

**CURRENCY COMPETITION IN THE DIGITAL AGE**

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## I. Introduction

A striking macroeconomic fact is the dramatic recent decline in world-wide inflation. What accounts for this new found discipline by central banks around the globe? I will argue that a major but largely overlooked factor is technological innovation in transactions and payments services. Such innovations have significantly reduced the costs of using an alternative means of payment if the local currency is depreciating in value rapidly. A quarter century ago, Hayek (1976 and 1978) argued that breaking the monopoly of issue by a central bank is necessary to protect against the inflationary excesses to which government central banks have succumbed throughout history. To achieve this end, Hayek argued for the abolition of legal tender laws and the elimination of government controls on monetary movements around the globe. I will argue that advances in transactions and payments technology have eroded the local monopoly of issue and resulted in greater discipline on central bank behavior. In addition, these advances have enhanced the feasibility of private sector provision of monetary services.

In the next section, I document the trends in world-wide inflation during the last 40 years. I then discuss alternative explanations for the recent reduction, including the rise of central bank independence, the role of fixed exchange rates as discipline devices, and various political and fiscal factors. I also explain in more detail the role of technology. This will then form the basis for a more speculative discussion of what the evolution of these transactions technologies imply for the feasibility of private provision of monetary services and the likely forms that such competition to central bank issue will take.

## II. The Rise and Decline of Inflation Around the World since 1960

Figure 1 presents the median annual rate of inflation for all of the countries in the IMF's International Financial Statistics database from 1960 to the present. The number of countries included ranges from a minimum of 68 in 1960 to a maximum of 159 in 1996. In all of the figures and tables, inflation is measured by the Consumer Price Index (CPI).<sup>1</sup> Figure 2 contains the median inflation rates broken down by various regions of the world.

Median world inflation begins its upward trend during the last years of the Bretton Woods system. In the early 1970s, median world inflation jumps as the Bretton Woods system collapses and the OPEC oil price shock hits. Median world inflation then rises again in the early 1980s and then drifts lower until the early 1990s when median world inflation begins to move up. The increase in the 1990s is driven by the entry of the countries of the former Soviet Union. As Figure 2 shows, the countries of Europe and Central Asia experience bouts of high inflation in the early 1990s.<sup>2</sup>

What is most striking in the data is the steady and sharp decline in inflation world-wide during the last five years to levels that have not been seen since the end of the Bretton Woods era. The 1999 world median annual inflation rate is 3 percent. This decline has occurred despite the tumultuous conditions in many parts of the world, from the Asia crisis in 1997 to the Russia crisis in 1998 to the devaluation in Brazil in 1999. In the past, financial and fiscal crises were often associated with episodes of high inflation. Clearly, this has not generally been the case as of late.

The lower panel of Figure 1 reports inflation rates by decile (that is, the line for "decile 9" represents the inflation rate for country with the top decile inflation rate in that year). Thus, even examining the experience of the top decile country with the worst inflation performance,

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<sup>1</sup> The patterns appear the same using GDP deflator as the measure of inflation.

<sup>2</sup> There is also a temporary spike in Sub-Saharan Africa with the end of the CFA-Franc area.

that country's annual inflation rate is now only 18 percent. The inflation performance of the top decile has not been this low since before the end of Bretton Woods.

This recent reduction in inflation stands in sharp contrast to the overall abysmal inflation experience world-wide in the post-Bretton Woods era. Table 1 reports the change in the CPI and the extent of the decline in purchasing power of each national currency from 1972 to 1999. Not a single currency has maintained even half of its purchasing power over the period. As the pie chart in Figure 3 shows, more than half of the countries have experienced a reduction in purchasing power of more than 90 percent (that is, the price level is more than 10 times higher today than it was at the end of 1972).<sup>3</sup> I now turn to consider alternative explanation for why inflation performance in the most recent period has improved so much relative to the period from the early 1970s to the early 1990s.

### **III. Alternative Explanations for the Recent Decline in World Inflation**

#### *A. Central Bank Independence*

A popular remedy for poor central bank performance is to increase the independence of the central bank from the rest of the government (e.g., Alesina and Summers 1988). In principle, such a separation reduces the political pressures that a central bank has to monetize government debt or to try to manipulate the economic performance for political purposes as, for example, prior to an election. Greater independence also may increase the credibility of a central bank with the public. Enhanced inflation-fighting credibility then mitigates the "time consistency" problem that can result in high inflation even though neither the public nor the central bank prefers such an outcome (e.g., Barro and Gordon 1983).

The consistent inverse correlation between various measures of central bank independence and inflation have led to policy recommendations in favor of greater central bank

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<sup>3</sup> For more details on currency debasement in the post-WWII era, see Mas (1995).

independence (e.g., Alesina and Summers 1988). These recommendations have led to greater independence in practice during the last decade. The European Union, for example, required independence in order to be eligible to join the Euro, and the central banks in Europe became more independent of the governments. The Bundesbank, which was one of the highest ranked in terms of independence, is the model for the European Central Bank (ECB), and this structure was consciously chosen to enhance credibility. The World Bank and IMF also have urged emerging and transition economies to adopt independent central banks, and many have done so.

While the recent trend towards greater independence of central banks is correlated with the improved inflation performance around the world, I believe that central bank independence can provide no more than a partial explanation. First, for central bank independence to lead to lower inflation, the independent central banker must have a preference for lower inflation. This proposition may be a reasonable approximation for the central bankers who have been appointed in OECD countries in recent years, but it cannot be assumed for emerging and transition economies. In Russia, for example, the central bank and its employees enjoyed a direct benefit from inflation because it was able to keep some of the profits from high inflation for its management and staff (Shleifer and Treisman 2000). During part of the 1990s, the independence of the Russian central bank from political control was an obstacle to inflation control. In other countries, “independent” central bankers may effectively represent particular constituencies that prefer high to low inflation.

Second, the inverse correlation between independence and inflation does not necessarily imply causation. Posen (1995a), for example, has argued that the costs of disinflation are no lower and disinflation occurs no faster when central banks have high independence rankings. Posen also finds that a government’s seigniorage revenue does not decline with central bank independence. These results suggest that the independence of the central bank may be the result

of a coalition of anti-inflation interests or a deeper political consensus against inflation rather than an separate anti-inflation force (e.g., Posen 1995b).<sup>4</sup>

Third, central bank independence is a fragile and difficult to define concept. At the Bundesbank, for example, the Finance Minister was an ex officio member of the committee that set monetary policy, in sharp contrast to the US, but the Bundesbank was typically ranked among the most independent central banks. A simple vote in the German parliament could have altered the Bundesbank's structure. In addition, with the reunification of German, it was German parliament, over the strenuous objection of the Bundesbank, that determined that the conversion of the Ostmark into Deutschmark would take place at one to one. Since the market rate of the Ostmark was substantially below one-to-one, the government effectively forced the Bundesbank to engage in a large increase in the money supply. It might be very difficult to create an index of central bank independence that is not at least somewhat affected by the historical inflation performance of the central banks.

#### *B. Fixed Exchange Rates as a Disciplinary Device*

Following WWII, a consensus developed that a fixed exchange rate regime such as Bretton Woods would provide an effective way to discipline the central bank and check inflation. Bretton Woods broke down in the early 1970s precisely because central banks (in particular, the Fed) was pursuing faster money growth than was consistent with Bretton Woods parities. As Figure 1 shows, world-wide inflation was increasing during the 1960s but takes off sharply after the end of Bretton Woods in 1973. The lesson that some economists and policy makers have drawn from this is that some form of exchange rate peg can provide an effective means of reigning in domestic inflation forces.<sup>5</sup>

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<sup>4</sup> Actual experience with high inflation makes voters aware of the its costs in a way that no arguments from an economist can. The experience can provide information to voters so that citizens (hence, the median voter) put a more negative weight on inflation.

<sup>5</sup> In recent years, IMF does not seem to be of a single mind on this issue since it encourages maintenance of exchange rate pegs in some situations but floating rates in others.

In some circumstances, some form of pegging has been effective. The currency boards of Hong Kong, Argentina, and Estonia, for example, have been effective means of reducing inflation. The recent trend toward lower inflation, however, has been accompanied by less reliance on fixed or pegged regimes around the world, as Figure 4 shows. In addition, in recent years the end of exchange rate pegs has generally not led to significantly higher sustained inflation after the devaluation.

Consider the case of the Brazilian devaluation in early 1999. Given Brazil's history of hyperinflation and the important role that many believed the pegging to the dollar had in bringing inflation down in the mid-1990s (see Figure 5), there had been much concern about high inflation following the devaluation and floating of the currency. As the lower panel of Figure 5 shows, however, Brazil's inflation performance is little different after the devaluation than in the years following the peg in 1994. There has been no sign of a return to the hyperinflations of the late 1980s and early 1990s.

Russia provides a similar example. After experiencing extremely high inflation in the early 1990s, Russia was able to stabilize the value of the ruble and pegged ruble to the dollar. The peg was seen as an important commitment device that helped to achieve low inflation through 1996 and 1997 (see Figure 6). A series of adverse shocks and fiscal problems during 1998 caused a serious deterioration of Russia's economic conditions, setting the stage for a crisis. At the height of the Russia crisis in August 1998, Russia stops payment on some of its debt and ends the peg of the ruble to the dollar. The ruble then falls by nearly 70 percent against the dollar. As Figure 6 shows, however, the devaluation led to an initial sharp increase in the price level (as imports became more expensive in local terms) but not to sustained inflation. Subsequent inflation performance has been similar to the low inflation years during the peg. The examples of Brazil and Russia illustrate that within the last few years, moving from a pegged to a floating exchange rate even during a financial "crisis" period need not result in poorer inflation performance. Other forces, besides the discipline of an exchange rate peg, are keeping central bank from pursuing high inflation policies.

### *C. Reduction in Transactions Costs and Currency Competition*

A generally overlooked explanation for the recent decline in world-wide inflation is an effective erosion of the local central bank monopoly on the provision of monetary services. During the last decade, advances in electronic payments technologies and the widespread availability of alternative instruments for hand-to-hand transactions now permit competition among currencies and means of payment.<sup>6</sup> Dramatic reductions in the costs and increases in the reliability of information gathering, processing, and dissemination in the financial markets have made feasible the bypassing of locally issued money for undertaking both small and large transactions. A combination of the internet, credit card networks, reduced telecommunication costs, and greater security and reliability of electronic transactions now make holding assets and transacting in US dollars, for example, available to a much larger number of foreign individuals and businesses than was the case a decade ago. While I do not want to claim that these are the only forces putting greater discipline on central banks, I do believe that the increased competition through technological advances play a significant role and its importance is likely to be growing in the future.<sup>7</sup>

When there are few low-cost alternatives to central bank money for undertaking transactions in an economy, the government can raise more revenue through seigniorage or the inflation tax on real balances than when feasible alternatives exist. As technological innovation reduces the costs of switching away from the national money for transactions, the ability of the government to gather seigniorage falls. At low levels of inflation, people and businesses may tolerate a small “tax” on using the local currency. With improved transactions technology and the

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<sup>6</sup> Note that in Weimar Germany during the hyperinflation, many alternative currencies circulated but they did not exercise an important disciplinary force on the Reichsbank. Thus, the availability of currencies for hand-to-hand transactions does not by itself appear to be sufficient to keep a central bank in check.

<sup>7</sup> An unsigned essay on “Governments and Money” in the 1995 Annual Report of the Federal Reserve Bank of Cleveland does anticipate some of the themes on currency competition I develop here. I thank David Altig for alerting me to this reference.

availability of, for example, physical dollars for smaller transactions, the demand for the local currency becomes much more sensitive to the inflation rate. This greater elasticity of demand due to technological innovation reduces the amount of revenue that the government can raise for a given level of inflation. Inflation thus becomes a much less efficient means of raising revenue for the government. The government thus has a reduced incentive to try to tax through inflation than through other means. Seigniorage revenues thus would decline more sharply with inflation, again undercutting the incentive for high inflations.

Increased monetary competition can help to solve the puzzles posed above for why Brazil and Russia did not experience high inflation following the ends of their exchange rate pegs in 1998 and 1999. In the mid-1990s, Brazilian banks developed an advanced electronic payments network that permits businesses and individuals with bank accounts to move their funds into dollar denominated or dollar-indexed funds. This technology did not exist in the late 1980s and early 1990s when Brazilian inflation was out of control. Similarly, a reliable electronic payments network with international linkages was not available to most individuals and enterprises in the early years of the new Russia but had developed by the late 1990s.

Also, in both countries, the availability of US dollars (and Deutschmarks in the former Soviet states) for hand-to-hand transactions increased rapidly during the decade so that by the late 1990s, low cost alternatives to using the local currency was readily available. The demand for such foreign currency holding is a legacy of the previous bouts of inflation and shows that the national currency did not regain its effective monopoly after inflation came down for a few years. The spike in inflation in Russia, for example, is short-lived at least in part because feasible alternative transactions media were at hand. The next section describes the sharp world-wide increase in the international holding of US dollars and Deutschmarks during the 1990s.

### 1. Rapid Growth of International Currency Holdings of Dollars and Deutschmarks

One aspect of the growing competition of currencies is that economic actors have access to some alternative money in which to undertake their transactions. Recent studies suggest that

the availability of relatively stable currencies, such as the US dollar and Deutschmark, outside of their domestic markets is large and has been increasing (e.g., Doyle 2000). Compared with most other countries, both the US and Germany have very high levels of currency per capita, if the denominator is taken to be the domestic population. Table 2 compares the total amount of currency outstanding and currency per capita for a number of countries. For the US, currency in circulation is roughly \$1,750 per capita and it is roughly \$2,000 per capita for Germany.

These extremely high apparent levels of cash holdings, as well as the obvious availability of USD and DM in other countries, have led economists to attempt to try to calculate how much of these currencies are abroad.<sup>8</sup> Porter and Judson (1996), for example, estimate that 50 percent to 70 percent of the stock of US currency is outside of the US. Using direct data on currency shipments out of the country, Feige (1996) estimates that 40 percent of US currency is abroad. For Germany, the proportion of Deutschmarks abroad are estimated to be from 40 percent (Seitz 1995) to 70 percent (Doyle 2000).

Given the large size of the currency stocks of the US and Germany, these estimates imply that a significant degree of competition within countries exists between the USD and DM and domestic currencies around the world. To argue that such competition is a factor in the recent decline in inflation rates, however, requires evidence that this competition has been increasing. While most of the estimates discussed above are averages for recent time periods, Doyle (2000) examines currency substitution from the 1960s to the 1990s. He finds that currency substitution in the form of cash has tripled during the 1990s in constant dollar terms. Figure 7 illustrates the sharp increase in dollars estimated to be held outside the US during the 1990s. The total amount of US and German currency held by foreigners in 1996 is roughly \$220 billion in 1990 dollars.<sup>9</sup>

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<sup>8</sup> When US households and businesses are asked about their currencies holdings, the numbers they report in the surveys imply that only between 8 percent and 18 percent of this amount is in their hands (see Doyle 2000).

<sup>9</sup> Doyle (2000) also calculates the amount of Swiss currency held by foreigners to be roughly \$21 billion in 1990 dollars.

As Figure 8 shows, from the 1960s until the early 1970s, the fraction of the USD and DM currency stocks held by foreigners drifts downward. In the late 1970s and early 1980s, this number moves up sharply as inflation picks up in Latin America. Foreign currency holdings then jump up again beginning in the late 1980s and early 1990s and continue to rise sharply through the 1990s. This coincides with the high inflations in Latin America and the former Soviet bloc.

Doyle (2000) also has some suggestive information concerning who is using this money. Doyle (2000) find evidence of relatively large seasonal components in the demand for foreign holdings. Since drug smuggling and other illegal activities are unlikely to have strong seasonals, the results suggest that households and businesses in foreign countries are key players in the demand for the currencies.

A notable feature of the estimates is that the foreign holdings of these currencies does not appear to fall after inflation rates are reduced. Figure 8 shows only a slight dip in fraction of foreign holdings during the mid to late 1980s and then foreign holdings continue to climb sharply through the 1990s, even as domestic inflation rates begin to fall. This suggests that the domestic currencies, even after domestic inflation comes down, do not regain anything close to their previous market share in use in domestic transactions. The persistence in the use of the foreign currencies or “hysteresis” seems to be particularly important during the last decade, as foreign currency holdings remain at high levels despite the recent reduction in domestic inflation rates. The national central banks are unlikely to ever regain their monopoly position.

#### **IV. Challenges to Central Banks from Private Sector following Improvements in Transactions Technology**

The discussion of currency competition above focused primarily upon competition among different government fiat monies and the beneficial effect of this increase in competition on central bank behavior. In this section, I would like to speculate on how the same forces of technological innovation in payments and transactions services increase the feasibility of private sector competition to government fiat money.

## A. Concerns about the Feasibility of Currency Competition and the Role of Transactions

### Costs

A number of questions have been raised about the feasibility of full-fledged currency competition (see, e.g., Issing 2000). One concern arises from the currency substitution literature that multiple competing monies in one economy could lead to an explosion of velocity and instability in or indeterminacy of money demand (see Girton and Roper 1981 and overview by Giovannini and Tutelboom 1994). If my argument above is correct that increased competition among fiat monies has led to greater price level stability, however, this concern does not appear to have much empirical relevance. It is unclear why private parallel fiat monies would pose any more problems for the stability of money demand than parallel government fiat currencies (if private provision of monetary services takes the form of “unbacked” issues -- see below for alternatives).

Gresham’s Law that “bad money will drive out good” is another concern that has been raised about private currency competition. Would market competition in money simply lead to a race to the bottom? Hayek (1978, pp. 38-39) argued that the competitive process would work result in a race to the top:

...Gresham’s law will apply *only* to difference kinds of money between which a fixed rate of exchange is enforced by *law*. If the law makes two kinds of money perfect substitutes for the payment of debts and forces creditors to accept a coin of a smaller content of gold in the place of one with a larger content, debtors will, of course, pay only in the former and find profitable use for the substance of the latter.

With variable exchange rates, however, the inferior quality money would be valued at a lower rate and, particularly if it threatened to fall further in value, people would try to get rid of it as quickly as possible. The selection process would go on towards whatever they regarded as the best sort of money among those issued by the various agencies, and it would rapidly drive out money found to be inconvenient or worthless. [*italics in original*]

Transaction costs and convenience, which Hayek mentions in the last sentence, is fundamental to how the competition will operate. As Rolnick and Weber (1986) have

emphasized, it is quite rare to have enforced in practice a non-market fixed rate of exchange between currencies. “Black” and “gray” markets develop. Historically, both “good” and “bad” monies have tended to circulate simultaneously, and it was quite unusual for one completely to drive out the other. Economic agents would attempt to price the gold or silver content relative to par, e.g., a silver dollar would be worth 104.2 cents in gold and a silver nickel would then be worth 5.21 cents in gold. If there is a fixed transactions cost involved in non-par pricing of the coins (that is, the cost is independent of the denomination), then traders may not be willing to pay the premium on the silver nickel but would do so on the silver dollar. If that is the case, the silver dollar will continue to circulate along with gold coins but the silver nickel will not. A corrected version of Gresham’s Law can be based on a fixed transactions cost rather than a fixed rate of exchange: “Bad money drives good money out of circulation only when the costs of using the good money at a premium are significant” (Rolnick and Weber 1986, p. 198).

Advances in transactions technologies and increases in the liquidity of markets have been dramatically reducing the costs of pricing a wide variety of potential payments media. As I discuss below, the reduction in the costs of monitoring the value of privately issued instruments and the costs of converting from one instrument to another play an important role in determining the feasibility and form of private sector competition in money.

## **B. Alternative Approaches to Currency Competition and “Free Banking”**

Alternative approaches to currency competition can be put into three broad categories that correspond to three models of so-called free banking (Selgin and White 1994; Hayek 1978; and Cowen and Kroszner 1994). The key aspect in each of these approaches is that government involvement in the money and payments system would be dramatically reduced or eliminated and the role of private producers of monetary services be greatly enhanced. At the core of each approach is the ability of private banks, firms, or individuals to issue instruments that will be used as means of payments (media of exchange). Monetary policy, to the extent that such a concept is operative when monetary issues are decentralized, would then largely be in the hands of the

private sector. I will provide only an extremely compact summary here, with special attention to how the role of technology affects the feasibility of the alternative approaches.<sup>10</sup>

In the first scenario, the economy has a common medium of settlement, that is, all monetary instruments are ultimately redeemable in a single base (or “outside”) money at a fixed rate. The base money also serves as the common unit of account in the economy. Gold, silver or other commodities could serve as the base money. Selgin (1988) has even proposed freezing the total quantity of government-issued fiat money at a particular point in time and then using that as the medium of settlement in a free-banking economy. Private firms then issue notes that are redeemable in and denominated in the base money. Historical episodes of so-called “free banking” such as that in eighteenth and nineteenth century Scotland generally operated in this manner (e.g., Cowen and Kroszner 1989, 1992 and White 1984). Periodic clearing of balancing among issuers and the right of redemption were the keys to preventing excess private note issuance.

A second approach involves private firms issuing competing base monies. This is the scenario that Hayek (1978) proposed. Firms would in effect be issuing private fiat monies because their issues would not be redeemable. The issuers would make commitments either to limit the quantity of issue or to maintain the purchasing power in terms of some index. Hayek appeared to have in mind that there would be a common unit of account. Reputation of the issuers and monitoring of the quantity issued by the market would be the key factors in making this competition feasible.<sup>11</sup> As illustrated with the quotation in the previous section, Hayek argued that people would not hold unstable and depreciating monies so that competition would generate monetary stability.

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<sup>10</sup> For book-length treatments, see book-length treatments, e.g., White (1984), Selgin (1988), and Cowen and Kroszner (1994). Also, Friedman and Macintosh (2000) provide an analysis of how technological innovation undercuts traditional objections to “free banking.”

<sup>11</sup> In principle, there should not be greater acceptability problems for alternative monies than alternative credit cards: some establishments accept cash only or Visa and Mastercard but not Amex or Discover or Diner’s Club or charge a fee to use one or the other.

While improvements in monitoring technology and reductions in the transactions costs of using alternative media are important to improving the chance for successful operation of private monetary competition in the first two scenarios, the third relies more heavily on technological advances for its feasibility. This scenario involves a more fundamental change in how the monetary system would operate because there would be a separation of the medium of exchange from the unit of account. This approach can be characterized as developing from the “legal restrictions theory of money” and the “new monetary economics” and involving “sophisticated barter” (see Hall 1982, Greenfield and Yeager 1983, Wallace 1983, and Cowen and Kroszner 1994).

In such a sophisticated barter system, the media of exchange are explicit and continuously priced. Marketable financial assets serve as media of exchange and can offer dividends and interest, as well as capital gains and losses. Electronic information and transfer systems might be used to price these media conveniently and at low cost and crediting or debiting of accounts can take place at prevailing “exchange rates” among the various media. Issuers of financial assets have an incentive to increase the liquidity and marketability of their instruments so to enhance their demand as media of exchange. Individuals and firms can choose to hold whatever assets best satisfy their risk-return preferences, and they do not have to forgo a return on the assets they use as exchange media. The desire for obtaining pecuniary returns can motivate the displacement of non-return-bearing money as we know it in a deregulated environment. Physical forms of exchange media could eventually disappear as transactions technology improves.<sup>12</sup>

The distinction between money and other highly liquid assets becomes increasingly difficult to draw. Financial intermediaries might evolve away from traditional depository institutions towards institutions that more closely resemble mutual funds (Cowen and Kroszner 1990). Other intermediaries would engage in lending that we traditionally associate with banks,

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<sup>12</sup> If there is a desire for anonymity or distrust of the electronic network, bearer bonds could provide the media for such exchanges.

much as finance companies do today, and then repackage and securitize their assets and sell them to the market.<sup>13</sup> If the banking intermediaries are effectively mutual funds holding liquid assets, then the problem of a bank “run” would be minimized since the value of the deposit shares issued by the institution would be continuously priced based upon the value of the assets in the portfolio.

The explicit pricing of exchange media could even occur in terms of multiple units of account. To the extent that the transactions and information technology allows low cost pricing -- of groceries to bonds, multiple units of account can arise within an economy.<sup>14</sup> Wireless devices can report prices in any unit at low cost in retail outlets using “digital price tags.” “Currency-transparent” browsers can read prices off of a seller’s webpage in one unit, convert the prices to the units desired by the buy using a conversion rate from the seller’s financial institution, and display them for the buyer in her preferred unit (see Friedman and Macintosh 2000). While any discussion of how payments and pricing systems of the future may evolve, this discussion highlights the importance of technology for affecting the costs and hence feasibility of transacting using alternatives to central bank money.

## **V. Summary and Conclusions**

As an explanation for the recent decline in inflation rates around the globe, I have emphasized the role of increased currency competition. This enhanced competition has been made feasible and effective, I argue, due to innovations in payments technology and information processing and dissemination. Greater international competition among monies has put discipline on the behavior of national central banks since attempting to raise revenue through seigniorage is less effective and more costly than it once was. Even countries with notorious recent histories of

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<sup>13</sup> This raises the question of whether the liquidity supply function associated with traditional banking could be supplied through these other intermediaries. See Kashyap, Rajan, Stein (2000) on the role of traditional banks as liquidity providers.

<sup>14</sup> In Chile, for example, there is an “indexed” unit of account -- “UF” -- which is calculated daily and reported in the newspapers in addition to the peso. Many long-term contracts are denominated in UFs.

high inflation, such as Brazil and Russia, have kept inflation in check even after breaking their pegs to the US dollar.

I then consider what implications the payments innovations and increased competition among government fiat monies have for future competition from the private sector in the provision of monetary services. Technological advances would appear to be making competition from the private sector increasingly feasible. Not only are national central banks eroding their local monopolies by competition from other central banks but also from the private sector.<sup>15</sup> How payments technologies evolve will play a key role in determining what forms of private monetary competition will be likely to develop and the challenges that central banks will be facing in the future.

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<sup>15</sup> I have not considered here the political economy of these changes and what likely response will be. This is an important topic but beyond the scope of this paper. (One speculation would be that the reduction in feasible seigniorage revenue from central bank activities that has already occurred and cannot be legislated away might reduce the ability of central bankers to convince legislators to help them to maintain their monopolies.)

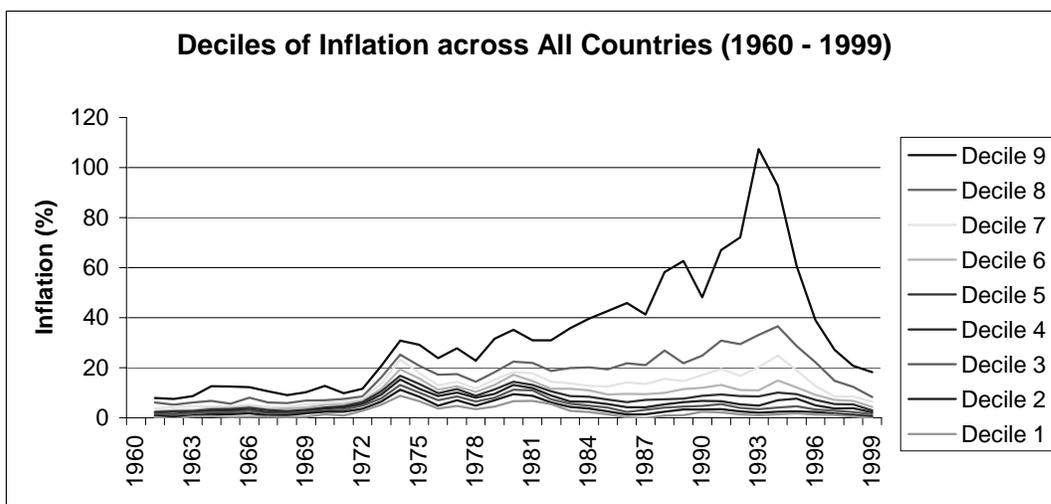
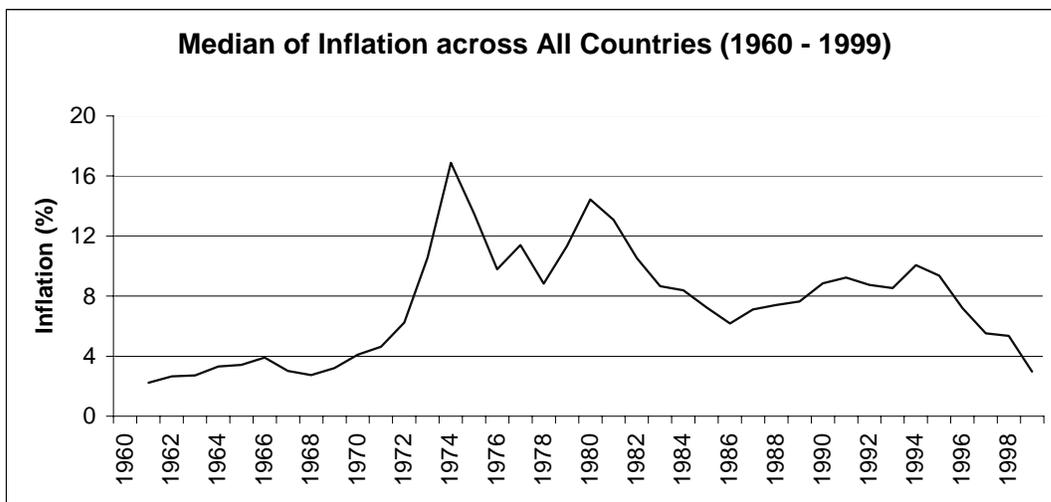
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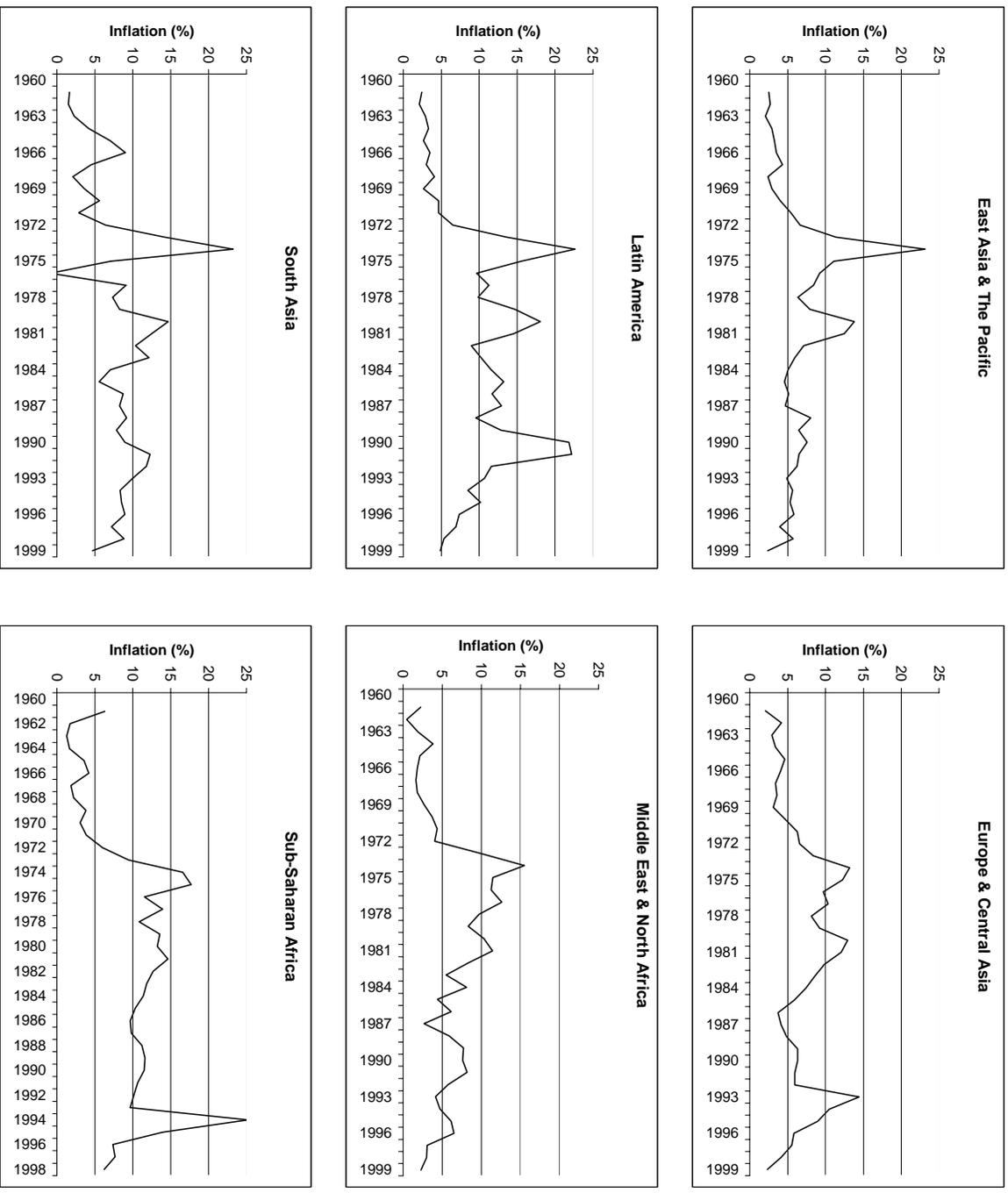
**Figure 1: Median and Deciles of Inflation across All Countries (1960 - 1999)**



*Note* The number of countries ranges from 68 to 159. Inflation is defined as a change in the consumer price index.

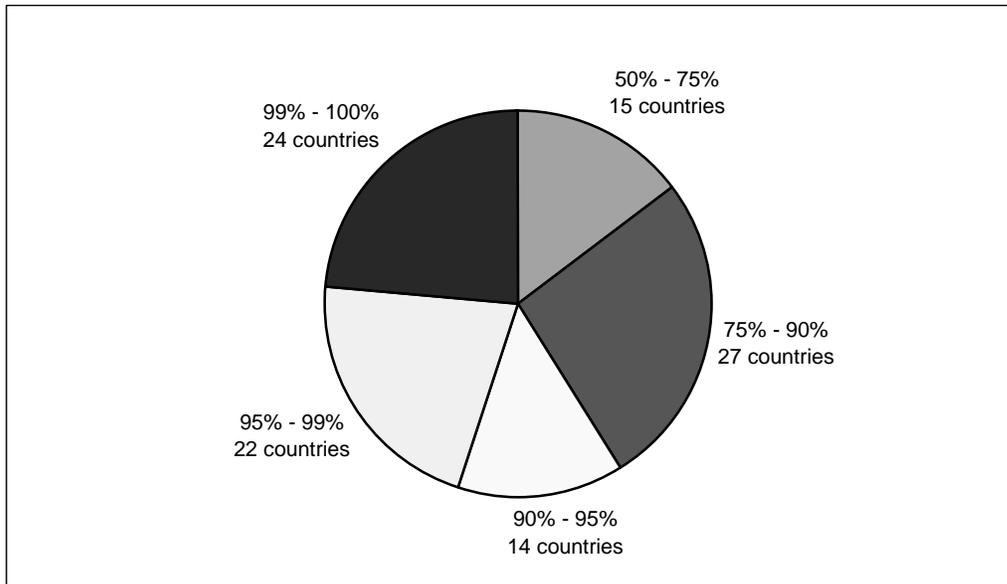
*Source* International Financial Statistics

**Figure 2: Medians of Inflation Categorized by Region (1960 - 1999)**



Note: The number of countries ranges from 68 to 159. Inflation is defined as a change in the consumer price index.  
Source: International Financial Statistics

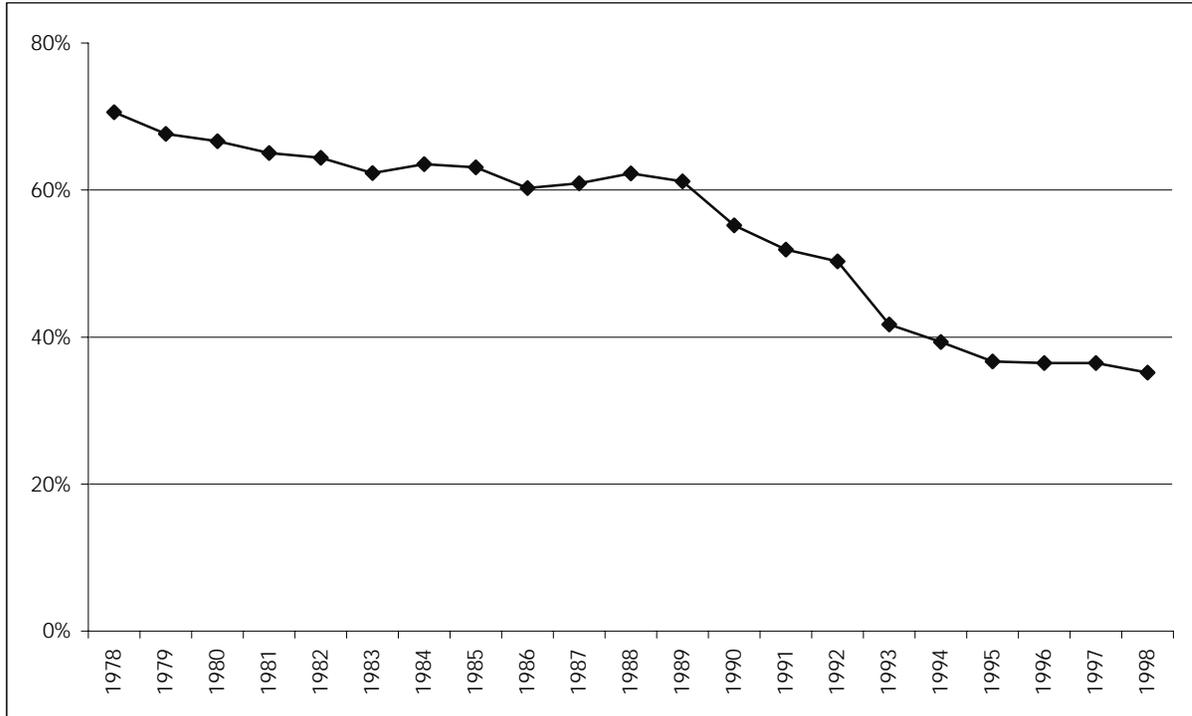
**Figure 3: Countries Categorized by the Extent of the Decline in the Purchasing Power of their Currency from 1972 to 1999**



*Note* The total number of countries is 102.

*Source* Table 1

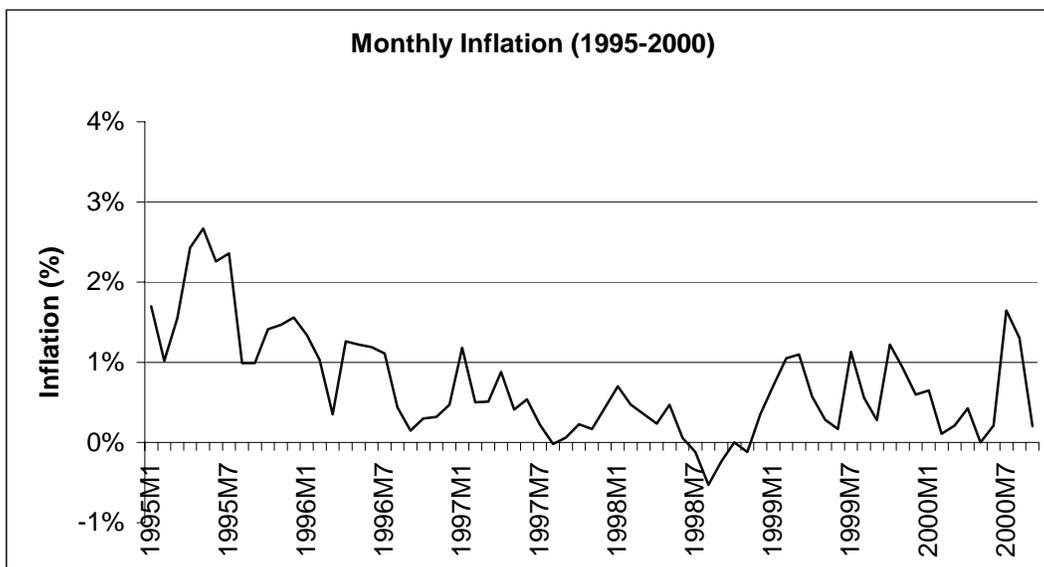
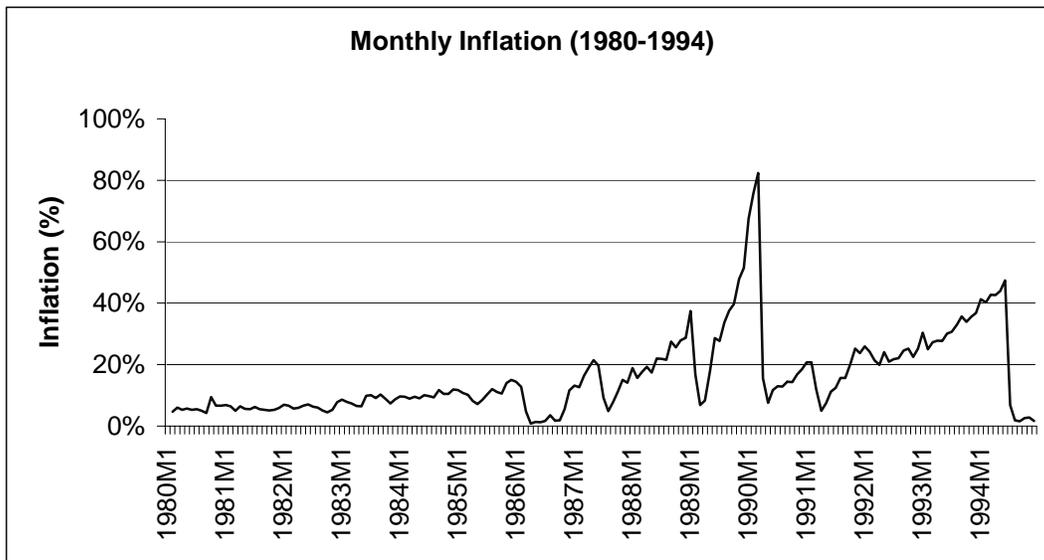
**Figure 4: Fraction of All Countries Using Fixed Exchange Rate**



*Note* The number of the countries ranges from 136 to 182 countries. The currency is under the fixed exchange rate regime if it is pegged to other single currency or to a composite of currencies.

*Source* International Financial Statistics

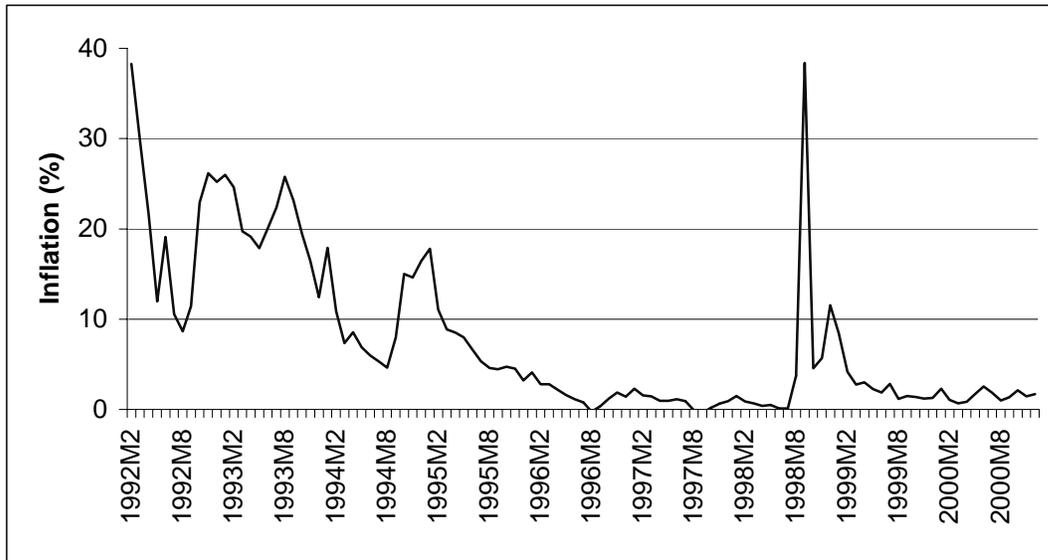
**Figure 5: Brazil Monthly Inflation (1980 - 2000)**



*Note* Monthly inflation is defined as a change of the consumer price index from the previous month.

*Source* International Financial Statistics

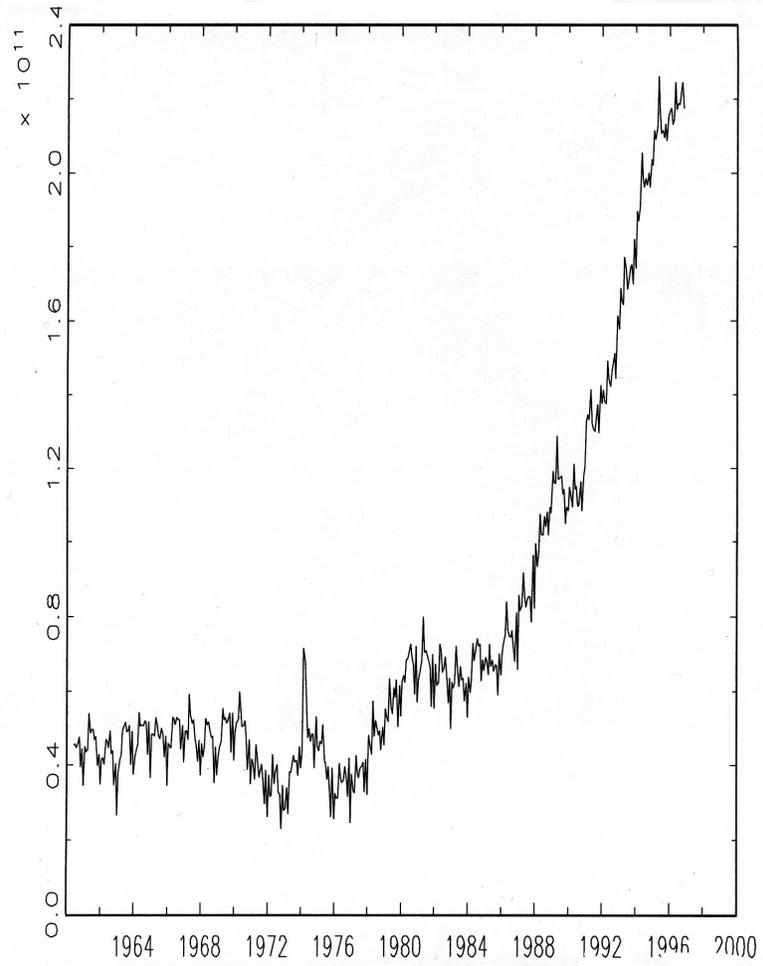
**Figure 6: Russia Monthly Inflation (1992 - 2000)**



*Note* Monthly inflation is a percentage change of the consumer price index from the previous month.

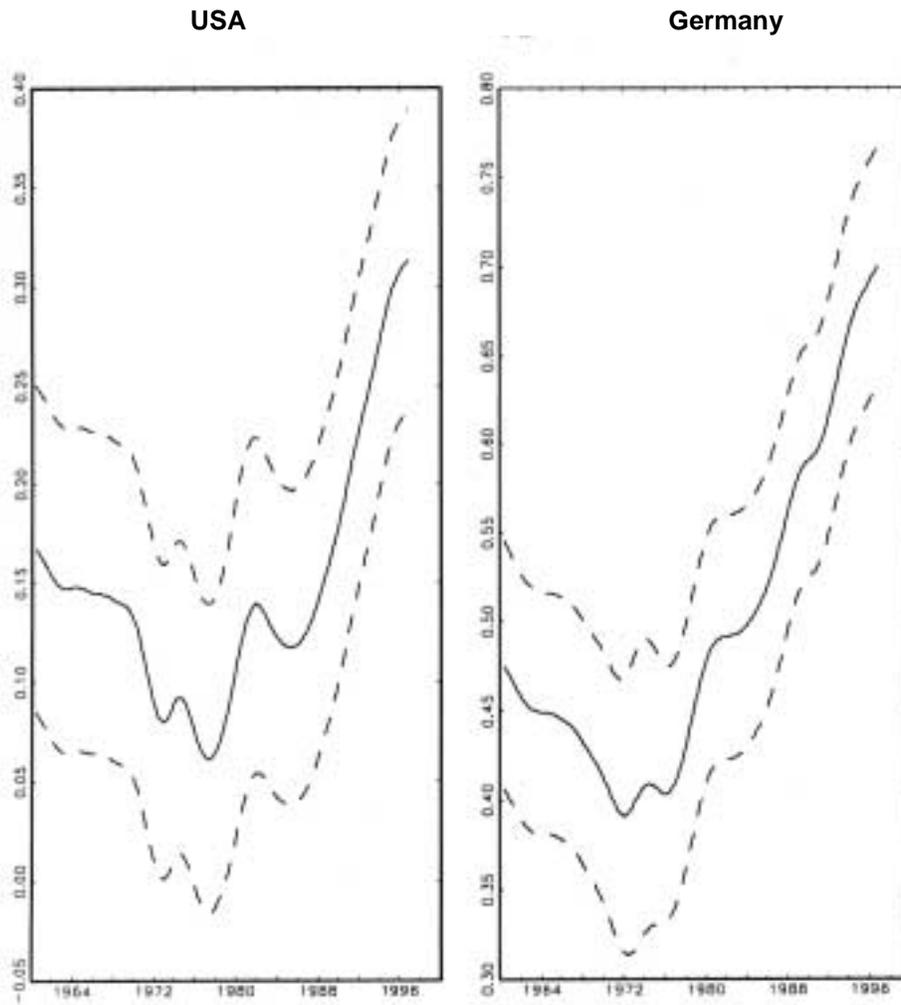
*Source* International Financial Statistics

**Figure 7: World Dollarization (in 1990 US Dollars)**



Source Doyle (2000)

**Figure 8: Foreign Holdings as a Percentage of the Currency Stock for the US and Germany**



*Note* The dashed lines represent 2 standard error bands

*Source* Doyle (2000)

**Table 1: Inflation and Decline in Purchasing Power of Currency 1972 - 1999**

<b>Country</b>	<b>Increase in CPI 1972-1999</b>	<b>Decline in Purchasing Power 1972-1999</b>
GERMANY	134%	-57.28%
SWITZERLAND	138%	-58.02%
PANAMA	143%	-58.82%
SINGAPORE	163%	-62.03%
NETHERLANDS	177%	-63.87%
JAPAN	184%	-64.74%
AUSTRIA	186%	-65.08%
MALTA	193%	-65.83%
SAUDI ARABIA	217%	-68.46%
LUXEMBOURG	220%	-68.72%
MALAYSIA	229%	-69.65%
KUWAIT	242%	-70.80%
BELGIUM	245%	-70.99%
BAHAMAS, THE	296%	-74.74%
UNITED STATES	298%	-74.89%
NETHERLANDS ANTILLES	308%	-75.50%
CANADA	324%	-76.41%
CYPRUS	338%	-77.18%
INDUSTRIAL COUNTRIES	340%	-77.28%
NIGER	347%	-77.62%
FRANCE	382%	-79.27%
DENMARK	383%	-79.28%
NORWAY	401%	-80.03%
SEYCHELLES	422%	-80.84%
SWEDEN	448%	-81.74%
THAILAND	466%	-82.35%
FINLAND	467%	-82.37%
FIJI	501%	-83.35%
MOROCCO	510%	-83.61%
TOGO	513%	-83.70%
SENEGAL	521%	-83.90%
AUSTRALIA	523%	-83.94%
ST. LUCIA	526%	-84.04%
BARBADOS	604%	-85.79%
DOMINICA	611%	-85.93%
JORDAN	639%	-86.46%
UNITED KINGDOM	661%	-86.86%
IRELAND	676%	-87.12%
PAPUA NEW GUINEA	684%	-87.24%
CAMEROON	781%	-88.64%
NEW ZEALAND	788%	-88.74%
COTE D IVOIRE	809%	-89.00%
INDIA	927%	-90.26%
KOREA	948%	-90.45%
SAMOA	1024%	-91.10%
ITALY	1061%	-91.39%
NEPAL	1072%	-91.47%
SPAIN	1119%	-91.79%
PAKISTAN	1195%	-92.28%
TRINIDAD AND TOBAGO	1309%	-92.90%
MAURITIUS	1373%	-93.21%

**Table 1: Inflation and Decline in Purchasing Power of Currency 1972 - 1999  
(Continued)**

Country	Increase in CPI 1972-1999	Decline in Purchasing Power 1972-1999
SOLOMON ISLANDS	1476%	-93.65%
SRI LANKA	1485%	-93.69%
GAMBIA, THE	1667%	-94.34%
RWANDA	1684%	-94.40%
BURUNDI	1772%	-94.66%
HONDURAS	1982%	-95.20%
SOUTH AFRICA	2034%	-95.31%
PHILIPPINES	2114%	-95.48%
HUNGARY	2229%	-95.71%
ALGERIA	2309%	-95.85%
SWAZILAND	2331%	-95.89%
EGYPT	2446%	-96.07%
GUATEMALA	2469%	-96.11%
HAITI	2478%	-96.12%
SYRIAN ARAB REPUBLIC	3205%	-96.97%
INDONESIA	3209%	-96.98%
EL SALVADOR	3244%	-97.01%
KENYA	3264%	-97.03%
PORTUGAL	3347%	-97.10%
MIDDLE EAST	4272%	-97.71%
MADAGASCAR	4479%	-97.82%
GREECE	4626%	-97.88%
DOMINICAN REPUBLIC	4645%	-97.89%
MYANMAR	6494%	-98.48%
PARAGUAY	6802%	-98.55%
ZIMBABWE	7127%	-98.62%
COSTA RICA	9847%	-98.99%
IRAN, I.R. OF	11922%	-99.17%
JAMAICA	15923%	-99.38%
TANZANIA	25625%	-99.61%
COLOMBIA	26585%	-99.63%
NIGERIA	27132%	-99.63%
ICELAND	34723%	-99.71%
VENEZUELA, REP. BOL.	53588%	-99.81%
ECUADOR	108910%	-99.91%
DEVELOPING COUNTRIES	115537%	-99.91%
SURINAME	144311%	-99.93%
MEXICO	309693%	-99.97%
POLAND	319677%	-99.97%
GHANA	682496%	-99.99%
SIERRA LEONE	821323%	-99.99%
SUDAN	1881780%	-99.99%
CHILE	3010882%	-100.00%
ISRAEL	4120433%	-100.00%
TURKEY	9167376%	-100.00%
URUGUAY	13207282%	-100.00%
BOLIVIA	141514922%	-100.00%
PERU	67235426470%	-100.00%
NICARAGUA	8067632087241%	-100.00%
ARGENTINA	9935301973387%	-100.00%
BRAZIL	273051504844993%	-100.00%

*Note* Inflation rates are computed as a change in consumer price index over 1972 - 1998 for all countries except for Brazil. The numbers for Brazil are computed from GDP deflator during 1972 - 1998.

*Source* International Financial Statistics

**Table 2: Currency per capita in 1998**

<b>Country</b>	<b>Currency (Billion US Dollar)</b>	<b>Population (Million)</b>	<b>Currency per capita (US Dollar)</b>
Argentina	13.51	36.12	374.02
Australia	13.99	18.73	746.77
Brazil	17.53	161.79	108.33
Canada	21.12	30.25	698.03
Chile	2.06	14.82	139.19
Czech Republic	4.26	10.29	413.92
Denmark	5.40	5.30	1,018.95
France	51.03	58.85	867.13
Germany	161.97	82.02	1,974.80
Hungary	3.05	10.11	301.22
Iceland	0.09	0.27	337.78
India	38.24	970.93	39.39
Ireland	4.52	3.70	1,222.00
Italy	75.54	57.59	1,311.69
Japan	469.81	126.41	3,716.56
Mexico	11.77	95.83	122.79
Netherlands	21.65	15.71	1,378.32
New Zealand	0.91	3.79	239.66
Poland	8.63	38.67	223.07
Russia	9.10	146.54	62.08
Saudi Arabia	12.02	20.18	595.69
Slovenia	0.58	1.98	293.43
South Africa	3.16	42.13	74.97
Switzerland	25.74	7.11	3,620.42
Thailand	8.67	61.20	141.75
United Kingdom	31.61	58.85	537.07
United States	473.19	270.56	1,748.93

*Note* Currency in US dollar is the currency in national unit converted by the exchange rate of the US dollar against the national currency. All data are end-of-the-year data.

*Source* International Financial Statistics