchange depreciation effects have moderated. Specifically, the equation estimated for Argentina and subsequently used to simulate the quantity of FCC in circulation in Croatia is:

(13) LUDI = c(1) + c(2)*LUDI(-1) + c(3)*dlex(+1) + c(4)*ratchet + c(5)*crisis

[19] At a later stage in the research we may attempt to employ an error correction model with cointergration procedures but the partial adjustment model was chosen as a first approximation because of its simplicity, and the ease of interpreting the results.
[20] A similar transformation is employed by Mongardini and Mueller (1999).
[21] Andy Berg of the IMF generously provided the bank crisis variable.

The ratchet variable takes the form of the highest previously attained rate of depreciation of the exchange rate.[22]

**Table 7**

**Regression Results –Argentina -1979-1998**

| | LUDI |
|---|---|
| const | -0.5839<br>(-4.1018) |
| LUDI(-1) | 0.81197<br>(19.0302) |
| dlex(+1) | 0.13781<br>(2.23524) |
| Ratchet | 0.25687<br>(4.0945) |
| Crisis | 1.67477<br>(4.56825) |
| R-squared | 0.97744 |
| Adjusted R-squared | 0.97624 |
| Durbin-Watson stat | 2.51075 |

*t- statistics are reported in parentheses.

The results of the OLS estimate obtained for Argentina are reported in Table 7. All of the coefficients have the expected signs and all are significant at the 5% level. Table 8 presents the corresponding long run estimate of the key coefficients of the model presented above.

**Table 8**

**Estimated Long Run Coefficients**

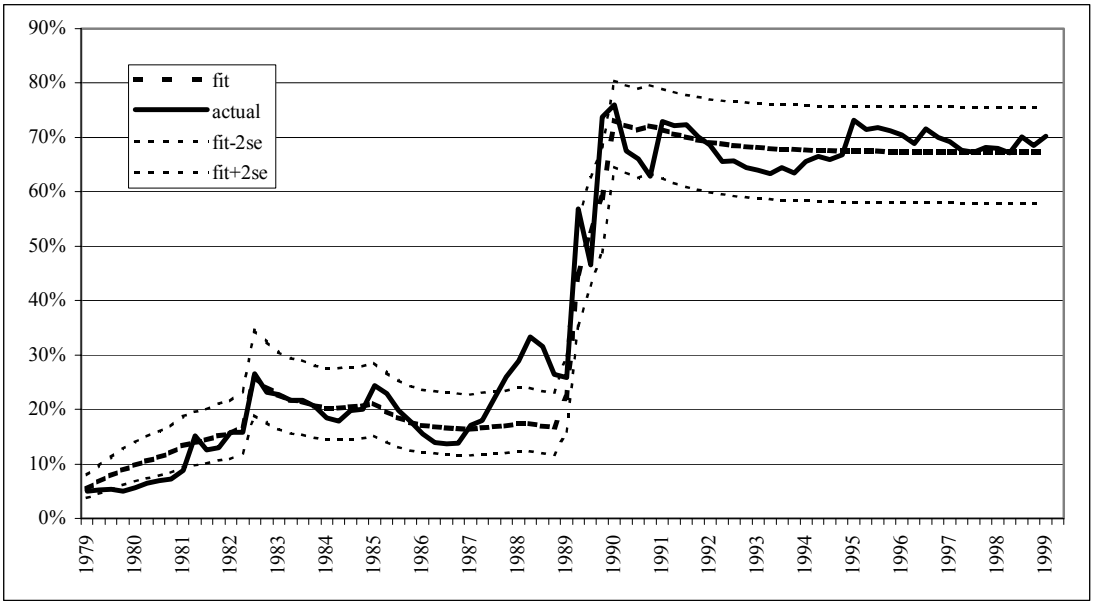
| Dependent Variable | LUDI |
|---|---|
| dlex(+1) | 0.73 |
| Ratchet | 1.37 |
| Crisis | 8.91 |

Figure 5 displays the actual and simulated values of UDI ratio for Argentina for the period 1978 – 1999 based on the estimated equation presented in Table 7.

**Figure 5**

[22] A number of ratchet variables were tested including the past peak inflation rate, depreciation rate and currency substitution index. All were highly significant and the past peak depreciation rate was chosen to simplify the simulation.

**Actual and Simulated UDI for the Argentina**

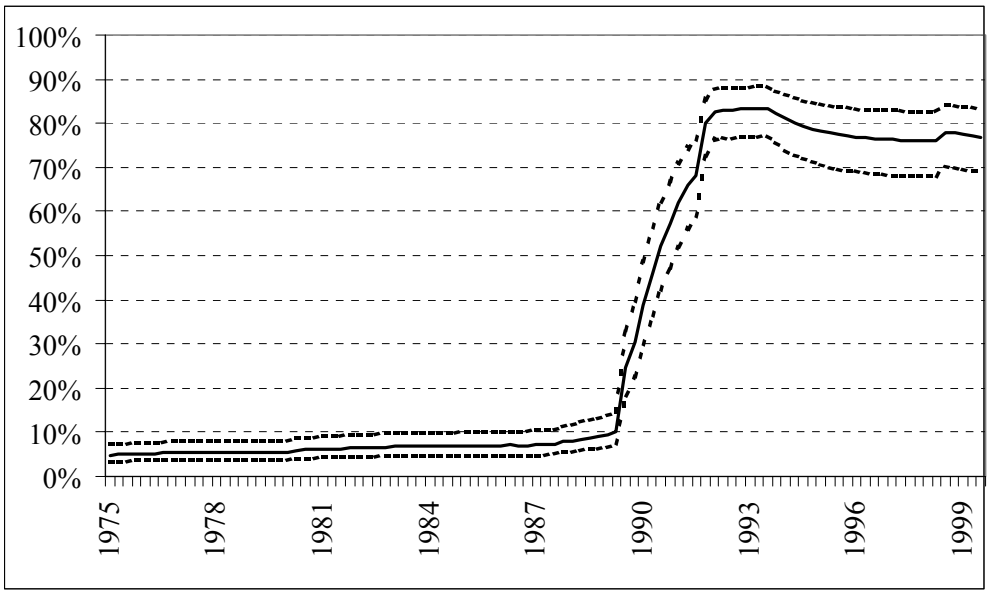



Figures 5 reveals that dollarization in Argentina began in the early 1980's and then accelerated dramatically during the period 1989-1990 as a result of a severe hyperinflation. Despite subsequent successful stabilization efforts, the unofficial dollarization index remained stubbornly around 70%.

Figure 6 presents the estimated values of the unofficial dollarization index ($\hat{UDI}$) simulated for Croatia on the basis of the equations for these variables estimated for Argentina. The overall pattern of the dollarization process simulated for Croatia appears to be very similar to that of Argentina. Both countries experienced hyperinflation episodes in late 80's during and after which the economies became increasingly dollarized. The estimates suggest that the extent of dollarization was so extensive as to make the process virtually irreversible. The Croatian simulation suggests that most of the dollarization of the economy took place before the period of Croatia's attainment of monetary sovereignty. This seems consistent with the denomination displacement method findings for Croatia.

**Figure 6**

**Simulated Unofficial Dollarization Ratios for Croatia**




Our basic aim is to employ the estimates of the Croatian unofficial dollarization index ($\hat{UDI}$) to obtain an estimate of the unknown amount of FCC in Croatia, which is believed to be held in the form of D Marks. Given an estimate of the dollarization ratio, we can derive the corresponding estimate of $\hat{FCC}_{UDI}$ as a function of the actual amounts of *M2* and *FCD* observed in Croatia:

$$\hat{FCC}_{UDI} = (\hat{UDI} * M2 - FCD)/(1 - \hat{UDI})$$

**Figure 7**

**Simulated Dollar Value of FCC in Croatia**

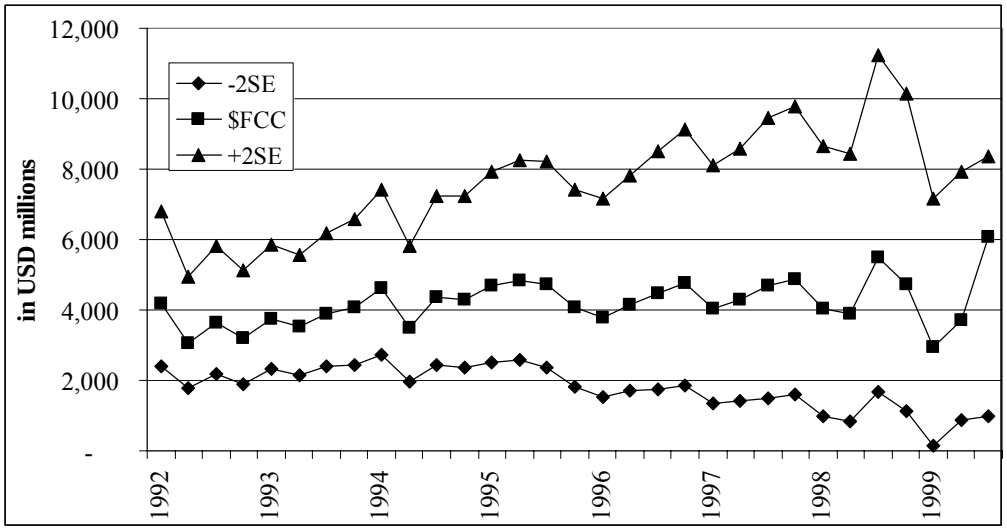


Figure 8 displays the estimated per capita dollar values of FCC holdings for the period 1992-1999 obtained by the UDI simulation approach as well as the estimate obtained by the denomination displacement method. As revealed by Figure 8, the estimated level of FCC obtained from the UDI simulation is significantly higher than the estimates obtained by the denomination displacement approach.

**Figure 8**

**Estimated FCC per Capita in Croatia**

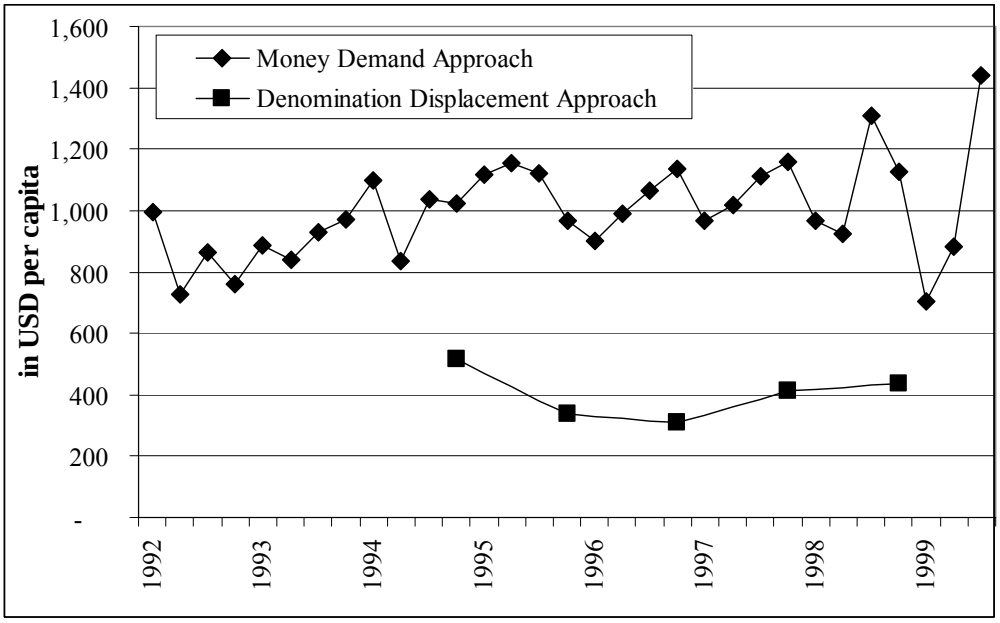



Table 9 presents the estimates of the dollar value of FCC in Croatia for the period 1991:4-1999:2 and shows the percentage of the total currency supply estimated to be held in the form of foreign currency.

**Table 9**

**Estimated Values of FCC and CSI in Croatia - 1991:1999**

| Date | | Per Capita FCC | CSI |
|---|---|---|---|
| Year | Quarter | Dollars | Percent |
| 1991 | Q4 | 993 | 95.1 |
| 1992 | Q1 | 727 | 95.2 |
| 1992 | Q2 | 865 | 95.4 |
| 1992 | Q3 | 760 | 95.2 |
| 1992 | Q4 | 888 | 97.5 |
| 1993 | Q1 | 839 | 97.4 |
| 1993 | Q2 | 930 | 97.6 |
| 1993 | Q3 | 973 | 95.3 |
| 1993 | Q4 | 1096 | 95.0 |

| | | | |
|---|---|---|---|
| 1994 | Q1 | 833 | 92.7 |
| 1994 | Q2 | 1036 | 92.2 |
| 1994 | Q3 | 1024 | 90.3 |
| 1994 | Q4 | 1114 | 90.4 |
| 1995 | Q1 | 1156 | 89.4 |
| 1995 | Q2 | 1123 | 88.8 |
| 1995 | Q3 | 966 | 86.8 |
| 1995 | Q4 | 900 | 86.6 |
| 1996 | Q1 | 990 | 86.7 |
| 1996 | Q2 | 1063 | 86.4 |
| 1996 | Q3 | 1136 | 86.1 |
| 1996 | Q4 | 965 | 84.5 |
| 1997 | Q1 | 1020 | 84.6 |
| 1997 | Q2 | 1114 | 85.1 |
| 1997 | Q3 | 1159 | 85.5 |
| 1997 | Q4 | 965 | 84.4 |
| 1998 | Q1 | 922 | 83.3 |
| 1998 | Q2 | 1308 | 86.2 |
| 1998 | Q3 | 1128 | 84.1 |
| 1998 | Q4 | 703 | 81.0 |
| 1999 | Q1 | 884 | 83.3 |
| 1999 | Q2 | 1442 | 89.0 |

Table 9 reveals that the estimated per capita holdings and the percentage of the currency supply held in the form of FCC seem to be unusually high. The estimated fraction of currency held in the form of FCC in Croatia is roughly 10-15% higher than the corresponding ratio for Argentina. In the immediate aftermath of the worst hyperinflation in Argentina, the FCC to total currency ratio reached a maximum of 89% and subsequently decline to a range of 76-80%. Most transactions in Argentina are now quoted in US dollars and dollars themselves openly circulate for even common purchases. This is not the case in Croatia where common purchases are quoted and conducted in Kuna and only large transactions are actually effected in DM. We therefore suspect that either the FCC estimate is overstated, or else, that the large estimated FCC holdings serve largely as a store of value rather than a medium of exchange.

Dollarization developments in Croatia and Argentina do not necessarily represent a universal pattern, however, it is likely that when currency substitution occurs on a large scale, network externalities in the use of currency (Feige et al, 2001) take hold and it becomes ever more costly to switch back to local currency even if expected inflation and exchange rate depreciation is brought under control. Proper measurement of FCC is crucial for understanding the true nature of unofficial dollarization, as well as for a proper assessment of the likelihood of flight back to

local currency usage after stabilization. These predictions are crucial for policy makers' choice of the exchange rate regime: if unofficial dollarization becomes entrenched and irreversible after stabilization, it is ever more difficult to derive the often cited benefits from flexible exchange rates.

# III Concluding remarks

In an effort to overcome the 'unobservability' problem that has plagued the currency substitution literature, this paper presents direct estimates of the amounts of US dollar foreign currency in circulation in many countries. Traditional measures of dollarization employed in earlier literature largely relied on foreign currency deposits as an indicator of currency substitution because actual measures of foreign currency in circulation were unavailable. Employing aggregated data derived from Currency and Monetary Instrument reports on dollars inflows and outflows to and from the US, we estimate the amounts of US dollars in circulation in a sample of 26 countries. These new estimates of the location of US currency held overseas permit a refinement of definitions and indicators of currency and asset substitution as well as broader indices of the extent of unofficial dollarization. We find that traditional measures of dollarization are highly correlated with asset substitution but perform poorly as measures of currency substitution and unofficial dollarization in countries that extensively use US dollars as a co-circulating means of exchange.

A remaining obstacle for the understanding and measurement of currency substitution and unofficial dollarization is the absence of any direct estimates of non-dollar foreign currencies in circulation in many of the transition countries of Central and Eastern Europe. Many of the transition countries employ DM as a co-circulating medium of exchange and aggregate estimates suggest that between 30 and 69 percent of DM circulate outside the borders of Germany. Hence, DM cash in circulation in these countries must be estimated by indirect methods. We propose a denomination displacement method and a demand for foreign currency method to determine the unknown amounts of DM in circulation in transition countries. We illustrate both approaches by undertaking preliminary estimates of the amount of DM in circulation in Croatia.

Preliminary analysis suggests that this is a promising line of research, whose predictions could be tested during the upcoming experiment in the year 2002, when the Euro is set to replace the national currencies of European Union (EU) countries. What is required is the establishment of a centralized information tracking system that systematically records the magnitude of Euros exchanged for EU national currencies in transition countries. Since the introduction of the Euro currency within the EU is the responsibility of each EU country's central bank, the obvious candidate for the supervision of the information tracking system for non-EU countries is the European Central Bank, which bears ultimate responsibility for the formulation of monetary policy in the EU. If monetary policy is to be conducted effectively, a necessary condition is knowledge concerning the effective money supply in circulation within the EU, which in turn requires knowledge of the level and changes in the usage of Euros outside the EU boundaries. Similarly, monetary and fiscal policies as well as indicators of economic activity in transition countries require knowledge of the extent of unofficial 'euroization' in these countries.

The methods for determining the amounts of non-dollar co-circulating currencies developed in this paper can be used to obtain estimates of the amounts of Euros that may be required when 'dmarkization' becomes 'euroization'. Such estimates should help to facilitate a timely and smooth transition. If the transition is successfully monitored, and accurate information is systematically collected, researchers, policy makers and national accountants all stand to gain from this unique historical experiment.

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