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"Financial Constraints and the Real Effects of Monetary Stabilization Policies under Alternative Exchange Rate Regimes"

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Abstract

A common argument against monetary stabilization policies in developing countries is that they lead to short-run output contractions. This paper shows that, in economies facing financial constraints, such results only need to hold in a fixed exchange rate system. Under flexible exchange rates, reductions in the nominal stock of money will be contractionary only if they are temporary. Permanent decreases in the stock of money will leave output unchanged or might even be expansionary. These conclusions will be valid, however, only if the stabilization policies are fully announced and followed by the governments in those economies.

1/ I wish to thank Peter Isard and Donald J. Mathieson for their valuable comments.

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Summary

A common argument used in developing countries against stabilization policies focused on the control of monetary aggregates is that they lead to output contractions in the short run. The theoretical models on which such arguments are based typically assume fixed exchange rates or a "crawling peg" regime on the grounds that the financial structure of those countries does not permit a viable floating exchange rate system. Recently, however, the exchange rate arrangements of developing countries have evolved toward greater flexibility. This raises the question of whether, in economies facing severe financial constraints, the short-run response of output to monetary stabilization policies is affected by the choice of the exchange rate regime.

This paper argues that a restrictive monetary policy will be more likely to have a contractionary effect on real output with a fixed rather than flexible exchange rate. Under a flexible exchange rate, a restrictive monetary policy will be contractionary only if it is temporary or if agents cannot distinguish between permanent and temporary shocks. Fully anticipated and permanent decreases in the money stock leave output unchanged. Moreover, if the authorities aim to reduce systematically the rate of inflation by reducing the trend growth rate of money, the level of aggregate output will increase.

These results suggest that a flexible exchange rate constitutes an important tool to prevent recessionary effects of monetary stabilization policies in developing countries, provided that the government makes a credible commitment to the stabilization program and supplies all relevant information to economic agents.

I. Introduction

A well recognized feature of developing countries is the existence of a severely limited capital market. In general, commercial banking constitutes the most important form of financial intermediation. The market for primary securities is at a very incipient stage in some of these countries and is even nonexistent in others. In addition, residents of these countries have limited access to international financial markets. 1/

While the literature on developing countries has long recognized that the existence of severely limited capital markets has an important influence on how financial policies affect the real sectors of these economies, 2/ most of that analysis is based on the assumption of a fixed exchange rate or "crawling peg" regime, reflecting the view that the financial structure of those countries does not permit a viable *floating exchange rate system. Recent experience with exchange rate* practices in developing countries, however, does not seem to support the appropriateness of that assumption. An increasing number of countries are relying on market determined floating exchange rates, while other countries that have chosen a multiple exchange rate system rely on flexible rates only for designated items. 3/ Indeed, the current situation with respect to exchange rate arrangements in developing countries ranges from fixed to independently floating exchange rates.

The main objective of this paper is to investigate whether in economies facing severe financial constraints, the short-run responses of output and prices to monetary stabilization policies are affected by the choice of the exchange rate regime. In doing so, this paper attempts to provide some insights to the policy discussion regarding the choice of exchange rate regime in developing countries.

The analysis is conducted by extending the "basic" rational-expectations two-goods model developed in Rojas-Suarez (1987) to allow for

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1/ Access to international financial markets has been particularly limited in the period since late 1982 when, mainly as a reflection of the international financial system's concerns about the creditworthiness of many countries, spontaneous lending to many developing countries has evolved very slowly. See Watson, Mathieson, Kincaid, and Kalter (1986).

2/ This literature has two main streams: on the one hand there are the McKinnon-Shaw Financial Development models initiated by the works of McKinnon (1973) and Shaw (1973) and the later formalizations and extensions of, among others, Kapur (1976), and Mathieson (1979). On the other hand, there are the "Neo-structuralist" financial models represented by Taylor (1981) van Wijnbergen (1982, 1986) and Buffie (1984), among others.

3/ Countries that in recent years have relied on flexible exchange rates include Bolivia, Dominican Republic, the Gambia, Ghana, Guinea, Jamaica, Lebanon, Nigeria, Philippines, Sierra Leone, South Africa, Uganda, Uruguay, Zaire, and Zambia. For an analysis of the recent experience with floating exchange rates in these countries, see Quirk, Christensen, Huh and Sasaki (1987).

alternative exchange rate regimes. In this model, the size of the capital market is limited to the domestic banking sector, and firms are assumed to face the following financial constraint: they have to finance their advances to labor services by borrowing from the domestic banking sector. Although most of the paper concentrates on an economy with zero capital mobility, a section of the paper extends the basic model to allow domestic firms to borrow from foreign creditors. It is shown that the results derived from the basic model still hold, provided that other sectors of the economy do not face a perfect international capital market. That is, this paper shows that as long as some domestic agents face some sort of imperfections in the capital market, the results of the basic model regarding the effects of monetary policy remain unchanged.

A crucial feature of the model is that, as a result of the firms' financial constraint, the outputs of tradable and nontradable goods depend positively on the equilibrium real monetary base (the financial constraint effect), which in turn is negatively correlated with the expected inflation rate. Thus, output and expected future inflation are negatively correlated. In addition, the supply of nontradables (tradables) depends negatively (positively) on the price of tradable goods relative to the price of nontradable goods (the relative price effect). Therefore, the response of output to monetary stabilization policies can be evaluated by analyzing the output response to the effects of such policies on expected inflation and relative prices.

In this paper monetary policy is associated with a change in the component of the monetary base which is exogenous under either exchange rate regime, that is, with a change in central bank credit to the government. 1/ In most of this paper, government credit is assumed to finance only governmental transfers to households. However, the last section of the paper extends the analysis to investigate the consequences of allowing the government to use credit from the central bank as a source of finance for government expenditure on goods and services.

In analyzing the effects of changes in monetary policy, this paper distinguishes between a policy that changes the level of government credit without altering the trend growth rate of government credit and a policy that changes the long-run trend growth rate of government credit. In addition, the paper also distinguishes between permanent and temporary monetary changes.

It is shown that the response of aggregate output to a change in the level of government credit strongly depends on the exchange rate regime. Under a fixed exchange rate, for example, the response depends on the relative strengths of the financial constraint effect and the relative price effect. In particular, if the financial constraint

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1/ The other component of the monetary base, namely the stock of foreign exchange reserves is an endogenous variable under a fixed exchange rate regime.

effect is strong enough, a fully anticipated stabilization policy that decreases (either permanently or temporarily) the level of government credit without altering its trend rate of growth will result in a short-run contraction of aggregate output. By contrast, under flexible exchange rates, a fully anticipated decline in government credit will leave aggregate output unchanged if it is permanent but will reduce output if it is temporary. However, it is shown that if, under flexible rates, agents cannot distinguish between permanent and temporary shocks, even permanent monetary changes can have real effects.

With respect to the second type of monetary policy change, it is shown that the response of aggregate output to an anticipated decrease in the long-term trend rate of growth of government credit is ambiguous under fixed exchange rates, but is expansionary under flexible rates.

A policy conclusion emerges from the previous analysis. Contrary to a common argument used in developing countries, monetary stabilization policies need not be contractionary in the short run. Such a policy will have no output effect or might even be expansionary if (1) the economy relies on a flexible exchange rate system; (2) the decline in government credit is permanent; and (3) the policy announced as permanent is credible instead of being viewed as being temporary.

The remainder of this paper is organized as follows: Section II briefly describes the model to be analyzed. Section III summarizes previous results obtained from solving the model under fixed exchange rates. Section IV solves the model under flexible rates and full current information. Here the analysis emphasizes the importance of the financial constraint in determining the effects of monetary stabilization policies on the outputs of tradable and nontradable goods. Section V relaxes the complete current information assumption in the flexible exchange rate case by introducing confusion between permanent and temporary shocks to the monetary base. Section VI introduces foreign loans into the model, and discusses the extent to which the basic results remain unchanged. Finally, Section VII concludes the paper by comparing the results obtained under the two exchange rate regimes and by discussing some of the policy implications derived from the analyses.

II. The Model

This section briefly summarizes the macroeconomic model used here to analyze the response of output, prices, and the exchange rate (or the level of foreign exchange reserves) to monetary policies in an economy facing a financial constraint. A detailed explanation of the model, as well as the microfoundations on which it is based, are explicitly presented in Rojas-Suarez (1987).

The model represents an economy inhabited by four kinds of agents: firms, households, banks, and the government. In this economy, all transactions are carried out with money. In addition, money is the only

(tradable) store of value. The transactions involve five markets: money, tradable commodities, nontradable commodities, labor and credit.

This economy nonetheless is assumed to face a severely limited capital market. The chief limitations are the absence of a market for primary securities together with an absence of any type of financial intermediation other than commercial banking. Sales of equities or bonds (private and public) to domestic households or foreigners are ruled out. It is also assumed that banks do not engage in making loans to households. In this context, firms face the following "financial constraint:" they need to finance their advances to labor by demanding credit solely from the domestic banking sector. 1/ Thus, the availability of real credit places a constraint on the level of output.

The economy's current output consists of both tradable and nontradable commodities produced by firms using a single production process that yields joint products. This process requires domestic labor services provided by households as the only variable factor of production. Both types of commodities are treated solely as consumption goods.

The banking system is made up of a central bank and commercial banks. The central bank has three functions: it finances the government (whose only function is to provide transfers to households) through the issuance of high-powered money, imposes a required reserve ratio on the commercial banks, and acts as the foreign exchange authority. In this open economy model, the monetary base has two asset counterparts: the government credit and foreign exchange reserves.

Commercial banks hold reserves, supply credit to firms, and issue only one kind of deposit: demand deposits that do not pay interest. 2/ Bank loans have a maturity length of one period. It is assumed that households and firms keep all their money in the form of demand deposits issued by the commercial banks; that is, that their currency-deposit ratio is equal to zero. Hence, the entire monetary base is held as reserves by the banks.

Time is divided into discrete uniform intervals. A sequential trading arrangement in which labor and credit markets open and clear at the beginning of the period and the commodities and money markets at the end of the period is assumed.

At the beginning of the period, firms decide on their demand for labor and credit and on their supply of output, and households decide on their supply of labor. Given the level of banks' reserves (which equals

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1/ This assumption will be relaxed in Section VII by allowing firms to borrow in international financial markets.

2/ This assumption is taken to reflect the oligopolistic position of the banking sector in many developing countries. This noncompetitive situation reflects, in several cases, barriers of entry to the financial sector imposed by government regulations. See Fry (1982).

the monetary base) and the reserve requirement ratio, the supply of credit by the commercial banks is also determined at the beginning of the period.

In this model, the beginning-of-period monetary base differs from the end-of-period monetary base if there is any net change in the economy's stock of foreign reserves. While the component of the monetary base corresponding to the government credit is determined at the beginning of the period, independently of the exchange rate regime, changes in foreign exchange reserves in a system of fixed exchange rates occur at the end of the period when transactions in tradable commodities take place.

At the end of the period, households decide on their current and future consumption plans and thus, on their demand for money. They demand commodities, and the price of the nontradable good and the equilibrium level of foreign reserves (under fixed exchange rates) or the exchange rate (under flexible rates) are determined.

The structure described above gives rise to the following set of structural equations (expressed in log terms):

(1) $y_t^s = a_0 + a_1({}_ah_t - {}_{at}E(pi_{t+1})) + (1-\tau)\ ({}_{at}E(p_t - p_t^* - s_t)) + a_2u_t$

(2) $(y^*)_t^s = a_0 + a_1({}_ah_t - {}_{at}E(pi_{t+1})) - \tau\ ({}_{at}E(p_t - p_t^* - s_t)) + a_2u_t$

(3) $z_t^d = \delta_0 + \delta_1({}_{bt}E(pi_{t+1}) - p_t) + \delta_2({}_ah_t - p_t) + \varepsilon_t$

(4) $(z^*)_t^d = b_0 + b_1({}_{bt}E(pi_{t+1}) - p_t^* - s_t) + b_2({}_ah_t - p_t^* - s_t) + \varepsilon_t$

(5) $pi_t = \tau\ p_t + (1-\tau)(p_t^* + s_t)$

(6) ${}_ah_t = \omega_0 + \omega_1\ gc_t + (1-\omega_1)f_{t-1}$

(7) $y_t^s = z_t^d$

(8a) $(y^*)_t^s = (z^*)_t^d$ under a flexible exchange rate

(8b) $f_t = d_1(y^*)_t^s - d_2(z^*)_t^d + (1-d_3)(p_{t+}^* s_t) + d_3f_{t-1}$ under a fixed exchange rate

and: $\delta_1, \delta_2, b_1, b_2, a_1, a_2, \tau, \omega_o, \omega_1, d_1, d_2, d_3 > 0$

where: y_t^s = aggregate supply of the nontradable good in period t

$(y^*)_t^s$ = aggregate supply of the tradable good in period t

z_t^d = aggregate demand for the nontradable good in period t

$(z^*)_t^d$ = aggregate demand for the tradable good in period t

p_t = domestic price of the nontradable good in period t

p_t^* = foreign price of the tradable good in period t

s_t = the exchange rate during period t: the domestic currency price of foreign exchange.

pi_t = domestic price index in period t

${}_{at}E(p_t - p_t^* - s_t)$ = beginning of period t expectations about the relative price of nontradable to tradable goods (expressed in domestic terms) at the end of period t

${}_{at}E(pi_{t+1})$ = beginning of period t expectations about the period t+1 price index

${}_{bt}E(pi_{t+1})$ = end of period t expectations about the period t+1 price index

${}_a h_t$ = monetary base at the beginning of period t

gc_t = government credit during period t

f_t = foreign reserves at the end of period t

u_t = a term reflecting productivity changes in period t, with $u_t \sim N(0, \sigma_u^2)$

ε_t = a term reflecting changes in preferences between current and future consumption during period t, with $\varepsilon_t \sim (0, \sigma_\varepsilon^2)$.

Equations (1) and (2) are the aggregate supply functions for nontradable and tradable goods, respectively (see Appendix I for derivation). The second term on the right hand side of both equations reflects the financial constraint assumption. As stated before, this assumption implies that current output depends positively on the amount of real credit available to finance production. Since the financial structure of the economy consists of only a banking sector, the total amount of nominal credit is tied (through the reserve requirement ratio) to the nominal monetary base. Therefore, output depends positively on the real monetary base, with the relevant deflator being the price index

expected at the beginning of period t to prevail in period t+1. 1/ Moreover, the coefficients a_0 and a_1 are common to equations (1) and (2) because of the assumption that firms engage in a single production process that yields joint products. For the same reason, the productivity term (u_t), assumed to affect positively the supply of output, shares the same coefficient (a_2) in both equations. 2/

The other argument in the supply of both outputs is the expected relative price term. Firms decide on their relative productions of tradable and nontradable goods according to their expectations regarding the relative price of those commodities. 3/

Equations (3) and (4) describe the aggregate demands for nontradable and tradable goods, respectively. They depend positively on the expected inflation rate (expectations about the future price index relative to the current price of each good), because a higher expected inflation rate induces households to substitute towards current consumption and away from future consumption. In addition, the third term on the right hand side of equations (3) and (4) represents a wealth variable measured as the real value of the monetary base. This variable is assumed to affect positively the desired level of consumption of both commodities. Finally, an increase in ε_t represents a change in preferences that has a positive effect on current consumption.

Equation (5) defines the domestic price index as a weighted average of the price of nontradables and the domestic price of tradables.

1/ In order to understand why ${}_{at}E(pi_{t+1})$ is the relevant deflator for the current period monetary base, it is important to notice that the microfoundations of the model imply the following supply function for nontradable goods:

$$y_t = a_0 + a_1\,({}_a h_t - {}_{at}E(pi_t)) - a_2\,({}_{at}E(pi_{t+1} - pi_t))$$
$$+ (1-\tau)({}_{at}E(p_t - p_t^* - s_t)) + a_2\,u_t$$

where the second term reflects the financial constraint assumption and the third term reflects the assumption that current leisure is a gross substitute for current consumption. Since the microfoundations on which this equation is based imply $a_1 = a_2$, equation (1) is obtained. The same reasoning holds for equation (2).

A more detailed explanation of this issue is contained in Rojas-Suarez (1987).

2/ See Appendix I.

3/ The coefficients of the relative price terms in equations (1) and (2) correspond to the "weights" given to the commodities in the price index. See Appendix I.

Equation (6) defines the beginning-of-period monetary base as a weighted average of the current stock of government credit plus the previous end-of-period level of foreign reserves. 1/

Equation (7) represents equilibrium in the market for nontradable goods and holds irrespectively of the exchange rate regime. In contrast, the equilibrium in the market for tradable goods is expressed by equation (8a) under a flexible exchange rate or by equation (8b) under a fixed exchange rate system. In this zero-capital-mobility version of the model, changes in foreign reserves are equal to the value of the domestic net excess demand for the tradable good. This excess demand is zero under flexible rates because the exchange rate adjusts completely to clear the money market and, therefore, equation (8a) is obtained. However, under fixed exchange rates, the level of foreign reserves becomes an endogenous variable. Hence, equation (8b) is a linear approximation of the definition of changes in foreign reserves.

Although equations (1) to (8) only deal with the two markets for commodities, the money market is implicitly represented in that formulation since equilibrium in the commodities markets implies, by Walras' Law, that the money market is also in equilibrium. In fact, the aggregate demand for money derived from the microfoundations, and implicit in the model formed by equations (1) to (8), depends positively on real output and negatively on the expected inflation rate. 2/ As stated above, it is not necessary to include this equation to solve the macro system. 3/ However, the negative dependence of the demand for real money on expected inflation is a crucial feature of the model. This is so because any change in an exogenous variable leading to an increase in expected inflation also tightens the financial constraint faced by firms since it lowers the equilibrium real amount of money and, therefore, also lowers the real amount of bank credit in the economy.

Finally, to close the model, it is necessary to specify the processes that generates the exogenous variables gc_t, p_t^*, and s_t. Since the analysis in this paper will concentrate only on monetary policy, it is

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1/ Recall that changes in foreign reserves under fixed exchange rates occur at the end of the period and therefore do not form part of the beginning-of-period monetary base. In contrast, under flexible exchange rates, the level of foreign reserves remains unchanged (ignoring valuation adjustments) and hence the beginning and end-of-period monetary bases are equal.

2/ See Rojas-Suarez (1987) for a complete derivation of the demand for money implicit in this model.

3/ Notice that the macro system could also be formed by the equations describing the money market and those describing either commodity market. Instead, we have chosen to deal explicitly with the two commodities markets because we are interested in the output response to various exogenous shocks.

assumed that p_t^* is constant through time. That is, $p_t^* = p^*$. 1/ In addition, it is assumed that:

$$(9) \quad gc_t = gc_{t-1} + m + v_t + x_t - x_{t-1}$$

Where m is a constant trend growth rate; v_t is a stochastic permanent shock; x_t is a stochastic temporary shock; and v_t and x_t, are white noise processes that are serially independent distributed.

The model just described is solved under the assumption that expectations are rational in the sense of Muth (1961). The response of aggregate output to monetary stabilization policies under alternative exchange rate regimes is the subject of the next sections.

III. Monetary Policy under a Fixed Exchange Rate: A Summary

The fixed exchange rate version of the model is formed by equations (1) through (7), equation (8b), and equation (9). In addition, it is assumed here that the exchange rate is constant through time, that is: $s_t = \bar{s}$. Since this case is fully analyzed in Rojas-Suarez (1987), only a brief summary of the results is presented here in order to facilitate the comparisons with the flexible exchange rate case. In particular, we will only concentrate on the economy's response to a stabilization policy commonly used in developing countries; namely, a change in the monetary base arising from a decrease in the stock of the central bank credit to the government. 2/

1. The full current information case

Consider first a stabilization policy that decreases the level of government credit around a constant trend, and hence reduces the monetary base. Assume that the monetary change is permanent (i.e., assume a decrease in v_t). As in any monetarist model, the price level of the nontradable good decreases and the level of foreign reserves increases. Moreover, as is clear from equations (1) and (2), the effects of the monetary policy on the levels of output of both goods can be decomposed into a "financial constraint effect" and a "relative price effect." While the monetary decrease generates an unambiguous relative price change favoring an increase in the output of tradables and a decrease in that of nontradables, the resulting "financial constraint effect" (the response of the real monetary base) needs some explanation. The contemporaneous increase in the level of reserves which follows a decrease in v_t occurs at the end of the period (see Section I) and, hence, does not affect the beginning-of-period monetary base (${}_ah_t$), which is the relevant variable for

1/ The analysis could, of course, be extended to investigate the economy's response to foreign price shocks. In that case, it would be necessary to specify a stochastic process governing the behavior of p_t^*.

2/ For an extensive analysis of the real effects of a devaluation in the context of the present model, see Rojas-Suarez (1987).

determining the current general price level (see equations (1) through (4)). However, it increases the future level of the nominal monetary base (see equation (6)), and, therefore, increases the expected future price level. This increase in the expected future price level combined with the decrease in the current price level (the decrease in the current price of the nontradable good) results in an increase in the expected inflation rate. As a consequence, the demand for real money decreases. Thus, the equilibrium level of the real monetary base (deflated by the future expected general price level) decreases, generating a negative financial constraint effect that tends to cause a short-run decrease in the output of both commodities. As a result, the response of nontradables' output is always negative following a decrease in v_t, but the output of tradables may either increase or decrease; it decreases if the negative financial constraint effect is greater than the positive relative price effect. Therefore, a monetary stabilization policy might be contractionary if the resulting financial constraint effect is strong enough.

If instead the stabilization policy involves a temporary decrease in the level of central bank credit to the government, the financial constraint effect is also negative because such monetary change also generates an increase in the expected inflation rate. Thus, either a permanent or a temporary decrease in the level of government credit might have contractionary effects on output, albeit different magnitudes.

Suppose now that the monetary stabilization policy involves an anticipated decrease in the long-term trend growth rate of government credit (i.e., a decrease in m). In this case, the price level of the nontradable good decreases and the level of foreign reserves increases, as in the previous case, but the magnitude of those changes is bigger than those corresponding to a decrease in v_t. While the relative price effect generated by a decrease in m is similar to (but bigger than) the one generated by a decrease in the level of government credit, the financial constraint effect can be positive or negative. This ambiguity results because of two opposite forces affecting the future expected rate of inflation. On the one hand, the decrease in the growth rate of government credit tends to reduce the future inflation rate, but on the other hand, the resulting increase in foreign reserves rises the future supply of money and hence tends to increase the expected inflation rate. If the financial constraint is positive, that is, if the expected rate of inflation decreases, the level of output of tradable goods unambiguously increases and the level of output of nontradables might increase if the positive financial constraint effect outweighs the negative price effect. That is, in this case, a monetary contraction might result in a short-run expansion of aggregate output.

2. The incomplete current information case

It is now assumed that agents lack full current information. Specifically, during the current period, they do not know the decomposition of a monetary shock between its temporary and permanent components.

interpreted here as a lack of credibility about the permanence of an announced monetary policy.

In this case, the direction of the responses of the price level of the nontradable good and the level of foreign reserves to either a permanent or a temporary decrease in the level of central bank credit to the government are the same as in the full current information case. This is so because, under full current information, the effects of either monetary changes are qualitatively similar. They are of different magnitudes, however. In addition, under full current information, both shocks generated a negative financial constraint effect and a relative price effect favoring the supply of the tradable good. However, as discussed in a previous paper, 1/ a temporary monetary change resulted in a larger financial constraint effect and in a smaller relative price effect than those generated by an anticipated permanent change. Thus, while confusion between permanent and temporary monetary shocks (or lack of credibility about the permanence of an announced shock) can affect the magnitude, but not the direction, of the responses of the output of the nontradable good, such confusion can imply a decrease in the output level of the tradable good following a permanent shock, even in situations where a fully anticipated permanent change would lead to an output expansion. 2/ However, if the financial constraint effect dominates the relative price effect, aggregate output will decrease following a monetary contraction independently of the agents' ability to disinguish between permanent and temporary shocks.

IV. Monetary Policy under a Flexible Exchange Rate and Full Current Information

We can now turn to the flexible exchange rate version of the model formed by equations (1) through (6), equations (7) and (8a) and equation (9).

As stated in Section II, under a flexible exchange rate system, there is no difference between the beginning and end-of-period monetary base because the exchange rate adjusts to clear the money market, with no change in the stock of foreign reserves (and hence: ${}_ah_t = h_t$). In what follows, it will be assumed that the stock of foreign exchange reserves expressed in domestic currency is exogenously fixed at a level f_0. This assumption allows us to consider the level of government credit as the

1/ See Rojas-Suarez (1987).

2/ An anticipated permanent monetary decrease would lead to an increase in the output level of the tradable good if the positive relative price effect outweights the negative financial constraint effect. However, if such permanet change is mistakenly viewed as temporary, the resulting negative (and larger) financial constraint effect might outweight the positive (and smaller) relative price effect and the output of tradables might decrease.

only source of variation of the monetary base and hence equation (9) applies for the entire monetary base. 1/

Under the assumption that the beginning-of-period expectations about the current price levels of both tradable and nontradable goods and the exchange rate are equal to their actual values (full current information), the macro-model of Section II yields the following set of semi-reduced forms for the price level of the nontradable good and the exchange rate:

$$(10)\quad p_t = \frac{1}{\det}\{[(\delta_0-a_0)(\tau+b_1+b_2) + (b_0-a_0)(1-\tau)]$$
$$+ [(\delta_2-a_1)(\tau+b_1+b_2) + (b_2-a_1)(1-\tau)]h_t$$
$$+ [(\delta_1+a_1)(\tau+b_1+b_2) + (b_1+a_1)(1-\tau)]\ {}_{at}E(pi_{t+1})$$
$$- [a_2(1+b_1 + b_2)]\ u_t \quad + [1+b_1+b_2](\varepsilon_t)\}$$

and:

$$(11)\quad s_t = \frac{1}{\det}\{[(b_0-a_0)(\delta_1+\delta_2+1-\tau) + (\delta_0-a_0)\tau]$$
$$+ [(b_2-a_1)(\delta_1+\delta_2+1-\tau) + (\delta_2-a_1)\tau]\ h_t$$
$$+ [(b_1+a_1)(\delta_1+\delta_2+1-\tau) + (\delta_1+a_1)\tau]_{at}E(pi_{t+1})$$
$$- [(1-\tau)(b_1+b_2) + \tau(\delta_1+\delta_2) + (\delta_1+\delta_2)(b_1+b_2)]\ p_t^*$$
$$- [a_2(\delta_1+\delta_2+1)]u_t \quad + [\delta_1+\delta_2+1]\varepsilon_t\}$$

where: $\det = (1-\tau)(b_1+b_2) + (\delta_1+\delta_2)\tau + (\delta_1+\delta_2)(b_1+b_2)$

Holding expectations constant for the time being, several important results emerge from equations (12) and (13). First, the level of the monetary base positively affects both the price level of the nontradable good and the exchange rate if (1) the elasticity of the demand for nontradables with respect to the expected real monetary base (δ_2) is greater than the elasticity of the supply of nontradables with respect to the real monetary base (a_1); and (2) the elasticity of the demand for tradables with respect to the expected real monetary base (b_2) is greater than the corresponding supply elasticity (a_1). In the rest of this paper, it will be assumed that these conditions hold. The need to impose the restrictions $\delta_2 > a_1$ and $b_2 > a_1$ arises because of the

1/ In addition, this assumption evades the "valuation" adjustment problem; i.e., the change in the domestic value of the level of foreign reserves due to a change in the exchange rate.

assumption that the expected real monetary base affects positively the supply functions for tradables and nontradables (because of the financial constraint faced by the firms).

Second, the expected future price index affects both the price of the nontradable good and the exchange rate positively because it enters positively into the demand function for both commodities (because of the intertemporal substitution effect in consumption) and negatively into the corresponding supply functions (because of the intertemporal substitution effect in the supply of labor). 1/

Third, although the foreign price of the tradable good is assumed to be constant here (that is, it is assumed that $p_t^* = \bar{p}^*$), it is obvious from equation (11) that allowing a change in its level would affect the exchange rate negatively with a coefficient equal to one in absolute value, and would have no effect on the price of the nontradable good or in the output of either commodity. This is so because p_t^* and s_t enter the model with the same coefficients; that is, the demand for tradables and the supply of both kinds of goods depend on the domestic currency value of the price of the tradable good. Hence, if p_t^* were allowed to increase, it would cause a "potential" substitution in production from nontradables toward tradable commodities and a "potential" decrease in the demand for tradables. Therefore, the exchange rate would decrease proportionally to keep constant the domestic price of the tradable good. With no change in the term $(p_t^* + s_t)$, the domestic price index would remain unchanged, and hence the rest of the endogenous variables of the system would remain unaffected.

Finally, a positive productivity change has a negative effect on both the price level of the nontradable good and the exchange rate while an exogenous positive change in preferences (a change in ε_t) has a positive impact on both prices.

Expectations are, of course, endogenous variables in the model, and hence equations (10) and (11) are not final solutions. To facilitate the exposition, the derivation of the rational expectations solutions for the exchange rate, the output levels, and the price level of the nontradable good are presented in Appendix II. 2/ As in Section III, the analysis that follows will concentrate on the effects of a restrictive monetary policy. Also, as in Section III, we distinguish here among three forms in which, as part of a stabilization program, a restrictive monetary policy might be implemented.

Consider first, a permanent decrease in central bank credit to the government that decreases the stock of the monetary base leaving the trend growth rate of money constant. In this flexible exchange rate

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1/ Once more, for the interested reader, it is important to recall that the microfoundations of the model are presented explicitely in Rojas-Suarez (1987).

2/ The solutions for the fixed exchange rate case are presented in Rojas-Suarez (1987).

case, such a permanent monetary shock (v_t) has a negative and proportional effect on the domestic price level of the economy. Thus, the price level of the nontradable good and the exchange rate will change in the same proportion as the change in v_t, leaving the levels of outputs unchanged. This result sharply contrasts with that obtained in the fixed exchange rate case.

Consider now a stabilization policy that temporarily decreases government credit and hence reduces the stock of the monetary base. A decrease in x_t induces two effects: (1) it increases the expected future inflation rate (because agents know that the policy is temporary and thus, expect an increase in the future level of money) and, hence, it lowers the value of the real monetary base (a financial constraint effect); and (2) it induces a change in the relative price term: $(p_t - \bar{p}^* - s_t)$, but the direction of this change depends on the relative elasticities of the aggregate demands for tradable and nontradable commodities. The explanation of this result is straight forward: the impact effect of a temporary decrease in the monetary base affects identically the aggregate supply of both commodities because the coefficient a_1 is common to both supply functions (see equations (1) and (2)); however, the impact effect on the demand sides can differ in magnitude, depending on the value of the demand elasticity of the nontradable good with respect to the real monetary base (δ_2) relative to the corresponding demand elasticity of the tradable good (b_2) and on the value of the demand elasticity of the nontradable good with respect to the expected inflation term (δ_1) relative to the corresponding demand elasticity of the tradable commodity (b_1) (see equations (3) and (4)). Only if $\delta_1 = b_1$ and $\delta_2 = b_2$, would the relative price effect vanish.

Taken together, the above effects of a temporary decrease in the monetary base result in a decrease of the levels of both tradable and nontradable goods. While the financial constraint effect induces firms to decrease their demand for labor and hence the output levels of both commodities, the relative price effect induces firms to increase the production of the good whose relative price has risen and to decrease the production of the other commodity. However, it can be shown that when both the financial constraint and the relative price effects are present, the relative price effect is smaller (in absolute value) than the financial constraint effect. Hence, the net effect is a reduction in the level of output of both commodities, 1/ albeit in different magnitudes. As a consequence, temporary monetary decreases might be contractionary under either fixed or flexible exchange rates.

1/ From equations (2.7) and (2.8) of Appendix II, it can be seen that the financial constraint effect will dominate the relative price effect if $|A_2 - B_2| < a_1$.

$$\text{Now:} \quad A_2 - B_2 = \frac{a_1(b_2+b_1-\delta_1-\delta_2) + \delta_1 b_2 - \delta_2 b_1}{\det} = a_1 \, (X)$$

Where the absolute value of X is less than one. Thus, the financial constraint effect dominates the relative price effect.

Finally, suppose that the stabilization policy involves a decrease in the trend growth rate of money. In that case, the levels of output of both commodities increase due to two effects: (1) a decrease in the expected inflation rate that increases the real value of the monetary base; and (2) a relative price effect of undetermined sign but of smaller magnitude (in absolute terms) than the effect in (1).

Therefore, the output response to a monetary contraction crucially depends on the nature of the policy. While a temporary monetary decrease leads to a decrease in output, a decrease in the trend growth rate of money results in an output expansion. The reason is, of course, that both policies have opposite effects on the expected inflation rate.

V. Monetary Policy under a Flexible Exchange Rate and Incomplete Current Information

In this section, agents are assumed to lack full current information in the same way as in the fixed exchange rate case (see Section II.2). Although at the beginning of the period agents know the current value of the monetary base, they cannot distinguish (during the current period) between permanent and temporary monetary shocks.

In this case, the model gives rise to the following semi-reduced form solutions for the incomplete current information price level of the nontradable good ($\hat{p}_t$) and the exchange rate ($\hat{s}_t$):

$$(12)\quad \hat{p}_t = \frac{1}{\delta_1+\delta_2}\{[\delta_0-a_0] - [1-\tau]\ {}_{at}E[p_t - s_t - p_t^*] + [a_1\tau]\ {}_{at}E[p_{t+1}] + [a_1(1-\tau)]\ {}_{at}E[p_{t+1}^* + s_{t+1}] + [\delta_1\tau]\ {}_{bt}E[p_{t+1}] + [\delta_1(1-\tau)]\ {}_{bt}E[p_{t+1}^* + s_{t+1}] + [\delta_2-a_1]\ h_t - [a_3]\ [u_t-\varepsilon_t]\}$$

$$(13)\quad \hat{s}_t = \frac{1}{b_1+b_2}\{[b_0-a_0] + \tau\ {}_{at}E[p_t - s_t - p_t^*] + [a_1\tau]\ {}_{at}E[p_{t+1}] + [a_1(1-\tau)]\ {}_{at}E[p_{t+1}^* + s_{t+1}] + [b_1\tau]\ {}_{bt}E[p_{t+1}] + [b_1(1-\tau)]\ {}_{bt}E[p_{t+1}^* + s_{t+1}] + [b_2-a_1]\ h_t - [b_1+b_2]\ p_t^* - [a_3]\ [u_t-\varepsilon_t]\}$$

The system formed by equations (12) and (13) differs from the corresponding system of the full current information case. It contains beginning-of-period expectations of both the exchange rate and the price of the nontradable good as well as distinguishing between beginning and

end of period expectations of this variable. 1/ However, in the context of the present model, expectations of the current and future price levels of the nontradable good and the exchange rate are identical at both the beginning and end of period. This is so because knowledge of the price levels at the end of the period does not help agents to distinguish between the temporary and permanent monetary shocks; hence,

$$_{at}E(h_t) = {}_{bt}E(h_t) = h_{t-1} + m + (v_t+x_t) - x_{t-1}.$$

The agents' inability to distinguish clearly between permanent and temporary monetary shocks, 2/ poses a signal extraction problem of the following form: Given the assumptions regarding the stochastic processes governing the behavior of x_t and v_t, the expectations of both random terms can be formed by running their regressions on the observed sum $(v_t + x_t)$.

That is: $E(v_t) = f_1\ (v_t + x_t)$

$E(x_t) = g_1\ (v_t + x_t)$

where: f_1 and g_1 (the regression coefficients) are: $f_1 = \sigma_v^2/(\sigma_v^2 + \sigma_x^2)$; $g_1 = \sigma_x^2/(\sigma_v^2 + \sigma_x^2)$; and σ_x^2 = variance of the temporary stock and σ_v^2 = variance of the permanent shock.

The solution to this version of the model is presented in Appendix II. It is shown that the only difference with the full current information solution lies in the effect of a permanent monetary shock on the levels of domestic prices, the exchange rate, and output levels.

The larger the variance of a temporary shock relative to the total variance of (x_t+v_t), (i.e., the higher the value of g_1), or, alternatively, the higher the probability assigned by economic agents that an announced permanent shock will be temporary, the smaller will be the effect of a monetary shock on the price level of the nontradable good and on the exchange rate and the larger the effect on the output levels. Notice that if $g_1 = 0$, then a permanent shock will affect p_t and s_t with a unitary coefficient with no effect on output; this is so because if the variance of a temporary shock is zero, all monetary shocks will be viewed as permanent. If, on the other extreme, $g = 1$, then all monetary shocks

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1/ Recall that for any variable X:

$_{at}E\ (X)$ = beginning of period t expectations of X.

$_{bt}E\ (X)$ = end of period t expectations of X.

Also recall that: $p_t^* = {}_{at}E(p_t^*) = {}_{at}E(p_{t+1}^*) = {}_{bt}E(p_{t+1}^*) = \overline{p}^*$.

2/ Alternatively, this lack of complete information can be interpreted as a credibility problem. That is, it might be taken to imply that a policy announced as permanent is viewed as having a positive probability of being temporary.

would be perceived as temporary. Therefore, permanent monetary shocks which are not credible will also affect the level of aggregate output. In addition, a permanent decrease in the level of the monetary base causes the exchange rate to "overshoot" relative to its full current information solution. 1/

VI. An Extension of the Model: Foreign Lending

Before turning to the comparison of results between the two exchange rate regimes, it is important to investigate the extent to which the results of the model might change by the introduction of foreign lending.

This section relaxes the assumption that the only source of firms' finance is credit from a domestic banking sector. Instead, it is assumed here that firms have full access to borrowing in international financial markets at the internationally determined interest rate. Every other feature of the model remains as in Section II, however. In particular, households remain without access to capital markets (domestic or foreign).

Although it is also unrealistic to assume that firms face a perfectly elastic supply of foreign loans, this extension of the model serves to prove a major point of the paper, namely that as long as some imperfections in the capital markets remain unchanged, the basic conclusions of the model analysed in the previous sections still hold.

In this modified version of the model, the aggregate supply function of nontradable and tradable goods take the following form: 2/

$$(14) \quad y_t^s = a_o' - a_1' i_t - a_1' {}_{at}E(pi_{t+1} - p_t) + (1-\tau) a_2' ({}_{at}E(p_t - p_t^* - s_t)) + a_3' u_t$$

$$(15) \quad (y^*)_t^s = a_o' - a_1' i_t - a_1' {}_{at}E(pi_{t+1} - p_t^* - s_t) - \tau a_2' ({}_{at}E(p_t - p_t^* - s_t)) + a_3' u_t$$

where

$$(16) \quad i_t = i_t^* + {}_{at}E(s_{t+1} - s_t)$$

and i_t^* = foreign nominal interest rate.

1/ This is so because now a permanent monetary decrease not fully perceived as such, increases the expected inflation rate. Therefore, aggregate output decreases and both the price level of the nontradable good and the exchange rate decrease less than proportionally to the monetary decrease.

2/ Equations (14) and (15) now replaces equations (1) and (2) of Section II.

Equation (16) states that the domestic interest rate needs to be equal to the foreign interest rate after it has been adjusted for expectations about exchange rate movements.

The derivation of equations (14) and (15) is presented in Appendix III. The most importanty result is that, because of the remaining imperfections in the capital market, the aggregate supplies of both commodities depend negatively on the expected inflation rate. Therefore, as in the previous sections, only change in exogenous variables leading to an increase in the expected rate of inflation will have a negative effect on the level of output. The intuition for this result is as follows: In the aggregate supply functions of the model presented in Section II (equations (1) and (2)), an increase in the expected inflation rate had a negative effect on output through two channels: (1) it decreased the real amount of money and the real amount of credit available to finance production; and (2) it induced a decrease in the supply of labor since inflation favors an increase in both current consumption and leisure and a decrease in future consumption.

The introduction of a perfectly elastic supply of foreign loans available to domestic firms eliminates channel (1), since domestic real credit is no longer a constraint on the supply of output. However, channel (2) remains unchanged. This is so because the supply of labor involves an intertemporal decision which, under the assumption that households are excluded from borrowing and lending activities, is affected by the expected inflation rate. 1/ The important consequence of this result is that the basic conclusions obtained in the previous sections still hold even in the presence of foreign lending. For example, under flexible exchange rates a temporary decrease in the stock of money or an increase in the long run trend of money growth increases expectations about the future inflation rate and hence has a negative effect on aggregate output. Moreover, those monetary changes will also result in an expected depreciation of the exchange rate and hence, in this modified version of the model, the domestic nominal interest rate increases (see equation (16)), reinforcing the negative effect on output because of the resulting increase in the cost of credit. This line of reasoning holds for all the rest of policy experiments analyzed in the paper. 2/ The main conclusion of this section is, therefore, that as long as domestic agents face <u>some</u> sort of imperfections in the capital market, monetary policy will affect the short-run behavior of aggregate real output in the manner discussed in the previous sections.

1/ If we were to assume, instead, that households also face a perfect capital market, the supply of labor would depend on the real interest rate. See Lucas and Rapping (1969).

2/ Under fixed exchange rates, the term ${}_{at}E(s_{t+1}-s_t)$ vanishes, but the negative relation between output and expected inflation still holds.

VII. A Comparison Between Alternative Exchange Rate Regimes: Conclusions and Some Policy Implications

Stabilization policies in developing countries often involve the use of restrictive monetary policy. The results presented in the previous sections will now be summarized and used to discuss (1) how does the exchange rate regime followed by a developing country affect the economy's response to monetary policies; (2) how the results in equation (1) are affected if the restrictive monetary policy is combined with a restrictive fiscal policy; and (3) how can the results of the model contribute to the policy debate regarding the choice of the appropriate exchange rate regime. Before turning to the above issues, it is useful to stress that the most important result derived from the previous sections is that in economies facing severe financial constraints, expectations about the future inflation rate constitute a crucial channel of transmission of monetary policy into the level of real economic activity. In particular, the model of this paper predicts a negative correlation between the expected inflation rate and aggregate output. However, the response of the expected inflation rate to monetary policies is more intricate under fixed exchange rates than under flexible rates. This is so because, under fixed rates, the stock of foreign reserves is an endogenous variable which in turn is a component of the future stock of money and hence impinges on expectations about the future inflation rate.

Let us now turn to the comparison of results between the two alternative exchange rate regimes and to the analysis of how those results are affected if fiscal policy is combined with monetary policy.

1. Restrictive monetary policies

A crucial feature of the solution is that while under a fixed exchange rate regime, the response of aggregate output to monetary changes depends on the relative importance of the financial constraint and relative price effects. Under a flexible exchange rate regime, the financial constraint dominates the relative price effect. Therefore, flexible rates strengthen the effects of the financial constraint and hence the negative effect of expected inflation on aggregate output.

In this model, monetary contractions always lead to a decrease in the general price level independently of the exchange rate regime. 1/ In addition, monetary decreases always result in an appreciation of the exchange rate under flexible rates and in an increase in the level of foreign reserves under fixed rates. However, the effects of a restrictive monetary policy on the aggregate level of output depends on the exchange rate regime.

The most important results regarding the response of output to alternative restrictive monetary policies are summarized in Table 1.

1/ This result contrasts with those neo-structuralist models that use a cost-push approach to inflation. They conclude that a restrictive monetary policy is inflationary because it raises the interest rate.

Table 1. Aggregate Output Responses to Alternative Monetary Policies under a Strong Financial Constraint Effect

	Fixed Exchange Rate	Flexible Exchange Rate
Anticipated permanent decrease in the stock of money	-	0
Anticipated temporary decrease in the stock of money	-	-
Permanent decrease in the stock of money mistakenly viewed as temporary	-	-
A decrease in the trend growth rate of money	?	+

where: - = a decrease in output; + = an increase in output; 0 = output remains unchanged; and ? = the response of output is ambiguous.

Under fixed exchange rates, an stabilization policy involving an anticipated decrease in the level of government credit (either permanently or temporarily) results in a short-run contraction of aggregate output if the financial constraint is strong enough. 1/ Moreover, this result hold even if agents cannot infer if the monetary contraction is permanent or temporary (or if the agents belief that a monetary decrease announced as permanent has a positive probability of being temporary) as long as the financial constraint effect dominates the relative price effect (see Section III). If instead, the monetary policy involves a reduction in the trend growth rate of government credit, the response of output is ambiguous. 2/

1/ As stated in Section III, a decrease in the level of government credit leads to an increase in the stock of foreign reserves. This in turn increases the expected future stock of money and hence, the expected inflation rate. Therefore, such monetary contraction generates a negative financial constraint effect on output.

2/ The ambiguity arises because, in this case, the future beginning-of-period rate of growth of the monetary base is subject to two opposite forces: (1) the stock of foreign reserves increases relative to the previous period level; and (2) the rate of growth of the exogenous component of the monetary base decreases as a result of the contractionary monetary policy.

The response of output under a flexible exchange rate system strongly differs from that under a fixed exchange rate system. Aggregate output will decrease only if the authorities undertake a temporary reduction of the money stock that is fully anticipated by the public or if the monetary contraction is permanent but economic agents perceive it as being, at least partly, temporary. If, instead, the contraction in the level of the money stock is permanent and fully anticipated output will remain unchanged. 1/ Moreover, if the authorities decrease the trend growth rate of money, output will increase as a result of a reduction in the expected inflation rate.

2. Restrictive monetary and fiscal policies

It is important to notice that this paper has so far concentrated only on pure monetary policy in the sense that a decrease in government credit has not been associated with a decrease in government expenditure on real goods and services but only with a decrease in monetary transfers. These considerations tend to limit the applicability of the model since, as it is well known, monetary and fiscal policies are strongly interrelated in developing countries. However, to the extent that public services raise the marginal products of private factors of production, and therefore increase the aggregate supply of output, the effects of introducing real government expenditures can be easily analyzed.

Assume that an anticipated permanent decrease in nominal government credit corresponds to a decrease in real government expenditures. In that case, the output decrease will be exacerbated under a system of fixed exchange rates. This is so because now there are two forces impinging negatively on the supply of both tradable and nontradable goods: (1) a negative financial constraint effect; and (2) a reduction in the marginal productivity of private production factors. By contrast, the neutrality of permanent monetary changes under a system of flexible exchange rates will no longer hold. While no financial constraint effect is generated by the permanent decrease in nominal government credit, the decrease in real government expenditure reduces the level of output. This result is exacerbated if the monetary decrease is temporary, since, as discussed above, such policy causes a negative financial constraint effect even under flexible exchange rates.

Therefore, when real government expenditures are included, a flexible exchange rate no longer eliminates the contractionary effects of permanent monetarist stabilization policies. That system minimizes those effects, however, since it prevents the occurance of a negative financial constraint effect.

1/ As explained in Section IV, the neutrality effect of anticipated permanent monetary changes arise because the expected inflation rate remains unchanged and hence, no financial constraint is generated. Moreover, the exchange rate changes in the same proportion as the resulting change in the price level of the nontraded good and hence, there is no relative price effect.

3. Some policy considerations

A common argument used in developing countries against monetary stabilization policies is that they lead to output contractions in the short run. The analysis of the previous sections can now be used to examine the validity of such an argument.

The contractionary effect of a restrictive pure monetary policy only needs to hold in a system of fixed exchange rates. As shown above, monetary decreases will be contractionary under flexible exchange rates only if they are temporary. In this exchange rate regime, a fully anticipated permanent decrease in government credit leaves output unchanged. Moreover, if the authorities aim to systematically reduce the rate of inflation, they will reduce the trend growth rate of government credit and in that case, the level of aggregate output will increase. Therefore, from the point of view of minimizing the negative effects of monetary stabilization policies, a system of flexible exchange rates seems preferable to a system of fixed rates. Furthermore, even when a restrictive monetary policy is accompanied by a restrictive fiscal policy, a flexible exchange rate system is preferable because the resulting decrease in output will be lower than in a fixed exchange rate system.

However, a note of caution needs to be added here. The contractionary effects of monetary reductions will be minimized under flexible exchange rates only if such monetary changes are: (1) permanent; and (2) fully anticipated and credible by the public. If a monetarist stabilization policy announced as permanent is viewed as having a positive probability of being temporary, the policy will be contractionary even in a flexible exchange rate regime. Therefore, an important policy implication is that the monetary stabilization policy needs to be announced and followed by the government in order to minimize the negative impact on aggregate output.

Finally, it should be emphasized here that this paper's conclusion regarding the desirability of flexible exchange rates in the presence of monetary stabilization policies by no means precludes the desirability of fixed exchange rates in the presence of alternative shocks not considered here. In particular, if the shocks impinging on the economy are mostly real, fixed exchange rates might be more desirable than flexible rates. The relevance of the nature of shocks affecting the economy in order to decide on the optimal exchange rate regime has been emphasized by Frenkel and Aizenman (1982). They have shown that the higher the variance of monetary shocks the larger the desirability of flexible exchange rates and that the higher the variance of real shocks the larger the desirability of fixed exchange rates. Since in the model analyzed here we have only considered monetary shocks, our results are in accordance with those of Frenkel and Aizenman.

Derivation of the Aggregate Supply Functions for Tradable and Nontradable Goods

Assume a representative firm that produces both tradable (Y_t^*) and nontradable (Y_t) commodities using a production process that yields joint products. A single input, domestic labor supply (L_t) is used in the production of the two outputs. In addition, labor has to be financed in advance by demanding credit (C_t^d) from domestic banks. The objective of the firm is to maximize expected profits ($_{at}E(^f\pi_t)$):

$$(1.1) \quad \underset{\{Y_t^s,(Y^*)_t^s\}}{\text{Max}} \quad {}_{at}E(^f\pi_t) = {}_{at}E\,\{P_t\ Y_t^s + P_t S_t^*\ (Y^*)_t^s - W_t\ L_t^d - i_t\ C_t^d\}$$

where: P_t = price level of the nontradable good;

P_t^* = price level of the tradable good;

S_t = exchange rate: the domestic currency price of the foreign exchange;

W_t = nominal wage rate; and

i_t = nominal interest rate.

Subject to the following product transformation curve:

$$(1.2) \quad L_t = \frac{1}{2}(Y_t^2 + (Y^*)_t^2)\frac{1}{\phi_t}$$

Equation (1.2) states costs of production in terms of labor units. ϕ_t is a productivity shock and is assumed to affect both outputs equally.

In addition, the firm faces the folowing financial constraint:

$$(1.3) \quad C_t^d = W_t L_t^d$$

The information set that the firm uses at the beginning of the period to form its expectations consists of the information on variables up to period t-1, plus the current wage rate, the interest rate, and the productivity term.

Therefore, the maximization procedure leads to the following supply functions for the nontradable and tradable goods:

$$(1.4) \quad Y_t^s = \frac{{}_{at}E(P_t)}{W_t(1+i_t)}\ \phi_t$$

$$(1.5) \quad (Y^*)_t^s = \frac{{}_{at}E(P_t^*\ S_t)}{W_t(1+i_t)}\ \phi_t$$

From these decisions rules, it is clear that the supply of each commodity depends positively on its own price and on a "common" productivity shock, and negatively on the "effective" cost of labor: $W_t(1+i_t)$.

Log-linear approximations for equations (1.4) and (1.5) are as follows: (with the exception of the interest rate, lower case letters are used to represent the log of a variable)

$$(1.6) \quad y_t^s = -w_t - i_t + {}_{at}E(p_t) + u_t$$

$$(1.7) \quad (y^*)_t^s = -w_t - i_t + {}_{at}E(p_t^* + s_t) + u_t$$

where $u_t = \log \phi_t \sim N(0,\sigma_u^2)$ and u_t is independently distributed from other variables in the model.

Substituting equations (1.4) and (1.5) into equation (1.2) yields the demand for labor, which can be expressed in log form as follows:

$$(1.8) \quad l_t^d = \alpha_o + \alpha_1[{}_{at}E(pi_t) - w_t - i_t] + u_t$$

where: $pi_t \equiv \tau\, p_t + (1-\tau)(p_t^* + s_t) \equiv$ price index

The demand for labor depends positively on the expected money prices of the final outputs and on the productivity shock, and negatively on the effective cost of labor.

Finally, equation (1.3) can be used to derive the firms' demand for credit:

$$(1.9) \quad c_t^d = \beta_o + \alpha_1[{}_{at}E(pi_t) - i_t] + (1-\alpha_1)\, w_t + u_t$$

To complete the derivation, it is now necessary to specify the supplies of labor and credit. It is asumed here (and derived in Rojas-Suarez (1987)), that the supply of labor (l_t^s) behaves according to:

$$(1.10) \quad l_t^s = \gamma_o + \gamma_1(w_t - {}_{at}E(pi_{t+1}))$$

Moreover, the assumptions regarding the nature of the capital market imply that the supply of credit (c_t^s) is a constant proportion of the beginning of the period monetary base (${}_ah_t$). That is:

$$(1.11) \quad c_t^s = k + {}_ah_t$$

Equations (1.16) through (1.11) and the market equilibrium conditions: $l_t^d = l_t^s$ and $c_t^d = c_t^s$ give rise to supply functions in the main text (equations (1) and (2)) where the a's are functions of the βs and γs.

Derivation of the Model's Solutions Under Flexible Exchange Rates

I. The Complete Current Information Case

To work towards a solution to the problem involved here, equation (5) in the main text can be used to rewrite equations (10) and (11) in the following way:

$$(2.1)\quad p_t = A_o + A_1 h_t + A_2\ {}_{at}E(\tau p_{t+1} + (1-\tau)(p^*_{t+1} + s_{t+1})) + A_3 u_t + A_4 \varepsilon_t$$

$$(2.2)\quad s_t = B_o + B_1 h_t + B_2\ {}_{at}E(\tau\ p_{t+1} + (1-\tau)(p^*_{t+1} + s_{t+1})) + B_3 p^*_t + B_4 u_t + B_5 \varepsilon_t$$

where the As and Bs correspond to the right hand side coefficients of equations (10) and (11) of the main text. Equations (2.1) and (2.2) give rise to the following first order difference equations for the exchange rate and the price level of the nontradable good.

$$(2.3)\quad s_t = {}_{at}E(s_t) = [B_o + B_2 A_o \tau - B_o A_2 \tau] + [B_2(1-\tau) + A_2 \tau]\ {}_{at}E(s_{t+1}) + K_1\ {}_{at}E(V_t)$$

$$(2.4)\quad p_t = {}_{at}E(p_t) = [A_o + A_2(1-\tau)B_o - (1-\tau)A_o B_2] + [B_2(1-\tau) + A_2 \tau]\ {}_{at}E(p_{t+1}) + K_2\ {}_{at}E(V_t)$$

where K_1, K_2, and ${}_{at}E(V_t)$ are defined as:

$$K_1' = \begin{bmatrix} B_1 \\ B_2 A_1 \tau - B_1 A_2 \tau \\ -1 \\ B_2(1-\tau) + A_2 \tau \\ B_4 \\ B_5 \end{bmatrix};\quad K_2' = \begin{bmatrix} A_1 \\ A_2 B_1(1-\tau) - A_1 B_2(1-\tau) \\ 0 \\ 0 \\ A_3 \\ A_4 \end{bmatrix};\quad {}_{at}E(V_t) = \begin{bmatrix} {}_{at}E(h_t) \\ {}_{at}E(h_{t+1}) \\ {}_{at}E(p^*_t) \\ {}_{at}E(p^*_{t+1}) \\ {}_{at}E(u_t) \\ {}_{at}E(\varepsilon_t) \end{bmatrix}$$

To find the final solution for the current levels of the exchange rate and the price of the nontradable good, the method of undetermined coefficients is applied. Based on equation (2.3), given the information

set and given our assumptions concerning the processes governing the exogenous variables (equation (9) in the main text and the assumption $p_t^* = \overline{p}^*$), it can be conjectured that the solution for the full current information exchange rate is:

$$(2.5) \quad s_t = \pi_o + \pi_1 h_{t-1} + \pi_2 m + \pi_3 v_t + \pi_4 x_t + \pi_5 x_{t-1} + \pi_6 \overline{p}^* + \pi_7 u_t + \pi_8 \varepsilon_t$$

where the πs are the unknown coefficients.

The method of undetermined coefficients implies that the solutions for the π are:

$$\pi_o = [B_o+B_2A_o\tau-B_oA_2\tau]/[1-B_2(1-\tau)-A_2\tau]$$

$$\pi_1 = \pi_3 = 1$$

$$\pi_2 = [1+B_2\tau-A_2\tau]/[1-B_2(1-\tau)-A_2\tau] > 1$$

$$\pi_4 = B_1 < 1$$

$$\pi_5 = \pi_6 = -1$$

$$\pi_7 = B_4 < 0$$

$$\pi_8 = B_5 > 0$$

Using the same procedure, it can be conjectured that the solution to the full current information price level of the nontradable good is:

$$(2.6) \quad p_t = \theta_o + \theta_1 h_{t-1} + \theta_2 m + \theta_3 v_t + \theta_4 x_t + \theta_5 x_{t-1} + \theta_6 \overline{p}^* + \theta_7 u_t + \theta_8 \varepsilon_t$$

Solving for the undetermined coefficients yields:

$$\theta_o = [A_o + A_2(1-\tau)B_o - A_oB_2(1-\tau)]/[1 - B_2(1-\tau) - A_2\tau]$$

$$\theta_1 = \theta_3 = -\theta_5 = 1$$

$$\theta_2 = 1 + [A_2/1-A_2\tau-B_2(1-\tau)]$$

$$\theta_4 = A_1$$

$$\theta_6 = 0$$

$$\theta_7 = A_3$$

$$\theta_8 = A_4$$

Finally, the solution for the undetermined coefficients gives rise to the following final solutions for the levels of output of the two goods:

$$(2.7)\quad y_t = a_o - \left[\frac{a_1(\tau A_o + (1-\tau)B_o) - (1-\tau)(A_o - B_o + A_2 B_o - B_2 A_o)}{1-B_2(1-\tau)-A_2\tau}\right]$$

$$- \left[\frac{a_1 - (1-\tau)(A_2-B_2)}{1-B_2(1-\tau)-A_2\tau}\right] m + [a_1 + (1-\tau)(A_1-B_1)]\, x_t$$

$$+ [a_2 + (1-\tau)(A_3-B_4)]\, u_t + [(1-\tau)(A_4-B_5)]\, \varepsilon_t$$

$$(2.8)\quad y_t^* = a_0 - \left[\frac{a_1(\tau A_o + (1-\tau)B_o) + \tau\,(A_o - B_o + A_2 B_o - B_2 A_o)}{1 - B_2(1-\tau) - A_2\tau}\right]$$

$$- \left[\frac{a_1 + \tau\,(A_2-B_2)}{1-B_2(1-\tau)-A_2\tau}\right] m + [a_1 - \tau\,(A_1-B_1)]\, x_t$$

$$+ [a_2 - \tau\,(A_3-B_4)]\, u_t - [\tau\,(A_4-B_5)]\, \varepsilon_t$$

II. The Incomplete Current Information Case

The method of solving the model is similar to the full current information case. Hence, it will suffice to state here that the conjectured solutions for $\hat{p}_t$ and $\hat{s}_t$ will now be:

$$(2.9)\quad \hat{p}_t = \hat{\theta}_0 + \hat{\theta}_1\, h_{t-1} + \hat{\theta}_2 m + \hat{\theta}_3\,(v_t + x_t) + \hat{\theta}_5\, x_{t-1} + \hat{\theta}_6\, \overline{p}^*$$

$$+ \theta_7\, u_t + \theta_8\, \varepsilon_t$$

$$(2.10)\quad \hat{s}_t = \hat{\pi}_o + \hat{\pi}_1\, h_{t-1} + \hat{\pi}_2 m + \hat{\pi}_3\,(v_t + x_t) + \hat{\pi}_5\, x_{t-1} + \hat{\pi}_6\, \overline{p}^*$$

$$+ \hat{\pi}_7\, u_t + \hat{\pi}_8\, \varepsilon_t$$

With the exception of $\hat{\theta}_3$ and $\hat{\pi}_3$, all the coefficients are identical to the corresponding θs and πs derived for the full current information case. The only difference is that:

$$\hat{\theta}_3 = A_2\,(1-g_1) + A_1$$

$$\hat{\pi}_3 = B_2\,(1-g_1) + B_1$$

Where, g_1 stands for the variance of the temporary shock relative to the total variance of $(x_t + v_t)$.

The Supply Functions When Firms have Access to Foreign Lending

Assume that firms face the same maximization problem discussed in Appendix I (equations (1.1) to (1.3), but now firms have perfect access to foreign lending such that the domestic rate of intrest (i_t) equals:

$$(3.1) \quad i_t = i^* + {}_{at}E(s_{t+1} - s_t)$$

where: i^* = foreign nominal interest rate

${}_{at}E(s_{t+1}-s_t)$ = beginning of period expectations of the depreciation of the (log of) exchange rate.

In log form, the demand for labor remains as in equation (1.8) of Appendix I. Also, since it is still assumed that households do not have access to borrowing and lending activities, the supply of labor remains as in equation (1.10) of Appendix I. However, the main innovation here is that the availability of domestic bank loans does not play a role in the determination of the equilibrium level of employment because the interest rate no longer depends on the supply of domestic bank credit.

Specifically, assuming equilibrium in the labor market, the system formed by equations (1.8) and (1.10) of Appendix I and equation (3.1) can be solved for the equilibrium wage rate:

$$(3.2) \quad w_t = \frac{1}{\alpha_1 + \gamma_1}\{(\alpha_o - \gamma_o) - \alpha_1 (i_t^* + {}_{at}E(s_{t+1} - s_t)) + \alpha_1 \, {}_{at}E(pi_t) + \gamma_1 \, {}_{at}E(pi_{t+1}) + u_t\}$$

Substituting equation (3.2) into equations (1.6) and (1.7) of Appendix I, we obtain the supply functions for the nontradable and tradable goods, which are presented in the main text (equations (14) and (15)).

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