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CURRENCY SUBSTITUTION AND GOVERNMENT REVENUE FROM INFLATION*

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Abstract:

The purpose of this paper is to show that in the case of an open economy the calculations of revenue-maximing rates of inflation have been made using a restrictive model that assumes that domestic residents can only substitute between domestic money and goods (and real assets). The paper demonstrates that once the effects of currency substitution, so common in developing countries, are taken into account, the inflation rate that maximizes the proceeds of the inflation tax can be quite lower than would be the case when currency substitution is ignored.

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]. The conventional analysis of the inflation tax indicates that 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[2]. 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 semi-eleasticity 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].

* The views expressed in this paper are the sole responsibility of the authors. Helpful comments by a number of colleagues and an anonymous referee are gratefully acknowledged.

The purpose of this paper is to show that in the case of an open economy the calculations of revenue-maximizing rates of inflation have been made using a 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[4], 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[5]. 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 can be quite lower than would be the case when currency substitution is ignored[6]. It is also clear from the empirical findings of Blejer (1978), Ortiz (1983), Tanzi and Blejer (1982), and Ramírez-Rojas (1985), 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.

The remainder of the paper proceeds as follows: Section II develops the basic framework for the analysis using 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 III. The main conclusions of the paper are contained in Section IV.

II. A Theoretical Model of Inflationary Finance

Assuming that the economy has a stationary level of real income[7], and that equilibrium in the money market holds continuously, the demand for domestic real cash balances can be specified in the semi-logarithmic form as:[8].

$$(1) \qquad \frac{M}{P} = m = a\exp(-\beta\pi)$$

where M is the domestic nominal stock of money; P is the price level; π is the rate of inflation, $\frac{dP}{dt}\frac{1}{P}$; and a and β are positive constants.

The model described by equation (1) has 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 shourt-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[9]. For the sake or simplicity we also exclude interest rates on competing domestic financial assets from the formulation[10].

The revenue from money creation, denoted by R, in real terms is defined as:[11].

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

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

Combining equations (1) and (2) and since $\frac{d\pi}{dt} = 0$ in the steady state we obtain:

$$(3) \qquad R = \pi m$$

To calculate the rate of inflation that maximizes government revenues we can differentiate (3) with respect to π and set this equal to zero. The revenue-maximizing rate of inflation will be given by:

$$(4) \qquad \tilde{\pi}_1 = \frac{1}{\beta}$$

This is the standard result reported in the inflation tax literature[12], and we will refer to it as 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[13], 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 Ramírez-Rojas (1985), has shown that currency substitution can take place in countries that differ considerably in levels 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 eactly 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 arguéd 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:[14]

$$(5) \qquad m = a\exp(-\beta\pi - \gamma\dot{e})$$

where e is the proportional change in the exchange rate, $\dot{e} = de/e$[15], and γ is the exchange rate semi-elasticity of the demand for money, $\gamma > 0$[16]. 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 obviously have to be the same.

Going through the relevant maximization procedure for the currency substitution model we find that the inflation rate that maximizes revenues ($\tilde{\pi}_2$) is given by:

$$(6) \qquad \tilde{\pi}_2 = \frac{1}{\beta + \gamma \frac{d\dot{e}}{d\pi}}$$

In comparing equations (4) and (6) we observe that the difference between the classical result and the result that we obtain with currency substitution dependes 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 obviously back in the classical case given by equation (4).

The interesting cases arise, of course, when 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.

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[17]. 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 stready state can be written as:

$$(7) \qquad \dot{e} = \pi - \pi^*$$

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 (7) into (6) we obtain the revenue-maximizing rate of inflation:[18]

$$(8) \qquad \tilde{\pi}_2 = \frac{1}{\beta + \gamma}$$

which, since γ is positive, will be lower than the rate of inflation yielded in the classical case, equation (4). The difference between equation (4) and (8) will naturally depend on the value of γ[19].

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 (5) and (7) is more elastic with respect to the rate of inflation than the corresponding demand curve in the classical model. In the latter case the inflation elasticity of money demand (ϵ_1) is:

$$(9) \qquad \epsilon_1 = -\beta\pi$$

For the model with currency substitution, the elasticity can be calculated by combining equations (5) and (7), taking logarithms, and differentiating with respect to inflation to obtain:

$$(10) \qquad \epsilon_2 = \pi \frac{d\log m}{d\pi} = -(\beta + \gamma)\pi$$

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

The difference between the demand curves that correspond to (9) and (10) 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 $-(\beta + \gamma)\pi$. Assume that the initial position is given by π_0 ($= \pi^*$) and log $(M/P)_0$, where the revenues in the two cases are the same[20]. 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

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

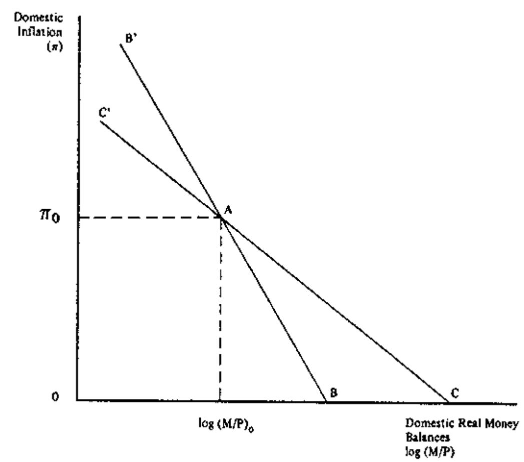

Figure 1 can also be used to compare the welfare costs imposed on money holders by inflation that emerge from the two models under consideration here. The welfare cost has been defined by Bailey (1956) and others as approximately the area under the demand schedule for real money balances. In Figure 1 this welfare cost of inflation is represented by 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:[21]

Classical model

$$(11) \quad w_1 = \frac{1}{2}\,\pi \log m \epsilon_1 = -\frac{1}{2}\,\pi^2 \log m \beta$$

Currency substitution model

$$(12) \quad w_2 = \frac{1}{2}\,\pi \log m \epsilon_2 = -\frac{1}{2}\,\pi^2 \log m\,(\beta + \gamma)$$

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

$$(13) \quad w_1 - w_2 = \frac{1}{2}\,\pi^2 \log m \gamma$$

The result given by (13) is quite important, since it shows that a relatively larger welfare gain can be achieved by reducing the rate of inflation in countries where cu-rrency substitution happens to exist. This reduction in the welfare costs imposed on the public should favor even more the lowering of inflation in developing countries.

III. 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 in-flation. This type of simulation experiment is particularly useful in providing a quan-titative 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[22]. We decided to limit the range of values for β to 0.5, 1.0, 2.0, and 3.0, since most estimates of the inflation semi-elasticity for developing countries have tended to cluster around these numbers[23]. In the case of γ, which measures the semi-elasticity of domestic real cash balances with respect to the diffe-rential 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 γ directly from them. Thus, for the analysis we arbitrarily selected the following values for the parameter γ: 0, 0.5, 1.0, 2.0, and 3.0. The estimates obtained in most studies on currency substitution generally fall within this range[24]. It is important to note also that the values of β and γ here are also representative of the estimates obtained when both the expected rate of inflation and the expected change in the exchange rate are jointly introduced into the specification (Abel *et al.* (1979), and Blejer (1978)).

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 γ				
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

The results in Table 1 show the importance of currency substitution even in the situation semi-elasticity, β, is small. Generally speaking, allowance for substitution between domestic money and foreign money lowers the revenue-maximizing rate of inflation dramatically. If, for example, 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 17-25 percent per annum. Clearly these are a far cry from the estimates of 30 to 50 percent (or higher) that would emerge from the classical model with values of β between 2 and 3.

So far it has been assumed that real income is constant and thus does not enter into calculations. If one relaxes this assumption the revenue-maximizing rate of inflation ($\tilde{\pi}_2$) is given by:[25]

$$(14) \quad \tilde{\pi}_2 = \frac{1}{\beta + \gamma} - \eta_y\, g_y$$

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 (14) that the revenue-maximizing rates of inflation reported in Table 1 would be reduced by a further 5 percentaje points.

IV. 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.

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 be significantly lower than the values that are obtained from the more standard models.

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.

NOTES

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), Khan and Knight (1982), and von Furstenberg (1980).

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

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

4 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.

5 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.

6 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 gobernment revenue from inflation. For an earlier discussion of how to increase revenues from inflation, see Nichols (1974).

7 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.

8 This functional form is due to Cagan (1956).

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

10 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.*, the Fisher equation was assumed to hold.

11 See Cagan (1956).

12 See, for example, Friedman (1971).

13 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.

14 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).

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

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

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

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) One should, therefore, be careful in comparing the value of β obtained from equation (1) with the corresponding estimate from equation (5).

17 See Levich (1984).

18 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 (7), and provided they were independent of π, the calculation shown in (8) would not be affected.

19 The precise difference will be equal to $\gamma / \beta (\beta + \gamma)$. In general, notwithstanding the possibility that the β used in equation (4) may be biased if the true model includes currency substitution, empirical studies have shown that $(\beta + \gamma)$ is greater than β obtained from the simple Cagan model. See Blejer (1978), Tables 1 and 2, and Abel *et al.* (1979), Table 1.

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

21 In general terms the welfare cost is given by the following integral:

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

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.

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

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

24 See, for example, Ortiz (1983), and Ramírez-Rojas (1985).

25 See Friedman (1971).

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CONSIDERACIONES ACERCA DEL ESTADO DEL DEBATE EN TEORIA MACROECONOMICA*

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Abstract:

This paper tries to present the central issues around the macroeconomic debate, emphasizing the prominent role played today by the rational expectations school. The main propositions out of this school are explained, as well as the critiques advanced by its opponents.

I. Introducción

Si se examina la evolución que han experimentado a lo largo del tiempo las diferentes áreas de la teoría económica, resulta notorio el hecho de que mientras algunas de éstas han permanecido relativamente quietas durante un período prolongado –quizás reflejando un importante grado de acuerdo y satisfacción entre los economistas con respecto al contenido de estas teorías–, otras áreas han exhibido un alto dinamismo y una fuerte tendencia a los cambios profundos.

Dentro del primer grupo es posible identificar la teoría de los precios y las aplicaciones de ésta, como la teoría de las finanzas públicas y la teoría real del comercio internacional. En el segundo grupo se ubica el estudio del comportamiento agregado de la economía, conocido como macroeconomía.

Ciertamente, en la teoría de los precios y sus aplicaciones han aparecido nuevos elementos y desarrollos; sin embargo, en general este proceso pareciera seguir una trayectoria estable y gradual de innovaciones, al contrario de la macroeconomía, la que periódicamente experimenta profundas "revoluciones" y "contrarrevoluciones". De esta forma, en la teoría real del comercio internacional, por ejemplo, los diferentes desarrollos que han tenido lugar durante el presente siglo han ido configurado en forma gradual una teoría más completa y rigurosa, ello a pesar de las na-

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