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Currency Substitution and Government Revenue from Inflation *

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Summary

The conventional analysis of inflationary finance has shown that there is a rate of inflation that would maximize the revenues a government can acquire by using inflation as a tax on holders of real money balances. Attempts by the authorities to inflate above this revenue-maximizing rate would result in an erosion of the tax base (the stock of real money balances), and total revenues would in fact start to decline. This is well known at the theoretical level, and when applied to developing countries the analysis yields revenue-maximizing rates of inflation that range from 50 percent to over 100 percent a year. By most criteria these rates would be considered excessive, but as yet there has been no fully satisfactory explanation in the literature why standard models of inflationary finance produce such implausibly high inflation rates.

The purpose of this paper is to demonstrate that the models employed to calculate the rate of inflation that would maximize the proceeds from the inflation tax are in fact overly restrictive, since they permit only substitution between money and goods. In many developing countries the ability of domestic residents to substitute foreign money for domestic money, defined generally as currency substitution, can become an effective way for domestic residents to avoid the inflation tax on domestic money holdings. It turns out that once the effects of currency substitution are taken into account, government revenues from inflation, and consequently revenue-maximizing rates of inflation, become much lower than available empirical evidence would suggest. Using reasonable values for the relevant parameters, we show here that the range of revenue-maximizing rates of inflation would be around 10-20 percent per year. These rates are, of course, much more reasonable. The possibility of currency substitution would, therefore, appear to significantly reduce the scope for using inflation to finance government deficits.

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I. Introduction

The use of inflation as a way of generating resources for the government continues to evoke considerable interest on the part of economists. 1/ However, despite the attention paid to this subject, several puzzles still remain that have yet to be dealt with in a completely satisfactory fashion. One of these puzzles is the implausibly high rate of inflation that typically would appear to maximize government revenues from the inflation tax in developing countries. The conventional analysis of the inflation tax specifies the steady-state revenue from inflation as the stock of real money balances (the tax base) times the rate of growth of the nominal money stock (the tax rate). 2/ As in the case of other taxes, there is a revenue-maximizing equilibrium rate of monetary expansion (and corresponding rate of inflation), and attempts to inflate above this rate will result in a decline in total revenues. In the Cagan (1956) model, which is normally employed in analyzing this issue, the revenue-maximizing, or optimal, tax rate is given by the inverse of the semielasticity of the demand for real money balances with respect to inflation. After this point the gain in revenues from accelerating money growth is more than offset by the erosion of the tax base that results from the decline in holdings of real balances due to the now higher rate of inflation. Provided that a steady state exists, this basic result continues to hold when the analysis is cast in dynamic terms. 3/

All this is well known, and available estimates of the inflation semielasticity of money demand in developing countries, which range between 0.5 and 3.0, imply revenue-maximizing rates of inflation that vary from 200 percent to 33 percent, respectively. Clearly even the lower value for the revenue-maximizing inflation rate is quite high, and as such attempts to reduce it, either by raising the value of the semielasticity or by allowing for additional factors in the revenue calculations, have preoccupied a number of writers, starting with Friedman (1971). 4/ Apart from its obvious theoretical interest, this issue of high revenue-maximizing rates of inflation also has significant policy implications. For example, this result may well provide one possible explanation of why governments in developing countries sometimes find

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1/ The seminal papers on the subject are those by Cagan (1956), Bailey (1956), and Friedman (1971). More recent papers examining specific aspects of inflationary finance include those by Aghevli (1977), Auernheimer (1974), Chappell (1981), Frenkel (1976), and von Furstenberg (1980).

2/ See Cagan (1956) and Friedman (1971).

3/ See Auernheimer (1974), Cathcart (1974), and Chappell (1981).

4/ See von Furstenberg (1980) for a recent attempt in this direction.

it difficult to resist the temptation of resorting to inflation as a means of raising revenues, even though inflation is generally discredited as a taxing device on a wide variety of grounds. If the revenue-maximizing rate of inflation is in fact as high as the empirical literature suggests, then the domestic monetary authorities would seem to have considerable leeway to engage in expansionary policies to acquire revenues. On the other hand, if the revenue-maximizing rate of inflation turns out to be much lower than evidence based on the standard analysis would seem to indicate, there would presumably be less incentive for governments to pursue a policy of inflationary finance.

The purpose of this paper is to show that in the case of an open economy the standard methods hitherto employed have a systematic tendency to seriously overestimate the revenue-maximizing rate of inflation. Our basic argument is that the calculations have been made using an overly restrictive model that assumes that domestic residents can only substitute between domestic money and goods (and real assets). In many developing countries the potential for currency substitution, defined as the ability of domestic residents to switch between domestic and foreign fiat money, 1/ adds an important dimension to the analysis of the revenue-maximizing inflation tax, and makes the relevant calculations quite different. If domestic residents can hold foreign money balances, then currency substitution can become an effective way of avoiding the inflation tax on the holdings of domestic cash balances. 2/ This paper demonstrates that once the effects of currency substitution are taken into account, the inflation rate that maximizes the proceeds of the inflation tax turns out to be considerably lower than it is estimated to be when currency substitution is ignored. 3/ It is clear from the analysis here, together with the empirical findings of Blejer (1978), Ortiz (1983),

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1/ In actual fact, the definition of currency substitution covers a wide variety of possibilities, such as foreign currency deposits in the domestic financial system, deposits held abroad by domestic residents, and foreign currency notes circulating within the boundaries of the country.

2/ In a related paper Fischer (1982) also shows that the escape from domestic to foreign money results in a loss of seigniorage for the government.

3/ In a recent paper, Brock (1984) recognizes this possibility and discusses how the government could increase inflation tax revenues (by increasing the tax base) in an open economy by the use of reserve requirements on capital inflows and non-interest bearing import deposits. However, he does not formally deal with the issue of how currency substitution would reduce the revenue-maximizing rate of inflation, and consequently government revenue from inflation. For an earlier discussion of how to increase revenues from inflation see Nichols (1974).

Tanzi and Blejer (1982), and Ramirez-Rojas (1984), among others, that any realistic modelling of the demand for money--and thus the determination of the inflation tax--in developing countries should allow a role for currency substitution. Doing so goes a long way towards solving the puzzle of the "high" revenue-maximizing rates of inflation.

Since the analysis here is concerned exclusively with the steady state, it does not address the other major puzzle to emerge from the literature on inflationary finance, namely why observed rates of inflation in many developing countries far exceed even the high values of inflation that would apparently maximize government revenues. There is, of course, no particular reason for actual rates of inflation to be equal to the steady-state revenue-maximizing rates at all points in time, as inflation can be the result of a number of factors, only one of which is the government's attempts to gain revenues. However, even in this particular case if, as argued by Khan and Knight (1982), in the short run the public reacts with some delay to changes in government policies, inflation would not necessarily be limited to the revenue-maximizing rate since the government could always increase the tax base temporarily by raising the rate of monetary expansion unexpectedly. Consequently, both the tax base and the tax rate would increase and the government could thus acquire additional revenues, irrespective of what the current rate of inflation was in relation to its steady-state value. In the long run, however, the public would fully adjust and the government could not gain any additional revenue, and would actually lose revenues, by increasing the rate of inflation above the revenue-maximizing rate.

The remainder of the paper proceeds as follows: Section II develops the basic framework for the analysis. Section III contains a discussion of the conventional Cagan-type money demand model, and compares the standard result with that obtained in this paper. A numerical example showing the quantitative importance of currency substitution is given in Section IV. The main conclusions of the paper are contained in Section V.

II. A Theoretical Model of Inflationary Finance

Assuming that the economy has a stationary level of real income, 1/ and that equilibrium in the money market holds continuously, the demand for domestic real cash balances can be specified as:

1/ Friedman (1971) has shown that if real income growth is allowed, the revenue-maximizing rate of inflation would be lowered somewhat. At the same time, however, Aghevli (1977) has argued that if the proceeds of the inflation tax are used by the government to increase the growth rate, the revenue-maximizing rate of inflation would be increased. We make the assumption of fixed real income here for analytical simplicity. This assumption is relaxed later in the paper to determine the quantitative significance of allowing for a positive rate of growth of real income.

$$(1) \quad \frac{M}{P} = m = f(\pi)$$

where M is the domestic nominal stock of money; P is the price level; and π is the rate of inflation, $\frac{dP}{dt}\frac{1}{P}$. Since π represents the opportunity cost of holding money instead of goods, we would expect that $\frac{df(\pi)}{d\pi} < 0$.

Models of the type described by equation (1) have been widely used for analyzing the revenue-maximizing inflation tax in developing countries, but it should be pointed out that this function is strictly relevant only in the steady state. For analyzing the short-run behavior of the demand for money, one would have to consider π as the "expected" rate of inflation, devise some method of calculating this unobservable variable, and perhaps also allow for some type of delayed adjustment in the money market. 1/ For the sake of simplicity we also exclude interest rates on competing domestic financial assets from the formulation. 2/

The revenue from money creation, denoted by R, in real terms is defined as:

$$(2) \quad R = \frac{dM}{dt}\frac{1}{P} = \frac{dM}{M} m$$

In this equation the variable m is interpreted as the tax base, and (dM/M) as the tax rate. 3/

Combining equations (1) and (2) we obtain:

$$(3) \quad R = \left[\pi + \frac{1}{f(\pi)}\frac{\partial f(\pi)}{\partial \pi}\frac{d\pi}{dt}\right] m$$

Since the economy is in steady state, the inflation rate will be constant ($\frac{d\pi}{dt} = 0$), and equation (3) would reduce to:

$$(4) \quad R = \pi m$$

1/ Typically one would introduce variants of the general error-learning model, such as the adaptive-expectations and partial-adjustment models, into the specification.

2/ While in some developing countries this would involve a degree of misspecification, for most developing countries, where there are limited financial assets and widespread controls over interest rates, this is not a serious exclusion. In any case, however, this assumption would affect the analysis only if interest rates were closely related to inflation, i.e., if a Fisher-type equation was assumed to hold.

3/ Strictly speaking, the money variable should be defined as the liabilities of the monetary authorities, e.g., high-powered or reserve money.

To obtain the rate of inflation that maximizes government revenues we can differentiate (4) with respect to π and set this equal to zero. The maximization yields:

$$(5) \quad \frac{dR}{d\pi} = \frac{\pi dm}{d\pi} + m = 0$$

$$= m[\frac{\pi dm}{d\pi} \frac{1}{m} + 1]$$

and the solution is:

$$(6) \quad \pi[\frac{df(\pi)}{d\pi} \frac{1}{f(\pi)}] = -1$$

Since the inflation elasticity of the demand for money is defined as:

$$\varepsilon = - \frac{df(\pi)}{f(\pi)} \frac{\pi}{d\pi}$$

then it is readily apparent from equation (6) that revenues will be maximized at the point where the inflation elasticity equals unity, i.e., $\varepsilon = 1$. Equation (6) can be solved for the inflation rate that would yield the maximum level of revenues: 1/

$$(7) \quad \tilde{\pi} = f(\pi) \frac{d\pi}{df(\pi)}$$

This is the standard result reported in the inflation tax literature, 2/ and we will refer to it the "classical" case.

It should be stressed that this last result is a direct implication of a model, equation (1), that only admits substitution between domestic money and goods. Once this restrictive assumption is relaxed to include the possibility of substitution between domestic money and foreign money, the results are substantially changed. At first currency substitution was thought to be relevant only in countries with developed financial and capital markets, 3/ but there is now a growing body of evidence pointing to the importance of currency substitution in a number of developing countries as well. Work by Arriazu (1983), Ortiz (1983), Tanzi and Blejer (1982), and Ramirez-Rojas (1984), has shown that currency substitution can take place in countries that differ considerably in levels

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1/ Assuming the expression within brackets is negative.

2/ See for example Friedman (1971).

3/ Earlier papers on the subject, such as Miles (1978), looked specifically at the case of the United States and Canada. More recently Cuddington (1983) has extended the analysis to cover other industrial countries as well.

of financial development, the degree of integration with the rest of the world, and types of exchange rate regimes and practices. The empirical evidence provided by these authors would also certainly not come as a surprise to anyone who has observed the thriving markets for foreign currencies that are found in many developing countries.

In broad terms, foreign money is held by domestic residents both for transactions purposes and as a hedge against inflation. The general consensus is that the principal determinant of currency substitution is the expected change in the exchange rate, although there are disagreements in the literature as to how exactly this should be defined. Other things equal, an expected depreciation of the domestic currency, for whatever reason, would cause domestic residents to shift out of domestic money into foreign money, and vice versa. Depending on the degree and extent of exchange controls, it could also be argued that such substitution would be relatively easier to make than would substitution between domestic money and goods. In any case, given the empirical evidence it would certainly seem reasonable to allow for some degree of currency substitution and specify the demand for money function to explicitly incorporate the change in the exchange rate as follows: 1/

$$(8) \quad m = f(\pi, \dot{e})$$

where $\dot{e}$ is the proportional change in the exchange rate, $\dot{e} = de/e$. 2/ Here also, as in the case of the inflation rate, we use the actual change in the exchange rate rather than the expected change because we are working in the steady state and the two would have to be the same. The derivatives would have the following signs:

$$\frac{\partial f(\pi, \dot{e})}{\partial \pi} < 0; \quad \frac{\partial f(\pi, \dot{e})}{\partial \dot{e}} < 0$$

Going through the relevant maximization procedure we can derive the corresponding result for the currency substitution model, equation (8). In this case we find that the maximum is reached when:

$$(9) \quad \pi \left[\frac{df(\pi, \dot{e})}{d\pi} \frac{1}{m}\right] = -1$$

1/ This type of equation has been used to study the demand for money in three Latin American countries (Brazil, Chile, and Colombia) by Blejer (1978). It has also been estimated for the German hyperinflation by Abel et al. (1979).

2/ The variable e is defined in the customary way as the domestic price of foreign currency.

or,

$$(10) \quad \frac{\pi}{m}\left[\frac{\partial f(\pi,\dot{e})}{\partial \pi} + \frac{\partial f(\pi,\dot{e})}{\partial \dot{e}}\,\frac{d\dot{e}}{d\pi}\right] = -1$$

From (10) we can see that the value of the inflation rate that satisfies this equation will be, in general, different from the one obtained in equation (7). 1/ In comparing equations (6) and (10) we observe that the difference between the classical result and the result that we obtain with currency substitution depends critically on the effect of inflation on the change in the exchange rate, i.e., on the sign of $\frac{d\dot{e}}{d\pi}$. If this derivative is equal to zero then we are back in the classical case given by equation (6), and the revenue-maximizing rate of inflation will be given by equation (7).

The interesting cases arise, of course, when the value of the derivative is non-zero. When $\frac{d\dot{e}}{d\pi} > 0$ we find that the rate of inflation that maximizes government revenues would be smaller than in the classical case. In other words, if the domestic currency depreciates as domestic inflation increases, the revenue-maximizing rate of inflation would be lower. This would seem to be plausible since we know that high domestic inflation is one of the principal causes of the depreciation of the domestic currency. Of course if $\frac{d\dot{e}}{d\pi} < 0$, the revenue-maximizing rate of inflation with currency substitution would be higher than that calculated from the classical model. The hypothesis that higher inflation would result in a nominal appreciation of the exchange rate is, however, quite counter-intuitive, and should therefore be regarded as somewhat of a theoretical curiosity without much empirical content.

1/ Again assuming the expression within brackets is negative, the revenue-maximizing rate of inflation in the presence of currency substitution is given by:

$$\tilde{\pi} = f(\pi,\dot{e})\left[\frac{\partial \pi}{\partial f(\pi,\dot{e})} + \frac{\partial \dot{e}}{\partial f(\pi,\dot{e})}\,\frac{d\pi}{d\dot{e}}\right]$$

III. Currency Substitution in the Cagan Model of Money Demand

In order to directly compare the results here with previous treatments of inflationary finance, we felt it would be useful to conduct the analysis within the framework of the specific Cagan-type functional form of the demand for money, rather than retaining the general form discussed above. Almost all prior work on aspects of the inflationary tax has used the semi-logarithmic specification of Cagan (1956), and we follow this tradition by reformulating our basic money demand function with currency substitution as:

$$(11)\quad m = a\exp(-\beta\pi - \alpha\dot{e})$$

where a, β, and α are positive constants. The Cagan model is obtained from (11) by setting $\alpha = 0$. 1/

Using the results for the revenue-maximizing rates of inflation in the previous section and assuming $\alpha = 0$, we obtain for the classical case the familiar result that:

$$(12)\quad \tilde{\pi}_1 = \frac{1}{\beta}$$

where $\tilde{\pi}_1$ is the revenue-maximizing tax rate. By contrast, for the case of the model incorporating currency substitution, i.e., equation (11), the inflation rate that maximizes revenues ($\tilde{\pi}_2$) is given by:

$$(13)\quad \tilde{\pi}_2 = \frac{1}{\beta + \alpha\frac{d\dot{e}}{d\pi}}$$

Here again we can note that for given values of α and β, the difference between (12) and (13) depends on the sign of $\frac{d\dot{e}}{d\pi}$. In general, the conditions are:

1/ If in fact there is currency substitution and this is not taken into account, i.e., it is incorrectly assumed that $\alpha = 0$, then one would have an omitted variables problem that would bias the estimate of the inflation semielasticity. This bias can be formally expressed as:

$$\text{plim}\ \hat{\beta} = \beta + \alpha\,\text{plim}\ \theta_{\pi,\dot{e}}$$

where θ is the regression (correlation) coefficient between $\dot{e}$ and π. As θ would generally be positive $\hat{\beta}$ will be an upward biased and inconsistent estimate of the true effect of inflation on the demand for money. See Abel et al. (1979).

$$\tilde{\pi}_1 \gtrless \tilde{\pi}_2 \text{ as } \frac{d\dot{e}}{d\pi} \gtrless 0$$

Clearly crucial to the analysis is the relationship between the change in the exchange rate and inflation, and in order to proceed any further we need to be more precise about the link between these two variables. Of course, the modelling of the short-term behavior of the exchange rate, and more particularly exchange rate expectations, has proved to be exceedingly difficult. In general, it would be fair to say that there has been very little success in the area, whether for industrial countries or developing countries. 1/ The task does become somewhat easier when working in the steady state where one is concerned with long-term, or so-called fundamental, factors in the determination of the exchange rate. Furthermore, we are interested simply in the relationship between exchange rates and domestic inflation rather than in trying to develop a full-blown model of the exchange rate. Given our narrower focus it would be legitimate to utilize a straightforward relationship based on the notion of Purchasing Power Parity (PPP). Such a relationship in the steady state can be written as:

$$(14) \quad \dot{e} = [\pi - \pi^*]$$

where π^* is the (exogenous) foreign rate of inflation. In the long run if domestic inflation were above foreign inflation the exchange rate would have a tendency to depreciate, and vice versa.

Substituting for $\frac{d\dot{e}}{d\pi}$ from (14) into (13) we obtain the revenue-maximizing rate of inflation: 2/

$$(15) \quad \tilde{\pi}_2 = \frac{1}{\beta + \alpha}$$

which, since α is positive, will be lower than the rate of inflation yielded in the classical case, equation (12). The difference between equation (12) and (15) will naturally depend on the value of α. 3/

1/ See Levich (1984).

2/ Note that the foreign rate of inflation, π^*, does not appear in the solution. In fact, it is true that even if we had introduced a whole set of variables in equation (14), and provided they were independent of π, the calculation shown in (15) would not be affected.

3/ The precise difference will be equal to $\alpha/\beta(\beta + \alpha)$.

It is obvious that the reason why the revenue-maximizing rate of inflation in the model with currency substitution is lower than in the standard case is that the demand curve for real money balances obtained from equations (11) and (14) is more elastic with respect to the rate of inflation than the corresponding demand curve in the classical one. In the latter case it is relatively easy to show that the inflation elasticity of money demand (ε_1) would be:

$$(16) \quad \varepsilon_1 = -\beta\pi$$

For the model with currency substitution, the elasticity can be calculated by combining equations (11) and (14), taking logarithms, and differentiating with respect to inflation to obtain:

$$(17) \quad \varepsilon_2 = \pi \frac{d\log m}{d\pi} = -(\beta + \alpha)\pi$$

where ε_2 is the elasticity of money demand with respect to inflation in the currency substitution model.

The difference between (16) and (17) can be shown with the aid of a simple diagram in which the relationship between the log of domestic real cash balances, $\log(M/P) = \log m$, and the inflation rate, π, is depicted--Figure 1. In this figure the line BB' corresponds to the standard case with an elasticity $-\beta\pi$, while the currency substitution model yields the schedule CC' which has a larger elasticity $-(\beta + \alpha)\pi$. Assume that the initial position is given by π_0 (= π^*) and $\log(M/P)_0$, where the revenues in the two cases are the same. 1/ Now if there is an increase in the rate of inflation above π_0, the decline in real money balances would be greater, and thus government revenues lower, in the currency substitution model than in the classical case. It is also interesting to note from Figure 1 that if domestic inflation is pushed below π_0, and specifically below the foreign rate of inflation, government revenues would be larger in the currency substitution case, since there would be an incentive for the public to move into domestic money, thereby expanding the tax base.

Figure 1 can also be used to compare the welfare costs imposed on money holders by inflation that emerge from the two models under consideration here. The welfare cost has been defined by Bailey (1956) and others as approximately the area under the demand schedule for real money balances. In Figure 1 this welfare cost of inflation is represented by

1/ For simplicity we have assumed that the intercept terms in the two equations are the same. As such the two schedules will intersect where $\pi = \pi^*$.

the area $AB[\log(M/P)_0]$ in the classical model, and by $AC[\log(M/P)_0]$for the currency substitution case. More formally the respective welfare costs for the two cases (w_1 and w_2) would be: 1/

Classical model

$$(18)\quad w_1 = \frac{1}{2}\pi \log m\varepsilon_1 = -\frac{1}{2}\pi^2 \log m\beta$$

Currency substitution model

$$(19)\quad w_2 = \frac{1}{2}\pi \log m\varepsilon_2 = -\frac{1}{2}\pi^2 \log m(\beta + \alpha)$$

The difference in the welfare costs incurred in the two cases is:

$$(20)\quad w_1 - w_2 = \frac{1}{2}\pi^2 \log m\alpha$$

The result given by (20) is quite important, since it shows that a relatively larger welfare gain can be achieved by reducing the rate of inflation in countries where currency substitution happens to exist. This reduction in the welfare costs imposed on the public should favor the lowering of inflation in developing countries.

IV. A Numerical Example

The arguments contained in this paper can be illustrated by assigning specific values to the parameters in the equation for calculating the revenue-maximizing rate of inflation. This type of simulation experiment is particularly useful in providing a quantitative impression of how much a difference it makes when allowance for currency substitution is made.

With respect to parameter values, previous studies have used values for β that range from 0.5 all the way up to 20. 2/ We decided to limit

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1/ The welfare cost is given by the following integral:

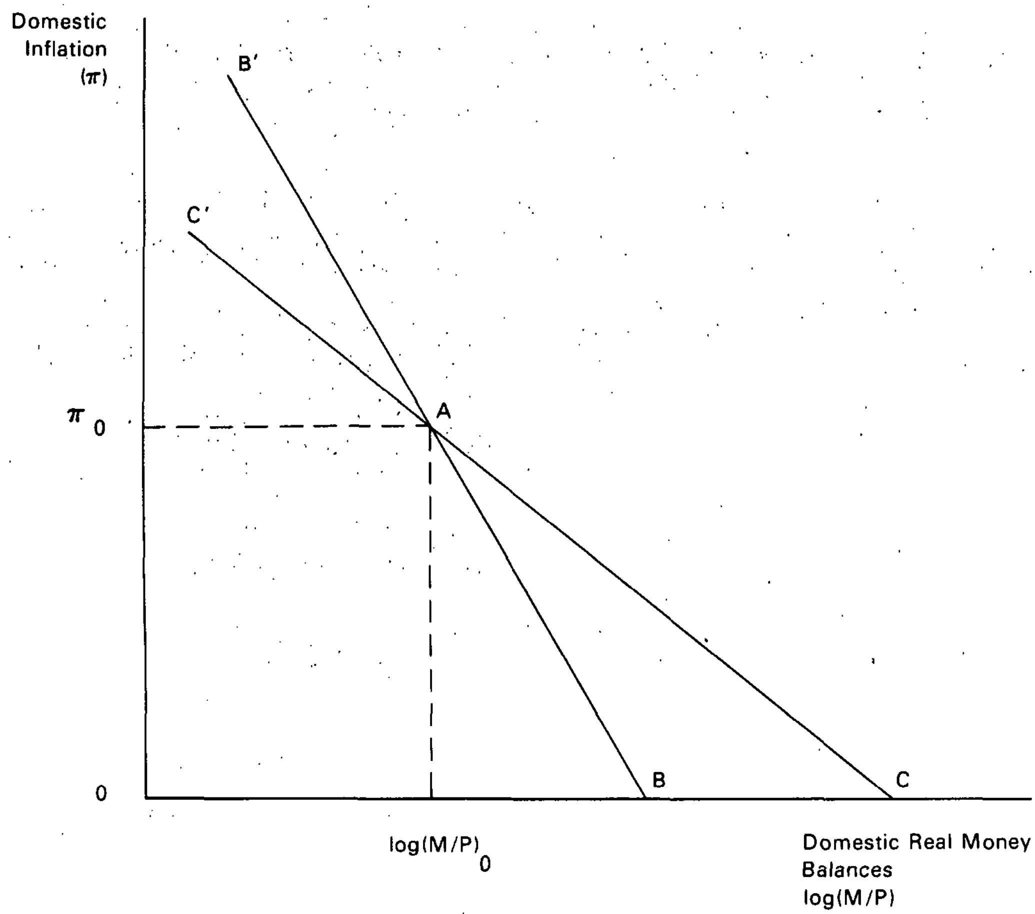
$$w = \int_{m_0}^{m_\rho} \pi dm$$

where m_0 and m_ρ correspond to the levels of real balances consistent with a rate of monetary expansion of zero and ρ, respectively.

2/ See, for example, Cagan (1956), Friedman (1971), and Aghevli (1977).

FIGURE 1

EFFECTS OF CURRENCY SUBSTITUTION ON THE DEMAND FOR DOMESTIC REAL CASH BALANCES



the range of values for β to 0.5, 1.0, 2.0, and 3.0, since most estimates of the inflation semielasticity for developing countries have tended to cluster around these numbers. 1/ In the case of α, which measures the semielasticity of domestic real cash balances with respect to the differential between domestic and foreign inflation, much less is known. While there are now several empirical studies of currency substitution in developing countries, they use quite different measures of exchange rate expectations and it is not clear that one can extract estimates of α directly from them. Thus, for the analysis we arbitrarily selected values for the parameter α that were similar to those assumed for β, i.e., 0, 0.5, 1.0, 2.0, and 3.0. 2/ The estimates obtained in most studies on currency substitution generally fall within this range. 3/

The revenue-maximizing rates of inflation that result from these values for the parameters are shown in Table 1 below.

Table 1

Rates of Inflation that Maximize Revenues from the Tax on Money Balances

(Percent per year)

	Value of β			
	0.5	1.0	2.0	3.0
Value of α				
0	200.0	100.0	50.0	33.3
0.5	100.0	66.7	40.0	28.6
1.0	66.7	50.0	33.3	25.0
2.0	40.0	33.3	25.0	20.0
3.0	28.6	25.0	20.0	16.7

1/ See Khan (1980) for estimates for a broad group of developing countries.

2/ Studies on the effect of exchange rate expectations on the demand for money, such as the one by Abel et al. (1979), obtained values of α that range between 1.1 and 2.6.

3/ See, for example, Ortiz (1983), and Ramirez-Rojas (1984).

The results in Table 1 show the importance of currency substitution even in the situation where the inflation semielasticity, β, is small. Generally speaking, allowance for substitution between domestic money and foreign money lowers the revenue-maximizing rate of inflation dramatically. If one considers values for the relevant parameters of between 2 and 3, which are probably close to actual empirical estimates for most developing countries, then the maximum inflation rates from a revenue point of view would be in the range of 15-25 percent per annum. Clearly these are a far cry from the estimates of 30 to 50 percent (or higher) that usually emerge from the classical model.

So far it has been assumed that real income is constant and thus does not enter into the calculations. If one relaxes this assumption the revenue-maximizing rate of inflation ($\tilde{\pi}_2$) is given by: 1/

$$(21) \quad \tilde{\pi}_2 = \frac{1}{\beta + \alpha} - \eta_y g_y$$

where η_y is the income elasticity of the demand for money and g_y is the rate of growth of real income. If, for example, η_y was equal to unity and the rate of growth was 5 percent per annum, it can be seen from equation (21) that the revenue-maximizing rates of inflation reported in Table 1 would be reduced by 5 percentage points. Again, taking values of β and α of between 2 and 3, the maximum rate of inflation would then be lowered to between 10-20 percent per annum. 2/

V. Conclusions

The literature on deficit financing has long argued against the use of the inflation tax to raise revenues. Aside from the well-documented adverse effects that a sustained period of high and variable inflation has on economic growth, income distribution, and the balance of payments, inflation has also been criticized for being a particularly inefficient method of taxation that imposes high welfare costs on the holders of cash balances. It has also been argued that inflation can cause other forms of revenues to fall off, so that the net gain to the government may be zero, or even negative.

While this is widely recognized, economists have not been able to fully reconcile these views with some of the results that emerge from the standard models developed to analyze inflationary finance. Such models yield, for example, surprisingly high rates of inflation that

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1/ See Friedman (1971).

2/ Making a similar adjustment in the classical model would correspondingly reduce the revenue-maximizing rates of inflation to the 25-45 percent per annum range.

would maximize government revenues, and past attempts to deal with this puzzle have been somewhat ad hoc in nature and thus not particularly convincing. In this paper we formulated a simple framework that extended the basic money demand model by allowing for substitution between domestic money and foreign money. The possibility of currency substitution, in addition to the substitution between domestic money and goods, was shown to have a strong negative effect on the revenue-maximizing rate of inflation. The end-result of this exercise is that for the typical developing country the revenue-maximizing rate of inflation would seem to be between 10 percent and 20 percent, or even lower, rather than the 25 to 45 percent range that are found in the more standard models. This result makes the difference even greater between revenue-maximizing and actual rates of inflation observed in many developing countries, and underscores the need for a reconciliation of the two. Some progress in this direction has been made by Khan and Knight (1982), but clearly more effort is called for.

As currency substitution is not simply a theoretical abstraction but a very real phenomenon in a number of developing countries, the results here have some interesting policy implications for authorities contemplating, or engaged in, inflationary finance. If the government attempts to inflate to acquire resources, the public could reduce its stock of cash balances by shifting into foreign money as well as domestic goods. In this case the authorities would find the inflation tax base shrinking at a more rapid rate than if substitution only took place between domestic money and goods. In fact when there is currency substitution a reduction in inflation would result in a relatively larger welfare gain for the public and at the same time relatively higher revenues for the government. Needless to say these arguments further strengthen the case against the use of inflation to finance government deficits.

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