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DOMESTIC CREDIT AND OUTPUT DETERMINATION IN A "NEW CLASSICAL" MODEL OF A SMALL OPEN ECONOMY WITH PERFECT CAPITAL MOBILITY

by

Peter Montiel
The World Bank
and
The International Monetary Fund
September 1986

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DOMESTIC CREDIT AND OUTPUT DETERMINATION IN A "NEW CLASSICAL"
MODEL OF A SMALL OPEN ECONOMY WITH PERFECT CAPITAL MOBILITY

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"Domestic Credit and Output Determination in a 'New Classical' Model of a Small Open Economy with Perfect Capital Mobility"

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Abstract

Several authors have argued that the appropriate monetary policy variable in Barro-type reduced-form output equations for small open economies is domestic credit. The rationale for this view is that in such economies the monetary authorities can control the stock of domestic credit, but not the money supply.

This assertion is not generally true, however. The controllability of the money supply in small open economies depends on the degree of substitutability between domestic and foreign interest-bearing assets and on the costs of adjusting portfolios. Monetary autonomy will be lost when domestic and foreign interest-bearing assets are perfect substitutes and portfolio adjustment is costless. This paper demonstrates, using a "new classical" structural model, that under these conditions neither money nor domestic credit belong in reduced-form output equations. This is because the conditions that make money uncontrollable in the short run simultaneously make credit policy powerless to affect aggregate demand. Neither anticipated nor unanticipated changes in the stock of domestic credit influence the level of real output under these conditions. Changes in the stock of credit, whether anticipated or otherwise, affect only the stock of foreign exchange reserves, in familiar Mundellian fashion. Empirical evidence that changes in the stock of domestic credit exert short-run effects on real output in small open economies therefore support the view that such economies possess at least some degree of short-run monetary autonomy.
# Outline

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>II. The Model</td>
<td>3</td>
</tr>
<tr>
<td>A. The Supply Specification</td>
<td>4</td>
</tr>
<tr>
<td>B. Demand Specification</td>
<td>7</td>
</tr>
<tr>
<td>III. The Reduced-Form Output Equations</td>
<td>10</td>
</tr>
<tr>
<td>IV. Credit Policy and the Stock of Reserves</td>
<td>19</td>
</tr>
<tr>
<td>V. Summary and Conclusions</td>
<td>24</td>
</tr>
<tr>
<td>Footnotes</td>
<td>27</td>
</tr>
<tr>
<td>References</td>
<td>28</td>
</tr>
</tbody>
</table>
I. Introduction

The relevance of "new classical" macroeconomic models to developing countries is an important empirical issue. The short-run output effects of stabilization policies in these countries--long a controversial topic--depend critically on the validity of the "policy ineffectiveness" proposition that has come to be associated with "new classical" models in industrial countries. The notion that "only unanticipated policy matters" in explaining deviations of output from its normal level has been tested for developing countries by many authors using a variant of Barro's (1976) reduced-form methodology. 1/ A recurring conceptual problem in such tests, however, has been the specification of the monetary policy variable. Barro's original closed-economy formulation considered money (M1), to be the relevant monetary policy instrument, and others have done likewise in the developing-country setting. A number of authors have argued, on the other hand, that the money supply cannot be considered to be under the control of the authorities in a small open economy which pegs its exchange rate, even in the short run, and that consequently the appropriate monetary policy variable is the stock of domestic credit (Blejer and Fernandez (1980), Edwards (1983a) and (1983b)).

The endogeneity of the money supply in a small open economy under fixed exchange rates was a central feature of the monetary approach to the balance of payments (see Frenkel and Johnson (1976)). In a world with capital mobility, the monetary authorities lose short-run control over the money supply when domestic and foreign interest-bearing assets are perfect substitutes and portfolio adjustment is costless. Thus the controllability of the money supply is an empirical issue--it cannot be settled apriori.

The question remains, however, how Barro-type reduced-form output equations should be specified for small open economies under fixed exchange
rates when perfect substitutability and costless portfolio adjustment render the money supply uncontrollable in the short run. The primary purpose of this paper is to demonstrate that contrary to what has been claimed, it is not appropriate to replace money with domestic credit in reduced-form output equations under these circumstances. The reason is a familiar Mundellian one: under fixed exchange rates and perfect capital mobility, monetary policy is powerless to affect output (Mundell (1963)). A secondary purpose of the paper is to determine what variables do belong in the reduced-form equation for output under these circumstances. We find that output will deviate from its normal level not in response to domestic credit shocks, but rather as a result of surprises about world interest rates, prices of traded goods, and domestic fiscal policy. The distinction between anticipated and unanticipated changes in the supply of domestic credit proves to be immaterial in this setting. Whether anticipated or not, changes in the stock of domestic credit simply result in offsetting changes in the monetary authority's stock of foreign exchange reserves.

These points are made below by analyzing the properties of a simple new classical model of a "dependent" economy which operates a fixed exchange rate under conditions of perfect substitutability between domestic and foreign interest-bearing assets and costless portfolio adjustment. While the model is indeed simple, it incorporates two features which enhance the power of monetary policy. These are:

a. The adoption of a "dependent economy" framework. In such a framework, it has been shown elsewhere (Montiel (1986)) that both anticipated and unanticipated monetary policy have real
output effects when costless portfolio adjustment and perfect substitutability are not assumed.

b. The assumption that agents forming expectations about the real interest rate can observe current aggregate information. Turnovsky (1980) and Buiter (1980) have shown that systematic monetary policy can have real output effects in this case by altering the information content of price signals.

Since these features of the model "stack the deck" in favor of finding real output effects of monetary policy, they serve to underline the generality of the results derived below.

The analysis is organized as follows: a simple model with a "new classical" structure and perfect capital mobility is presented in the next section. The model is solved in Section III and its reduced-form output equations are derived and analyzed. Section IV examines the determination of the stock of foreign exchange reserves in this model, with an emphasis on the role played by the stock of domestic credit. A brief summary of the main conclusions appears in Section V.

II. The Model

The open-economy classical model to be described here is a successor to the "dependent economy" model developed by Blejer and Fernandez (1980) and modified by Montiel (1986). The present version differs from its predecessors only in its specification of aggregate demand. This section describes the structure of the model, treating the supply side first.
A. The Supply Specification

Since the supply side of the model is identical to that in Blejer and Fernandez (1980) and Montiel (1986), the description here will be brief. More detailed expositions are available in the papers cited.

Production takes place in two sectors, which consists of traded and nontraded goods. Output in each sector is produced under conditions of diminishing marginal returns. The short-run production functions are:

\[ y^T, S = a_0 + a_1 \ln^T + \varepsilon^T \]  \hspace{1cm} (1)

\[ y^N, S = b_0 + b_1 \ln^N + \varepsilon^N, \]  \hspace{1cm} (2)

where \( a_0, b_0 > 0 \) and \( 0 < a_1, b_1 < 1 \). \( y^i, S \) and \( \ln^i \) are the logs of output and employment in sector \( i \) respectively. \( \varepsilon^i \) is a serially uncorrelated random productivity shock with zero mean and finite variance. The symbol \( \varepsilon^i \), with various superscripts, will be used throughout the paper to denote stochastic variables with these properties. Short-run profit maximization yields the labor demand functions:

\[ \ln^T = \ln^{TO} - (1-a_1)^{-1} (w - p^T) + a_1^{-1} \varepsilon^T \]  \hspace{1cm} (3)

\[ \ln^N = \ln^{NO} - (1-b_1)^{-1} (w - p^N) + b_1^{-1} \varepsilon^N. \]  \hspace{1cm} (4)

here \( w \) is the log of the nominal wage and and \( p^T \) and \( p^N \) are the logs of domestic prices of traded and nontraded goods respectively. The aggregate demand for labor is approximated in log-linear form by:
\[ \xi^D = \xi^O - c_1 (w - p^T) - c_2 (w - p^N) + \varepsilon^L \]  

(5)

where:

\[ \xi^O = (L^{TO} + L^{NO}) \]

\[ c_1 = (1 - \gamma)/(1 - a_1) > 0 \]

\[ c_2 = \gamma/(1 - b_1) > 0 \]

\[ \gamma = L^{NO}/(L^{TO} + L^{NO}); \quad 0 < \gamma < 1 \]

\[ \varepsilon^L = c_1 \varepsilon^T + c_2 \varepsilon^N \]

\(L^{TO}\) and \(L^{NO}\) are initial levels of employment in the traded and nontraded goods sectors.

Workers are assumed to negotiate a labor supply schedule one period ahead based on the price level they expect to prevail during that period. The aggregate supply of labor is therefore:

\[ \xi^S = \xi^O + d_1 (w - p^e_{-1,0}) + \varepsilon^L \]

(6)

where \(d_1 > 0\) and \(p^e_{-1,0}\) is the expectation of the current (time zero) price level \(P\) formed last period (time \(-1\)). The notation \(X_i^j\) will be used below to denote the expectation formed at time \(i\) of the value of the variable \(X\) expected to prevail at time \(j\). All expectations are assumed to be formed Muth-rationally, so that:
\[ x_{i,j}^e = E(X_{j|i}I_i), \]  

(7)

where \( E \) is the mathematical expectations operator and \( I_i \) denotes the set of information available at time \( i \).

Finally, the aggregate price level is the weighted average of the prices of traded and nontraded goods:

\[ p = (1 - \theta) p^T + \theta p^N, \]  

(8)

with constant weights \((1 - \theta)\) and \( \theta \) given by domestic expenditure shares on traded and nontraded goods respectively.

Blejer and Fernandez (1980) show that the supply side of the model can be summarized by the two equations:

\[ y_{TS} = y^{TO} + a_1(p^T - p^N) + \alpha_2(p^T - p^e) + \varepsilon_{TS} \]  

(9)

where:

\[ y^{TO} = a_0 + a_1 y^{TO} > 0 \]

\[ a_1 = \frac{a_1 c_2}{c_1 + c_2 + d_1} > 0 \]

\[ a_2 = \frac{a_1 d_1}{c_1 + c_2 + d_1} > 0 \]

\[ \varepsilon_{TS} = \varepsilon^T + a_1 \frac{c_2(\varepsilon^T - \varepsilon^N) + d_1 \varepsilon^T + \varepsilon^{LS}}{(1 - a_1)(c_1 + c_2 + d_1)} \]
and:

\[ y^{NS} = y^{NO} - \alpha_3 (p^T - p^N) + \alpha_4 (p^N - p_{-1,0}^e) + \varepsilon^{NS}, \]  

(10)

where:

\[ y^{NO} = b_0 + b_1 \varepsilon^{NO} > 0 \]

\[ \alpha_3 = \frac{b_1 c_1 / (1 - b_1)}{c_1 + c_2 + d_1} > 0 \]

\[ \alpha_4 = \frac{b_1 d_1 / (1 - b_1)}{c_1 + c_2 + d_1} > 0 \]

\[ \varepsilon^{NS} = \varepsilon^N + b_1 \frac{c_1 (\varepsilon^N - \varepsilon^T) + d_1 \varepsilon^N + \varepsilon^{LS}}{(1 - b_1) (c_1 + c_2 + d_1)}. \]

Thus, output of traded goods responds positively and output of nontraded goods negatively to a depreciation of the real exchange rate (an increase in \( p^T - p^N \)). An increase in each sector's price relative to the expected aggregate price level, on the other hand, is associated with an increase in output in both sectors.

### B. Demand Specification

The law of one price is assumed to hold continuously for traded goods. Since the economy in question is small, this means that demand for traded goods is given by:

\[ p^T = s + p^{T*}, \]  

(11)
where $s$ is the log of the exchange rate (the domestic currency price of foreign exchange) and $p^T$ is the world price of traded goods in foreign currency.

Domestic demand for nontraded goods is a function of their relative price, of the real interest rate, and of real government spending on nontraded goods:

$$y^{ND} = y^N + e_1 (p^T - p^N) - e_2 r + e_3 g^N + \varepsilon^{ND},$$

(12)

with $e_1, e_2, e_3 > 0$. Equation (12) is in the form of a conventional IS curve, except for the inclusion of the relative price term. The real interest rate is denoted $r$ and $g^N$ is the log of government spending on nontraded goods.

The model's LM curve is:

$$m - p = f_0 - f_1 i + f_2 y + \varepsilon^M,$$

(13)

where $f_1, f_2 > 0$, $i$ is the nominal interest rate, and $y$ denotes the log of aggregate real output, measured in terms of the consumption bundle. $y$ is in turn approximated by:

$$y = y_0 + (1 - \theta) y^T + \theta y^N,$$

(14)

where $y_0$ is a constant and it is assumed that output shares of traded and nontraded goods are initially equal to domestic expenditure shares. The supply of money can be derived from the balance sheet of the banking system as:

$$m = m_0 + \psi n + (1 - \psi) d,$$

(15)
where $m_0$ is a constant and $n$ is the log of net foreign assets (assumed positive), while $d$ is the log of domestic credit. The fraction $\psi$ denotes the initial proportion of the domestic money stock backed by foreign exchange reserves.

To complete the description of financial equilibrium, the link between the real and nominal interest rates is given by the Fisher relation:

$$ r = i - (p_e^0, 1 - p), $$

(16)
i.e., the real interest rate is the difference between the nominal interest rate and the expected rate of inflation. Note that in forming expectations of inflation individuals are assumed to observe the current price level and to utilize current information to form expectations about next period's prices, following Turnovsky (1980) and Buiter (1980). This is in contrast to the use of last period's information in the labor market. This asymmetry arises because the use of last period's information in the labor market does not result from an information lag, but rather from the existence of one-period non-contingent wage contracts. Thus individuals in all markets have access to current information, but workers cannot alter their current labor supply schedules based on this information, because they are bound by preexisting contracts. For a similar formulation in a closed-economy context, see Turnovsky (1980).

Finally, with domestic and foreign assets considered to be perfect substitutes, and costless portfolio adjustment, the arbitrage relationship:

$$ i = i^* + (s_e^{0,1} - s) $$

$$ = i^* $$

(17)

must hold at every instant, where $i^*$ is the world nominal interest rate. The second equality holds on the assumption that the exchange rate is pegged by
the authorities and that the initial level of reserves and the stance of policies are such as to make the existing peg credible. Under these conditions, $s_{0,1}^e = s$.

The model is closed with the "classical" assumption that the market for nontraded goods must clear in every period.

$$y^N = y^N.$$  \hspace{1cm} (18)

In the next section the model is solved and the reduced-form equations for output of traded and nontraded goods are derived.

II. The Reduced-Form Output Equations.

Barro's (1976) methodology for testing that only unanticipated policy matters involves estimating reduced-form output equations and testing whether anticipated policy changes contribute significantly as explanatory variables. This section will show that domestic monetary policy variables—anticipated or otherwise—do not enter the reduced-form output equations in the present model. Output in both sectors depends instead on government spending on nontraded goods, on the world real interest rate, and on the domestic price of traded goods.

To derive the reduced-form equation for output of nontraded goods, use equation (8) to express (10) and (16) in terms of the prices of traded and nontraded goods:

$$y^N = y^N - \alpha_3 (p - p^N) + \alpha_4 [p^N - (1 - \theta) p_{-1,0} - \theta p_{-1,0}^N] + \varepsilon^N$$  \hspace{1cm} (10a)

$$r = i - [(1 - \theta) p_{0,1}^T + \theta p_{0,1}^N] - (1 - \theta) (1 - \theta) p^T - \theta p^N$$  \hspace{1cm} (16a)
Substituting (17) into (16a) and the result into (12) allows the "IS curve" to be written as:

\[
y_{ND} = y_{NO} + e_1 (p^T - p^N) - e_2 \{ i^* - [(1-\theta)p_{0,1}^T + \theta p_{0,1}^N] - (1 - \theta) p^T - \theta p^N \} \\
+ e_3 g^N + \epsilon_{ND}.
\] (12a)

Finally, substituting (10a) and (12a) into the market-clearing condition (18) and solving for the market-clearing price \( p^N \) produces:

\[
p^N = \frac{\alpha_1^2}{\phi_0} \frac{Ne}{p_{-1,0}^T} + \frac{e_2}{\phi_0} \frac{Ne}{p_{0,1}^T} + \frac{a_3 - e_2 (1 - \theta) + e_1}{\phi_0} p^T \\
- \frac{e_2}{\phi_0} i^* + \frac{e_3}{\phi_0} g^N + \frac{\alpha_4 (1 - \theta) Te}{p_{-1,0}^T} + \frac{e_2 (1-\theta)}{\phi_0} p_{0,1}^T + \epsilon_{NP}
\] (19)

where:

\[
\epsilon_{NP} = (\epsilon_{ND} - \epsilon_{NS})/\phi_0
\]

\[
\phi_0 = \alpha_3 + \alpha_4 + e_2 \theta + e_1 > 0.
\]

Taking expectations conditioned on information available last period yields:

\[
p_{-1,0}^N = \frac{e_2}{\phi_1} \frac{Ne}{p_{-1,1}^T} + \frac{e_3}{\phi_1} g_{-1,0} - \frac{e_2}{\phi_1} i^* e_{-1,0} + \\
+ \frac{a_3 + a_4 (1-\theta) - e_2 (1 - \theta) + e_1}{\phi_1} \frac{Te}{p_{-1,0}^T} + \frac{e_2 (1-\theta)}{\phi_1} \frac{Te}{p_{-1,1}^T},
\]

with \( \phi_1 = \alpha_3 + \alpha (1-\theta) + e_2 \theta + e_1 > 0. \) It is convenient to write this as:

\[
p_{-1,0}^N = \frac{e_2}{\phi_1} \frac{Ne}{p_{-1,1}^T} + \frac{e_3}{\phi_1} g_{-1,0} - \frac{e_2}{\phi_1} r_{-1,0} - \frac{e_2}{\phi_1} \frac{Te}{p_{-1,1}^T} + \frac{Te}{p_{-1,0}^T}
\] (20)
where \( r^* = \eta^* - (p_{0,1} - p^T) \) is the external real interest rate. This is a first-order nonhomogeneous difference equation in \( p_{-1,0}^N \). Its solution is:

\[
\lim_{t \to \infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t p_{-1,t}^N + \sum_{t=0}^{\infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t \left[ \frac{e^3}{\phi_1} g_{-1,t}^N - \frac{e^2}{\phi_1} r_{-1,t} - \frac{e^2}{\phi_1} r_{-1,t+1} + \frac{Te}{p_{-1,t+1}} + \frac{Te}{p_{-1,t}} \right]
\]

Since \( e^{2\theta}/\phi_1 \approx 1 \), ruling out "bubbles" in \( p^N \) permits us to write:

\[
\lim_{t \to \infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t p_{-1,t}^N + \sum_{t=0}^{\infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t \left[ \frac{e^3}{\phi_1} g_{-1,t}^N - \frac{e^2}{\phi_1} r_{-1,t} - \frac{e^2}{\phi_1} p_{-1,t+1} + \frac{Te}{p_{-1,t+1}} + \frac{Te}{p_{-1,t}} \right] .
\]

This can be simplified to:

\[
\frac{e^3}{\phi_1} g_{-1}^N - \frac{e^2}{\phi_1} r_{-1} - \frac{e^2}{\phi_1} p_{-1,t+1}
\]

\[
= p_{-1,0} + \sum_{t=0}^{\infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t \left[ \frac{e^3}{\phi_1} g_{-1,t}^N - \frac{e^2}{\phi_1} r_{-1,t} \right]
\]

\[
= p_{-1,0} + \sum_{t=0}^{\infty} \left( \frac{e^{2\theta}}{\phi_1} \right)^t X_{-1,t}^e,
\]

where the exogenous demand variable \( X \) is defined as:

\[
X = \left( \frac{e_3}{\phi_1} \right) gN - \left( \frac{e_2}{\phi_1} \right) r^*.
\]

to simplify notation. Equation (21) is the reduced-form equation for last period's expectation of the current price of nontraded goods. It depends on
last period's expectation of the current price of traded goods and on the entire expected future paths of the real variables $g^N$ and $r^*$. Note that the expected future evolution of traded goods prices is absent from this equation.

By analogy to (21), we can write:

$$p_{0,1}^N = p_{0,1}^T + \sum_{t=0}^{\infty} \left( \frac{e_2}{A_1} \right)^t x^e_{0, t+1}$$

(22).

Equations (21) and (22) can now be substituted into (19) to derive the reduced-form expression for $p^N$. After some algebra, this reduced-form expression can be shown to be:

$$p^N = p_{-1,0}^T + x^e_{-1,0} + (1 + \frac{\alpha_4}{\phi_0}) \sum_{t=0}^{\infty} (e_2/\phi_1)^{t+1} x^e_{-1, t+1}$$

$$+ (1 - \alpha_4/\phi_0)(p^T - p_{-1,0}^T) + (1 - \alpha_4/\phi_0)(X - x^e_{-1,0})$$

$$+ \sum_{t=0}^{\infty} (e_2/\phi_1)^{t+1} (x^e_{0, t+1} - x^e_{-1, t+1}) + \varepsilon^N_{WD}.$$  

According to this expression, the price of nontraded goods depends on the price of traded goods, on current and anticipated future values of exogenous demand, and on the composite random shock $\varepsilon^N_{WD}$.

The effects on $p^N$ of the current values of $p^T$ and $X$ depends as usual on whether these values were anticipated in the previous period. As in common in "new classical" models, the price effects of anticipated shocks exceed those of unanticipated shocks. 3/ Anticipated changes in traded goods prices change the prices of nontraded goods pari passu (the coefficient of $p_{-1,0}^T$ in (23) is unity). An unanticipated increase in traded goods prices, on the other hand (i.e., an increase in $(p^T - p_{-1,0}^T)$) increases the price of nontraded
goods only by a factor of $1 - \alpha_4/\phi_0 < 1$. Similarly, the coefficient of anticipated exogenous demand ($X_{e-1,0}$) exceeds that of unanticipated demand ($X - X_{e-1,0}$), since $1 - \alpha_4/\phi_0 < 1$. Finally, the third and sixth terms on the right-hand side of (23) divide the effects of expected future demand into the component which was expected last period and a component which reflects revisions of last period's expectations based on "news" -- i.e., information revealed during the current period. As can be seen from (23), since $\alpha_4/\phi_0 > 0$, the effects on $p^N$ of the previously anticipated component exceed those of the "surprise" component. 4/

Equation (23) can be used to derive an expression for the real exchange rate $p^T - p^N$:

$$
p^T - p^N = X_{e-1,0} - (1 + \alpha_4/\phi_0) \sum_{t=0}^{\infty} \left( \frac{e^2}{\phi_1} \right)^{t+1} X_{e-1,t+1} + \frac{\alpha_4}{\phi_0} (p^T - p_{e-1,0}) \tag{24}
$$

$$
- (1 - \frac{\alpha_4}{\phi_0}) (X - X_{e-1,0}) - \sum_{t=0}^{\infty} \left( \frac{e^2}{\phi_1} \right)^{t+1} (X_{e-1,t+1} - X_{e-1,t+1}) - e^{NP}
$$

Since $p^T$ is determined exogenously, aggregate demand shocks -- present or future, anticipated or unanticipated -- will affect the real exchange rate only through their effects on $p^N$. Thus each exogenous demand variable enters (24) in the same form as it does (23), but with the opposite sign. Anticipated changes in traded goods prices do not affect the real exchange rate since, as mentioned above, the prices of nontraded goods will change in proportion. Hence $p_{e-1,0}$ does not appear on the right-hand side of (24). Unanticipated increases in traded goods prices (e.g., an unanticipated nominal devaluation) raise the prices of nontraded goods less than in proportion ($1 - \alpha_4/\phi_0 < 1$ in (23)) and thus are associated with a real devaluation (an increase in $p^T - p^N$) in (24).
As a final step before deriving the reduced-form output equations, note that the expected price level $p_{-1,0}^e$ can be written as:

$$
p_{-1,0}^e = (1 - \theta) p_{-1,0} + \theta p_{-1,0}^e
= p_{-1,0} + \theta x_{-1,0} + \theta \sum_{t=0}^\infty \frac{e^{\theta t}}{\phi} x_{-1,t+1}^e.
$$

Thus, the expected price level depends on expected traded goods prices and expected demand shocks during the next and all future periods.

We can now write down the reduced-form equation for output of traded and nontraded goods. To solve for nontraded goods output, substitute (23), (24), and (25) into the supply equation (10). After simplifying, this yields:

$$
y^N = y^{NO} + \Pi_1 x_{-1,0}^e + \Pi_2 \sum_{t=0}^\infty \frac{e^{\theta t}}{\phi_1} x_{-1,t+1}^e + \Pi_3 (p^T - p_{-1,0})
+ \Pi_4 (X - x_{-1,0}^e) + \Pi_5 \sum_{t=0}^\infty \frac{e^{\theta t}}{\phi_1} (x_{0,t+1}^e - x_{-1,t+1}^e) + \epsilon_{NR},
$$

where:

$$
\Pi_1 = (\alpha_3 + \alpha_4) - \alpha_4 \theta > 0
$$

$$
\Pi_2 = (\alpha_3 + \alpha_4) [1 - \theta \frac{\alpha_4}{\alpha_3 + \alpha_4} (1 - \frac{\alpha_3 + \alpha_4}{\phi})] > 0
$$

$$
\Pi_3 = \alpha_4 (1 - \frac{\alpha_3 + \alpha_4}{\phi_0}) > 0
$$

$$
\Pi_4 = (\alpha_3 + \alpha_4) (1 - \frac{\alpha_4 \theta}{\phi_0}) > 0
$$
\[ \Pi_5 = \alpha_3 + \alpha_4 > 0 \]

\[ \epsilon_{NR} = (\alpha_3 + \alpha_4) \epsilon_{NP} + \epsilon_{NS}. \]

Again using (23), (24), and (25), but this time substituting into (9), produces the corresponding expression for output of traded goods:

\[
y^T = y^{T0} - \Pi_6 x^e_{-1,0} - \Pi_7 \sum_{t=0}^{\infty} \left( \frac{e^2}{\phi_1} \right)^{t+1} x^e_{-1,t+1} + \Pi_8 (p^T - p^e_{-1,0}) \]

\[
- \Pi_9 (x - x^e_{-1,0}) - \Pi_{10} \sum_{t=0}^{\infty} \left( \frac{e^2}{\phi_1} \right)^{t+1} (x^e_{0,t+1} - x^e_{-1,t+1}) + \epsilon_{TR},
\]

where:

\[ \Pi_6 = \alpha_1 + \alpha_2 \theta > 0 \]

\[ \Pi_7 = \alpha_1 (1 + \alpha_4 \theta / \phi_0) + \alpha_2 \theta > 0 \]

\[ \Pi_8 = \alpha_2 + \alpha_1 \alpha_4 / \phi_0 > 0 \]

\[ \Pi_9 = \alpha_1 (1 - \alpha_4 \theta / \phi_0) > 0 \]

\[ \Pi_{10} = \alpha_1 > 0 \]

\[ \epsilon_{TR} = \epsilon_{TS} - \alpha_1 \epsilon_{NS}. \]

These equations permit us to make the following observations about short-run output determination in this model:
1. Recalling that the "exogenous demand" variable X is a linear combination of $g^N$ and $r^*$, where the former is a fiscal policy variable and the latter is exogenous to the domestic economy, notice that neither money nor domestic credit appears in the reduced-form output equations. Domestic monetary policy -- whether anticipated or not -- simply has no short-run output effects under fixed exchange rates when domestic and foreign interest-bearing assets are perfect substitutes and portfolio adjustment is costless. This familiar proposition from Mundell (1963) remains valid in the present model. The real interest rate that affects domestic spending in the "IS curve" -- equation (12) -- is the difference between the domestic nominal interest rate and expected domestic inflation. The former is linked to the world nominal interest rate via the interest parity condition (17). The latter can deviate from the world inflation rate and so is not exogenous to domestic policy, but as equation (25) shows, expectations of future prices depend on expected world inflation and real interest rates and on expected domestic fiscal policy, not on current or future domestic monetary policy. 5/

2. Only unanticipated changes in traded goods prices affect domestic output in this model. Anticipated traded goods prices ($p_{-1,0}^T$) do not appear in either (26) or (27). This is the counterpart of the familiar closed economy "monetary neutrality" result for the present model. The reason for the absence of $p_{-1,0}^T$ from (26) and (27) is evident from (23) and (25). An anticipated increase in traded goods prices will increase prices of nontraded goods and the expected price
level in the same proportion. With all actual and anticipated prices changing proportionately, there are no real output effects. This means, of course, that an anticipated devaluation will have no real output effects. Likewise, since expectations of future changes in traded goods prices do not enter the reduced-form output equations, a preannouncement schedule of exchange-rate changes (a "tablita") would have no real output effects. Unanticipated increases in traded goods prices, on the other hand, are expansionary, increasing output in both sectors.

3. Increases in the exogenous components of demand -- whether anticipated or not, whether in the current period or anticipated in some future period -- expand output in the non-traded goods sector and contract it in the traded goods sector. In this model such increases can take the form of reductions in the external real interest rate or increases in government spending on nontraded goods. A similar result was obtained with a different aggregate demand specification in Montiel (1986). These results arise from the exogeneity of traded goods prices, which permit even anticipated changes in demand to affect the real exchange rate (equation 24). An increase in government spending on nontraded goods and/or a reduction in the external real interest rate result in an appreciation of the real exchange rate, according to equation (24), and thus shift output from traded to nontraded goods. This will occur even when such changes were previously anticipated.
4. The output effects of unanticipated changes in exogenous demand exceed those of anticipated changes in demand in the non-traded goods sector. The opposite holds true, however, in the traded goods sector. Notice that, since \((a_3 + a_4) / \phi_0 < 1\), in equation (26) \(\Pi_4 > \Pi_1\), and \(\Pi_5 > \Pi_2\). On the other hand, in equation (27) we have \(\Pi_6 > \Pi_9\) and \(\Pi_7 > \Pi_{10}\). The intuition behind the results is that when expansionary demand shocks are foreseen, workers will demand higher nominal wages next period. This leftward shift in the labor supply curve acts as a negative supply shock which partly offsets the expansion in demand in the nontraded goods sector, thus reducing the output responses in that sector. In the traded goods sector an expansion of demand for nontraded goods has an adverse effect through an induced increase in the equilibrium nominal wage. This negative effect is magnified when the labor supply curve shifts to the left.

IV. Credit Policy and the Stock of Reserves

The previous section demonstrated that changes in the stock of credit have no effects on aggregate demand in the present model. It is natural to ask, therefore, where the effects of changes in the stock of credit show up in this model. The answer is the conventional one given by the monetary approach to the balance of payments --- changes in domestic credit are reflected in changes in foreign exchange reserves. In this section, the reduced-form equation for the stock of foreign exchange reserves is derived and the effects of changes in the stock of credit as well as of other exogenous variables are analyzed.

To derive the reduced-form expression for foreign-exchange reserves, we first derive the corresponding expressions for domestic aggregate real
output and the domestic price level. We then use these together with equations (13) and (15) to solve for \( n \).

The reduced-form equation for aggregate real output is obtained by substituting (26) and (27) in (14). The result is:

\[
y = y_0 + \sigma_1 X_{-1,0}^e + \sigma_2 \sum_{t=0}^\infty \left( \frac{e^\phi}{\phi_1} \right)^{t+1} X_{-1,t+1}^e + \sigma_3 (p^T - p_{-1,0}^T) \\
+ \sigma_4 (X - X_{-1,0}^e) + \sigma_5 \sum_{t=0}^\infty \left( \frac{-e^\phi}{\phi_1} \right)^{t+1} (X_0 - X_{-1,t+1}^e) + \varepsilon^y,
\]

where:

\[
\sigma_1 = \left[ \theta (\alpha_3 + \alpha_4) - (1 - \theta) \alpha_1 \right] - \theta [\alpha_4^\theta + \alpha_2 (1 - \theta)]
\]

\[
\sigma_2 = \left[ \theta (\alpha_3 + \alpha_4) - (1 - \theta) \alpha_1 \right] (1 + \alpha_4^\theta / \phi_0) - \theta [\alpha_4^\theta + \alpha_2 (1 - \theta)]
\]

\[
\sigma_3 = \theta \Pi_3 + (1 - \theta) \Pi_8 > 0
\]

\[
\sigma_4 = \left[ \theta (\alpha_3 + \alpha_4) - (1 - \theta) \alpha_1 \right] (1 - \alpha_4^\theta / \phi_0)
\]

\[
\sigma_5 = \theta (\alpha_3 + \alpha_4) - (1 - \theta) \alpha_1
\]

\[
\varepsilon^y = \theta \varepsilon^{NR} + (1 - \theta) \varepsilon^{TR}.
\]

Note that only one of the parameters can be signed unambiguously — surprise increases in traded goods prices are expansionary, as discussed previously. The ambiguity in the remaining signs reflects the fact that increases in demand for non-traded goods simultaneously expand output of those goods and contract output of traded goods. Since \( 0 < \alpha_4 \theta / \phi_0 < 1 \), however, it can be verified by inspection that if \( \sigma_1 \) is positive, the remaining ambiguous parameters will also be positive—i.e., if anticipated current increases in
demand for nontraded goods increase aggregate output, then so will current unanticipated increases in demand as well as increases in either component of expected future demand. It can be shown that the condition $(1 - b_1) < (1 - a_1)$ --i.e. the demand for labor in the nontraded goods sector is less elastic than in the traded goods sector--is sufficient to render $\sigma_1$ positive. For concreteness, this is assumed to be the case. It follows that increases in domestic demand increase aggregate real output--i.e., $\sigma_1$, $\sigma_2$, $\sigma_3$, $\sigma_4$, and $\sigma_5$ are all positive.

Turning to the domestic price level, note first from equation (8) that $p$ can be written as:

$$p = p^T - \theta(p^T - p^N).$$

Substituting for the reduced-form expression for the real exchange rate (equation (24)) we therefore have:

$$p = p_{-1,0} + \theta x_{-1,0}^e + \theta(1 + \frac{\alpha_{4,0}^e}{\phi_{0}^e}) \sum_{t=0}^{\infty} \left( \frac{e_{2,0}^e}{\phi_{0}^e} \right)^{t+1} x_{-1,t+1}^e$$

$$+ (1 - \frac{\alpha_{4,0}^e}{\phi_{0}^e})(p^T - p_{-1,0}) + \theta(1 - \frac{\alpha_{4,0}^e}{\phi_{0}^e})(X - X_{-1,0}^e)$$

$$+ \theta \sum_{t=0}^{\infty} \left( \frac{e_{2,0}^e}{\phi_{1}^e} \right)^{t+1} (x_{0,t+1}^e - x_{-1,t+1}^e) + \theta^e NP$$

where $p^T$ has been divided into its anticipated and unanticipated components.

To obtain the reduced-form expression for the stock of foreign exchange reserves, substitute (15) into (13) and solve for $n$. This yields:

$$n = \psi^{-1} m_0 + \psi^{-1} p - \psi^{-1} f_{1,i} + \psi^{-1} f_{2,y} - \psi^{-1}(1 - \psi) d + \psi^{-1} e^M.$$
Using (17), (28) and (29) in this expression we have:

\[ n = n_o + \pi_{11} P_{-1,0} + \pi_{12} X_{-1,0} + \pi_{13} \sum_{t=0}^{\infty} \left( \frac{e_2^2}{\phi_1} \right)^{t+1} X_{-1,t+1} \]

\[ + \pi_{14} (p^T_{-1} - p_{-1,0}) + \pi_{15} (X_{-1,0}) + \pi_{16} \sum_{t=0}^{\infty} \left( \frac{e_2^2}{\phi_1} \right)(X_{0,t+1} - X_{-1,t+1}) \]

\[ + \pi_{17} \epsilon^* + \pi_{17} (p_{o,1} - p^T) - \pi_{18} d + \epsilon \eta R \]

where:

\[ n_o = \psi^{-1}(m_o + \ell_2 y_o) > 0 \]

\[ \pi_{11} = \psi^{-1} > 0 \]

\[ \pi_{12} = \psi^{-1}(\theta + \ell_2 \sigma_1) > 0 \]

\[ \pi_{13} = \psi^{-1}[\theta (1 + \alpha_4 \theta/\phi_o) + \ell_2 \sigma_2] > 0 \]

\[ \pi_{14} = \psi^{-1}(1 + \alpha_4 \theta/\phi_o + \ell_2 \sigma_3) > 0 \]

\[ \pi_{15} = \psi^{-1}[\theta (1-\alpha_4 \theta/\phi_o) + \ell_2 \sigma_4] > 0 \]

\[ \pi_{16} = \psi^{-1}(\theta + \ell_2 \sigma_5) > 0 \]

\[ \pi_{17} = - \psi^{-1} \ell_1 < 0 \]
\[ \pi_{18} = -\psi^{-1}(1 - \psi) < 0 \]

\[ \epsilon_{nR} = \psi^{-1} M. \]

Although the resulting expression is complicated in appearance, it has a straightforward interpretation. It is in essence a stock version of the familiar "reserve flow" equation of the monetary approach to the balance of payments generalized for the endogenous determination of domestic prices and output. Most important for our purposes, the effect of changes in the stock of domestic credit is to create offsetting changes in foreign exchange reserves. The coefficient of \( d \) in (30) is negative and equal in absolute value to the ratio of the proportion of the monetary base backed by domestic credit to the proportion backed by foreign exchange reserves. Thus changes in \( d \) will be exactly offset by changes in \( n \), leaving the money supply unchanged (this can be verified from equation (15)). Notice that, since only the actual stock of domestic credit enters (30), this statement holds whether the change in the stock of credit is anticipated or otherwise. The distinction between anticipated and unanticipated changes in domestic credit therefore plays no role anywhere in the model. With the money supply unchanged, the domestic interest rate is unchanged, and the monetary authorities are left without leverage over domestic demand. This accounts for the absence of \( d \) from the reduced-form output equations (26) and (27).

The effects of the remaining exogenous variables in (30) can be interpreted readily. An anticipated increase in traded goods prices increases the price level \textit{pari passu}. Since this increases the domestic demand for money, it gives rise to a capital inflow and an increase in \( n \) as long as \( d \) is unchanged. Current increases in government spending on nontraded goods
increase both real output and the domestic price level and thus increase the demand for money and the stock of reserves. The magnitude of this effect depends on whether the increase was anticipated or not \((\pi_{12} \neq \pi_{15})\), since this will determine both the total effect of \(g^N\) on nominal GDP \((p + y)\) and its composition. Similarly, a current reduction in external real interest rates increases the demand for money and therefore reserves, not only by increasing domestic output and prices, but also by reducing the domestic nominal interest rate. The first two effects appear in \(\pi_{12}\) and \(\pi_{15}\), the last in \(\pi_{17}\). Recall that \(r^*\) enters \(X\) with a negative sign, and \(\pi_{17}\) is negative. Unanticipated increases in traded goods prices also increase the stock of reserves, again because they cause the domestic price level and the level of real output to rise, thereby increasing the demand for money. Finally, an anticipated increase in traded goods prices increases the external nominal interest rate, given the real rate \(r^*\). As a consequence, the domestic nominal interest rate rises, the demand for money falls, and foreign exchange reserves decrease. Thus, an announced future exchange-rate depreciation leads to a capital outflow.

V. Summary and Conclusions

It is sometimes claimed that in a small open economy with fixed exchange rates the domestic monetary authorities have no control over the money supply, even in the short run. What the authorities in such countries do control is the stock of domestic credit. Several authors have therefore advocated replacing money by domestic credit in Barro-type reduced-form tests of policy ineffectiveness propositions for small open economies with fixed exchange rates, and for developing countries in particular.
Loss of short-run monetary autonomy is not a necessary attribute of such economies, however. The degree of substitutability between foreign and domestic interest-bearing assets and the costs of adjusting portfolios will have an important bearing on the degree of monetary autonomy observed in the short-run. The issue is therefore a country-specific empirical one. Cumby and Obstfeld (1983), for example, found that Mexico enjoyed a substantial degree of monetary autonomy during the 1970s, while Takagi (1986) found no scope for monetary control in several Central American countries during the 1950s.

The issue taken up here is the proper specification of the reduced-form output equation for those cases in which costless portfolio adjustment and perfect substitutability make for a complete absence of short-run monetary control. By solving a simple "new classical" structural model, this paper showed that it is not appropriate to simply replace money with credit in the reduced-form tests. This is because the conditions that make money uncontrollable in the short run simultaneously make credit policy powerless to affect aggregate demand. Fiscal policy in the form of spending on nontraded goods plays an important role in the determination of domestic output in this model, as do external real interest rates and unexpected changes in domestic currency prices of traded goods. When costless portfolio adjustment and perfect substitutability render short-run monetary control inoperative, reduced-form output equations for small open economies should contain variables such as these and omit both money and credit variables.

In view of these analytical results, a question naturally arises about the interpretation of empirical studies which find statistically significant short-run output effects associated with changes in the stock of domestic credit for various developing countries (see the survey by Khan and
Knight (1985)). Based on the analysis presented here, the results of these studies cannot be interpreted to be consistent with the loss of short-run monetary autonomy in the countries concerned, since in that case neither money nor credit should appear in reduced-form output equations. A more reasonable interpretation is that the presence of any monetary aggregate in reduced-form output equations provides evidence against the loss of monetary autonomy — i.e., against the empirical relevance for many developing countries of costless portfolio adjustment and perfect substitutability. In that case, the appropriate monetary aggregate to be included in such equations cannot be determined a priori, but will in general depend on the monetary policy regime in effect during the sample period.
Footnotes

1/ A list of references is given in Chopra and Montiel (1986).

2/ Note that (12) does not incorporate a real balance effect. The consequences of including such an effect are described in Section II.

3/ This is discussed at length in a framework similar to the present one in Montiel (1986).

4/ If agents forming expectations of real interest rates do not have access to current information or observe the current price level, the only modification required to the results of this section is that the expectations-revision term would not appear in reduced-form equations such as (23).

5/ This conclusion does not depend on the absence of a real balance effect in the specification of the IS curve. Intuitively, this is because, on present assumptions, domestic monetary policy cannot be used to alter real balances. To demonstrate the result formally, note that if equation (12) contained a term in $m-p$, equations (13), (14), and (17) could be used to express this variable as a function of $i^*$, $y^T$ and $y^N$. Using (9) and (10), $y^T$ and $y^N$ can in turn be expressed in terms of $P^1$, $P^N$, and $P^{-1,0}$. Since these variables already appear in the market-clearing condition (19) used to solve the current version of the model, it follows that the reduced-form output equations of the model modified to include a real balance effect cannot contain any exogenous variables which do not already appear in (19). Specifically, there would be no role for domestic credit in these equations.

6/ Recall that $\psi$ is a constant which measures the initial share of foreign exchange reserves in the domestic money stock.
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