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Output and Unanticipated Money in the
"Dependent Economy" Model

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Summary

An important attribute of the "new classical" macroeconomic models that have been developed for industrial countries during the past decade is the "policy ineffectiveness" proposition, which asserts that systematic aggregate demand policy cannot cause aggregate real output to deviate from its normal level. In view of the controversy that surrounds the short-run real output effects of stabilization policies in developing countries, the relevance of this hypothesis for such countries should be of substantial interest. Empirical tests of "new classical" propositions for developing countries have been based on the estimation of reduced-form real output equations, following Barro. However, these equations have not typically been derived from structural macroeconomic models suitable for developing countries.

This paper builds a "new classical" model for a fixed-exchange rate economy based on the "dependent economy" framework, which has proved particularly fruitful for the analysis of macroeconomic issues in developing countries. The implied reduced-form output equations are quite different from their closed, one-sector counterparts. In particular, anticipated policy changes have real effects in this model, though these effects differ from those of unanticipated changes. These equations are estimated for Mexico for the fixed exchange-rate period 1953-75. The results cast some doubts on the relevance of "new classical" analysis for Mexico during this period.

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I. Introduction

The question of whether policymakers can systematically use aggregate demand policies to stabilize output around its full-employment or "natural" level has been hotly debated by macroeconomists over the past decade. Contrary to the ruling orthodoxy of the early seventies, proponents of "new classical" macroeconomics, which combined the "natural-rate" hypothesis with the hypothesis of rational expectations, argued the "policy ineffectiveness" proposition that since only unanticipated aggregate demand shocks can affect the distribution of output about its "natural" level, aggregate demand policy cannot be systematically used to stabilize output, and may only succeed in destabilizing the price level. ^{1/} The theoretical arguments for this proposition were buttressed with empirical evidence in the form of reduced-form output equations developed by Barro (1978), which demonstrated that only the unanticipated component of monetary policy contributed to explaining deviations of output from its "natural" level in the United States.

The early theoretical and empirical literature of "new classical" macroeconomics--including the Barro reduced-form tests--was formulated in the context of the one-good closed-economy models that have typically been employed for macroeconomic analysis in the United States. Although Barro's tests have been applied to small open economies, the reduced-form output equation has generally either been adopted in its original form or has been modified through the addition of ad hoc variables to take account of the openness of the economies under study. The estimated reduced-form output equation has typically not been derived from an underlying structural model suitable for a small open economy. ^{2/}

For such economies, a key distinction is that between goods that are internationally traded and those that are not, since this characteristic has important implications for the demand conditions faced by domestic producers. Thus the Swan-Salter "dependent economy" model, in which commodities are aggregated into sectors producing traded and nontraded goods, has come to be the dominant framework for the study of macroeconomic issues in small open economies, in contrast to the one-good models that remain prevalent for macroeconomic analysis in large industrial countries. ^{3/} In view of the dominance of this framework, and of the importance of the policy issues raised by "new classical" macroeconomics, it is surprising that little attention has been given to the reformulation of "new classical" models in a "dependent economy" framework, with a view to deriving reduced-form output equations that can be tested for small open economies.

^{1/} See Sargent and Wallace (1975).

^{2/} For a discussion of these issues and a list of references, see Chopra and Montiel (1986).

^{3/} See Swan (1963) and Salter (1959). An extensive discussion of this framework is contained in Prachowny (1984).

The neglect of this issue is particularly surprising in the context of developing countries, where the short-run effects on the level of economic activity of restrictive monetary and fiscal policies associated with adjustment programs has long been a controversial topic, and where the adoption of such measures has often been postponed for fear of recessionary consequences. Such consequences would indeed be predicted by traditional Keynesian models, but the issue would become problematic if the economies in question could be described in "new classical" terms and "policy ineffectiveness" held sway. Thus, ascertaining the empirical relevance of "new classical" analysis for developing countries seems an important step in assessing the short-run costs of adjustment in these economies. Estimating Barro-type reduced-form output equations derived from "dependent economy" structural models for developing countries and testing for systematic effects of anticipated policy changes would appear to be a logical place to start.

This paper moves in that direction by building on the work of Blejer and Fernandez (1980), who constructed a small "dependent" economy model with "new classical" features for an economy with fixed exchange rates and estimated it for Mexico. Their model breaks with closed-economy "new classical" orthodoxy, however, in that its structure is recursive--the price of nontraded goods is determined on the demand side of the model, and this price in turn determines output levels in both the traded and nontraded goods sectors. Blejer and Fernandez do not derive reduced-form output equations for their model, which is estimated in structural form. By contrast, the model explored here--which can be viewed as a generalization of the Blejer-Fernandez model--makes use of a more conventional specification of aggregate demand and is fully simultaneous, in the spirit of closed-economy "new classical" models. In this model, anticipated changes in the money supply and in the nominal exchange rate will be general be nonneutral, in contrast with closedeconomy "new classical" orthodoxy. Real output in both the traded- and nontraded sectors will be affected by such measures, as will (except under very special circumstances) aggregate real output. Nonetheless, as is conventinal in "new classical" models, the real output effects of anticipated policy changes differ from those of unanticipated changes.

The remainder of this paper is divided into four sections. The next section describes the structure of the model. Section III derives the reduced-form sectoral output equations and analyzes their properties. The behavior of aggregate employment and output are investigated in Section IV. In Section V, the reduced-form equations for output in the traded and nontraded goods sectors are estimated for Mexico using data from Blejer and Fernandez. A final section summarizes the analytical and empirical results and presents some conclusions.

II. A "New Classical" Model of a Dependent Economy

In this section, a "new classical" model for a small open economy with a fixed exchange rate is formulated in a "dependent economy" framework. The section is divided into three parts. The first two parts develop the supply and demand sides of the model successively, while the third part presents the market-clearing conditions and describes the formation of expectations. The model is solved and analyzed in Section III.

1. The supply side

It is assumed that production in this economy takes place in two sectors, producing traded and nontraded goods (indexed T and N respectively). Firms employ capital and labor, and the sectoral production functions are Cobb-Douglas, taking the form:

$$(1) y_T^s = a_0 + a_1 k_T + (1-a_1)l_T + \epsilon_T$$

$$(2) y_N^s = b_0 + b_1 k_N + (1-b_1)l_N + \epsilon_N$$

In these equations y_i^s , k_i , and l_i denote the logs of output, capital, and employment in the i th sector. Throughout the paper, upper-case letters will denote levels of variables, while lower-case letters represent the corresponding logs (e.g., $y_t^s = \log Y_t^s$). The parameters a_1 and b_1 denote the shares of capital in the traded- and nontraded goods sectors respectively. They satisfy $0 < a_1, b_1 < 1$. In equations (1) and (2), as in the rest of the paper, ϵ_i will denote a serially uncorrelated random shock with zero mean and finite variance. The random variables ϵ_T and ϵ_N can be interpreted as productivity shocks in the traded and nontraded sectors, respectively.

Since the stock of capital in each sector is fixed in the short run, short-run profit maximization involves selecting the level of employment that equates the marginal product of labor to the product wage in each sector, given the sectoral capital stocks. This yields the sectoral short-run labor demand functions:

$$(3) \quad l_T = l_{T0} + k_T - a_1^{-1}(w-p_T) + a_1^{-1} \epsilon_T$$

$$(4) \quad l_N = l_{N0} + k_N - b_1^{-1}(w-p_N) + b_1^{-1} \epsilon_N,$$

where $l_{T0} = (a_0 + \log(1-a_1))/a_1$ and $l_{N0} = (b_0 + \log(1-b_1))/b_1$ are positive constants. w is the log of the nominal wage, which is the same in both sectors, since labor is homogeneous and intersectorally mobile in the short run.

The short-run aggregate demand for labor is the sum of the demand for labor by the traded goods sector and by the nontraded goods sector. This will in general be a complicated nonlinear function of the logs of the product wages in the two sectors. To preserve the log-linearity of the model, a log-linear approximation is employed:

$$(5) \quad l_D = l_0 - c_1(w-p_T) - c_2(w-p_N) + \epsilon_{LD}$$

where:

$$l_0 = \log(L_{T0} + L_{N0}) + (1-\gamma) k_T + \gamma k_N > 0$$

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

$$c_2 = \gamma/b_1 > 0$$

$$\gamma = L_{N0}/(L_{T0} + L_{N0}), \quad 0 < \gamma < 1$$

$$\epsilon_{LD} = c_1 \epsilon_T + c_2 \epsilon_N$$

L_{T0} and L_{N0} are the levels of employment in the initial equilibrium in the traded and nontraded sectors respectively. Since the sectoral capital stocks are constant, they are subsumed under the constant l_0 for notational brevity in this section. ^{1/}

^{1/} The sectoral capital stocks are treated differently for empirical purposes in Section V.

On the supply side of the labor market, workers are assumed to behave in accordance with the Friedman-Phelps natural rate hypothesis-- i.e., they negotiate a labor-supply schedule one period ahead based on the price level they expect to prevail during that period on the basis of current information. Thus the current supply of labor is given by:

$$(6) \quad lS = l_0 + d_1(w-pe) + \epsilon_{LS}$$

Here pe is the expectation of the current price level p formed on the basis of information available last period, ϵ_{LS} is a labor supply shock, and d_1

is a positive parameter which measures the elasticity of the supply of labor with respect to the expected real wage. 1/

The aggregate price level p is a weighted average of the prices of traded and nontraded goods, with weights given by the domestic expenditure shares on the two goods:

$$(7a) \quad p = (1-\theta)p_T + \theta p_N, \quad 0 < \theta < 1$$

where θ is the share of domestic spending devoted to nontraded goods. The expected price level pe is therefore:

$$(7b) \quad pe = (1-\theta)pe_T + \theta pe_N$$

2. The demand side

The supply side of the model presented in the previous subsection is essentially the same as in Blejer and Fernandez. The model developed here differs from theirs, however, in its specification of aggregate demand. It is assumed that aggregate demand for nontraded goods depends on the real money supply and on the real exchange rate, according to:

$$(8) \quad y_N^D = y_{N0} + \beta_1(m-p) + \beta_2(p_T-p_N) + \epsilon_{DN}$$

1/ The case in which workers contract for a fixed nominal wage one period ahead is approached in the limit as the parameter d_1 goes to infinity. The Friedman-Phelps formulation (6) thus generalizes this more familiar case.

where m denotes the log of the domestic money supply and ϵ_{DN} is an aggregate demand shock. 1/ The parameters β_1 and β_2 are both positive. 2/

Equation (8) indicates that an increase in the domestic money supply increases aggregate demand for nontraded goods, while an increase in the price of nontraded goods has the opposite effect. This equation also has the familiar property that the effect of an increase in the price of traded goods on aggregate demand for non-traded goods is ambiguous. The effect depends on the relative size of the parameters β_1 and β_2 and

on the share of domestic expenditures devoted to nontraded goods, θ . When p_T rises, domestic residents tend to shift demand from traded to

nontraded goods. The magnitude of this substitution effect is expressed by the parameter β_2 . At the same time, however, the increase in p_T

raises the domestic price level by $(1-\theta)dp_T$ and this reduction in the real money supply reduces demand for nontraded goods by $\beta_1(1-\theta)dp_T$. The total effect on demand for nontraded goods is $[\beta_2 - \beta_1(1-\theta)]dp_T$, which

will be positive if the substitution effect is strong (β_2 is large)

and/or the real balance is weak. The latter will be the case if real balances have weak effects on spending (β_1 is small) or if nontraded

goods absorb a large proportion of domestic spending (θ is large). Since, as equation (9) below shows, one cause of an increase in p_T is an exchange-rate depreciation, these issues are related to the possibility that devaluation could exert a contractionary effect on output and employment in this model (see Section IV).

The money supply m in equation (8) is assumed to be determined by the monetary authorities. This means both that the authorities can control the money supply, at least over short periods, and that they choose to do so. The controllability of the money supply is problematic for small open economies operating managed exchange rates. In principle it depends on whether domestic and foreign interest-bearing assets are close substitutes

1/ For a similar specification in a somewhat different model see Dornbusch (1982).

2/ The demand function (8) can be derived from the behavior of a representative consumer for whom current expenditure depends on his stock of real money and who possesses a Cobb-Douglas utility function.

and on the costs of portfolio adjustment (see Montiel (1986)). Thus the issue is ultimately an empirical one. The prevalence of capital controls among developing countries would seem to create a presumption in favor of the retention of at least some degree of short-run monetary autonomy. Nevertheless, authors have differed in their choice of the appropriate monetary policy variable. For Latin America, for example, Barro (1979), Hanson (1980), and Sheehy (1984) have used a monetary aggregate, while Blejer and Fernandez (1980) and Edwards (1983a) chose domestic credit on the presumption that the money stock was outside the control of the domestic monetary authorities.

For present purposes, all that is required is that the monetary authorities be able to control some financial aggregate which influences aggregate demand. Which particular aggregate is thus controlled is less important. The identification of the money stock as the controlled aggregate is consistent with empirical evidence for Mexico provided by Cumby and Obstfeld (1983).

The demand side of the model is completed with the specification of demand for traded goods. Since the economy in question is small and the law of one price is assumed to hold continuously for traded goods, this takes the form of the arbitrage relationship:

$$(9) \quad p_T = e + p_T^*.$$

where e is the log of the nominal exchange rate (the domestic currency price of a unit of foreign currency) and p_T^* is the world price of traded goods measured in foreign currency.

3. Equilibrium and expectations

The "new classical" features of the model are captured in the assumptions that wages and prices adjust instantaneously to clear the markets for labor and nontraded goods and that expectations are formed rationally. Thus the model is closed with the equations:

$$(10) \quad 1D - 1S = 0$$

$$(11) \quad y_N^D - y_N^S = 0$$

$$(12) \quad p_e = E(p | \Omega_{-1})$$

$E(\)$ is the mathematical expectations operator and Ω_{-1} denotes the set of information available the previous period.

III. Derivation of Reduced-Form Sectoral Output Equations

The structure of the model is given by equations (1)-(12). This section analyzes the workings of the model and derives the reduced-form expressions for output of traded and nontraded goods. The model's implications for aggregate output and employment are analyzed in the next section.

1. Solutions for the nominal wage and the price of nontraded goods

To solve the model, we first use equations (10) and (11) to solve for w and p_N , conditional on p_e . Substituting (5) and (6) into (10) yields:

$$-c_1(w-p_T)-c_2(w-p_N)-d_1(w-p_e)+(\epsilon_{LD}-\epsilon_{LS}) = 0,$$

or

$$(13) \quad w = (c_1/\sigma_1)p_T + (c_2/\sigma_1)p_N + (d_1/\sigma_1)p_e + \sigma_1^{-1}(\epsilon_{LD}-\epsilon_{LS}),$$

where $\sigma_1 = c_1+c_2+d_1 > 0$ is the effect of an increase in the nominal wage

on the excess supply of labor. Equation (13) expresses the level of the nominal wage that clears the labor market, given the prices of traded and nontraded goods and the expected price level. Note that the coefficients of p_T , p_N , and p_e are positive numbers that sum to one. That is, increases

in p_T , p_N , and p_e will increase the nominal wage less than in proportion to

the respective price increase, but equal increases in p_T , p_N , and p_e increase the nominal wage by the same amount.

To derive a similar expression for the nontraded goods market, first use (4) to express the supply function (2) in terms of the product wage $w-p_N$:

$$(14) \quad y_N^S = y_{N0} - \frac{(1-b_1)}{b_1} (w-p_N) + b_1^{-1} \epsilon_N,$$

where $y_{N0} = b_0 + (1-b_1)l_{N0} + k_N$, and the short-run constancy of the capital

stock allows it to be subsumed under the constant. Next, eliminate p from equation (8) by substituting from equation (7a):

$$(15) \quad y_N^D = y_{N0} + \beta_1 m - (\beta_2 + \theta\beta_1)p_N + [\beta_2 - (1-\theta)\beta_1]p_T + \epsilon_{DN}$$

Substituting (15) and (14) into (11) now produces:

$$\beta_1 m - (\beta_2 + \theta\beta_1)p_N + [\beta_2 - (1-\theta)\beta_1]p_T + \frac{1-b_1}{b_1}(w-p_N) + \epsilon_{DN} - b_1^{-1}\epsilon_N = 0$$

or:

$$(16) \quad p_N = (\beta_1/\sigma_2)m + \frac{\beta_2 - (1-\theta)\beta_1}{\sigma_2} p_T + \frac{1-b_1}{b_1\sigma_2} w + \frac{\epsilon_{DN} - b_1^{-1}\epsilon_N}{\sigma_2}$$

where $\sigma_2 = \beta_2 + \theta\beta_1 + (1-b_1)/b_1 > 0$ is the effect of an increase in p_N on the excess supply of nontraded goods. This equation expresses the value of p_N necessary to clear the market for nontraded goods as a function of m , p_T , w , and random shocks in the nontraded sector. The coefficients of m , p_T , and w sum to unity, so an equiproportionate increase in money, the price of traded goods, and the nominal wage increases the price of nontraded goods in the same proportion. If $\beta_2 - (1-\theta)\beta_1 > 0$ --i.e., if substitution effects dominate real balance effects in domestic demand--all coefficients are positive and less than unity. If not, the coefficient of p_T is negative and that of m may exceed unity. The sum of the coefficients of these two variables is always positive, however.

Equations (13) and (16) can be solved for the values of w and p_N that simultaneously clear the labor and nontraded goods markets, given m , p_T and p_e . To do so, use (16) to substitute for p_N in (13). After simplifying, this produces:

$$(17) \quad w = \alpha_1 m + \alpha_2 p_T + \alpha_3 p_e + \epsilon_w$$

where:

$$\alpha_1 = \beta_1 c_2 / \phi > 0$$

$$\alpha_2 = (c_1 \sigma_2 + c_2 (\beta_2 - (1-\theta)\beta_1)) / \phi = ?$$

$$\alpha_3 = d_1 \sigma_2 / \phi; \quad 0 < \alpha_3 < 1$$

$$\epsilon_w = (\sigma_2 / \phi) (\epsilon_{LD} - \epsilon_{LS}) + (c_2 / \phi) (\epsilon_{DN} - b_1^{-1} \epsilon_N)$$

$$\phi = \sigma_1 \sigma_2 - c_2 (1-b_1) / b_1 > 0$$

Thus, increases in m and p^e increase the nominal wage. The coefficient of p^e can be shown to be less than unity. The coefficient of p_T will be positive if the condition $\beta_2 - (1-\theta)\beta_1 > 0$ is met. In this case, α_1 can be shown to be less than unity. Whether $\beta_2 - (1-\theta)\beta_1$ is positive or not, it will be true that $\alpha_1 + \alpha_2 + \alpha_3 = 1$, so equal changes in m , p_T , and p^e change w by the same amount. To derive the corresponding equation for p_N , substitute (17) in (16) and simplify. The result is:

$$(18) \quad p_N = \alpha_4 m + \alpha_5 p_T + \alpha_6 p^e + \epsilon_{PN},$$

with:

$$\alpha_4 = \beta_1 \sigma_1 / \phi > 0$$

$$\alpha_5 = [c_1 (1-b_1) / b_1 + \sigma_1 (\beta_2 - (1-\theta)\beta_1)] / \phi = ?$$

$$\alpha_6 = [d_1 (1-b_1) / b_1] / \phi; \quad 0 < \alpha_6 < 1$$

$$\epsilon_{PN} = [(1-b_1) (\epsilon_{LD} - \epsilon_{LS}) / b_1 + \sigma_1 (\epsilon_{DN} - b_1^{-1} \epsilon_N)]$$

The properties of (18) are similar to those of (17). The coefficients of m , p_T , and p^e sum to unity. Increases in m and p^e increase p_N , the latter with a coefficient which is less than one. If $\beta_2 - (1-\theta)\beta_1 > 0$, the effect of an increase in p_T is to increase p_N . In this case, α_4 can be shown to be less than unity.

These results can be illustrated with the aid of Figure 1. The curve NN is the locus of points in w - p_N space for which the nontraded goods market is in equilibrium. Its equation is given by (16). Its slope is $\sigma_2 b_1 / (1-b_1) = b_1 (\beta_2 + \theta \beta_1 + (1-b_1)) / (1-b_1) > 1$. When $\varepsilon_N = 0$, this curve has a horizontal intercept at $(\beta_1 / \sigma_2)m + ((\beta_2 - (1-\theta)\beta_1) / \sigma_2)p_T$, so its position depends on m and p_T . Similarly, equation (13), the equilibrium condition for the labor market, is represented in Figure 1 by the locus LL, with slope $c_2 / \sigma_1 < 1$ and vertical intercept $(c_1 / \sigma_1)p_T + (d_1 / \sigma_1)p^e$, so its position depends on p_T and p^e . Equilibrium is initially at point A, where LL and NN intersect and the combination (w_0, p_{N0}) simultaneously clears the labor and nontraded goods markets. Units have been chosen that $w_0 = p_{N0} = p_{T0}$, so the original equilibrium lies along a 45 degree line from the origin, ray OR. Along this ray, $w = p_N$.

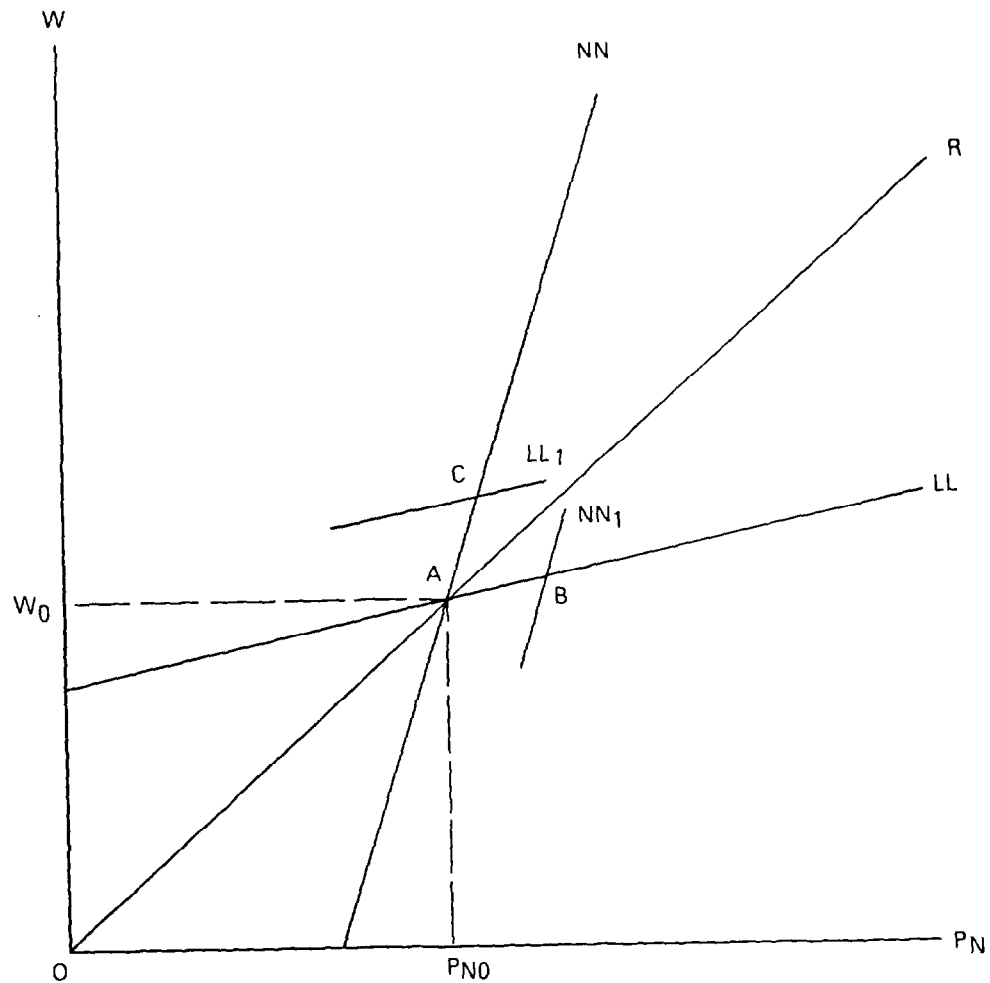
An increase in m increases demand for nontraded goods by $\beta_1 dm$. To restore equilibrium in the nontraded goods market at the original nominal wage requires an increase in the price of nontraded goods of $(\beta_1 / \sigma_2)dm$.

Thus the NN curve shifts to the right by this amount, say to NN_1 .

Since m does not affect the labor market directly, LL is unaffected by the change in m . However, since the increase in p_N increases the demand

for labor in the nontraded goods sector, the nominal wage must rise to maintain labor market equilibrium. Thus the economy moves along LL from

●



A to B. At B, w and p_N are both higher than in the original equilibrium.

Note, however, that since LL is flatter than NN, B lies below the 45 degree line, so the increase in w is less than that of p_N , and the product wage in the nontraded goods sector, $w-p_N$, falls.

An increase in traded goods prices is slightly more complicated to analyze. Traded goods prices affect both the labor and nontraded goods markets directly, so both curves will shift. Since an increase in p_T

will increase the demand for labor in the traded goods sector, the nominal wage must rise, so the LL locus shifts upward by $(c_1/\sigma_1)dp_T$. The shift in the NN locus depends on whether an increase in p_T creates an excess supply in the market for nontraded goods. If $\beta_2 - (1-\theta)\beta_1 > 0$,

the former will be the case, and NN will shift to the right. In this case, w and p_N will both rise, and the coefficients α_2 and α_5 will be positive

in equations (17) and (18). The effect on $w-p_N$ will be ambiguous, depending on the relative magnitudes on the shifts in the two curves.

Finally, an increase in p^e creates an excess demand for labor equal to $d_1 dp^e$ at the original (w_0, p_{N0}) . To restore labor market equilibrium the nominal wage must rise by $(d_1/\sigma_1)dp^e$, so LL shifts upward to LL_1 .

Since p^e does not affect the nontraded goods market directly, the position of NN does not change. However, the increase in w reduces output of nontraded goods, and this adverse supply shift in the nontraded goods markets necessitates an increase in p_N to restore equilibrium. The economy moves

along NN from A to C, where both w and p_N are higher than originally.

This time, however, the new equilibrium lies above the 45 degree line, so the product wage in the nontraded goods sector rises.

Equations (17) and (18) are not reduced-form expressions for w and p_N because the rational expectations assumption (12) implies that p^e is endogenous to the model. To eliminate this variable, use equation (7b) to write (18) in the form:

$$(18a) \quad p_N = \alpha_4 m + (\alpha_5 + \alpha_6(1-\theta))p_T^e + \alpha_6 \theta p_N^e + \varepsilon_{pN}$$

Under rational expectations, $p_N^e = E(p_N | \Omega_{-1})$. Taking conditional expectations of p_N in equation (18a) yields:

$$p_N^e = \frac{\alpha_4}{1-\alpha_6\theta} m^e + \frac{\alpha_5 + \alpha_6(1-\theta)}{1-\alpha_6\theta} p_T^e$$

But since $\alpha_5 + \alpha_6 = 1-\alpha_4$:

$$(19) \quad p_N^e = p_T^e + \frac{\alpha_4}{1-\alpha_6\theta} (m^e - p_T^e)$$

Thus anticipated changes in the value of the money supply measured in units of traded goods will give rise to anticipated changes in the relationship between prices of nontraded goods and prices of traded goods. Since $1-\alpha_6\theta = \alpha_4 + \alpha_5 + \alpha_6(1-\theta) > \alpha_4$, the coefficient of

$(m^e - p_T^e)$ is less than unity.

The reduced-form expression for the price of nontraded goods can now be derived by substituting equation (19) into equation (18a). After simplifying, this produces:

$$(20) \quad p_N = p_T^e + \frac{\alpha_4}{1-\alpha_6\theta} (m^e - p_T^e) + \alpha_4(m - m^e) + \alpha_5(p_T - p_T^e) + \varepsilon_{pN}$$

Thus the key exogenous variables in this model are the expected price of traded goods, the expected value of the money stock measured in terms of traded goods, unanticipated shocks in money and traded goods prices, and the various random shocks that impinge on the behavioral equations. To solve for the nominal wage in terms of these variables, substitute (7a) and then (19) into (17). The simplified reduced-form equation for w becomes:

$$(21) \quad w = p_T^e + (\alpha_1 + \alpha_3 \frac{\alpha_4}{1-\alpha_6\theta}) (m^e - p_T^e) + \alpha_1(m - m^e) + \alpha_2(p_T - p_T^e) + \varepsilon_w$$

The reduced-form effects of $(m - m^e)$ and $(p_T - p_T^e)$ on w and p_N in equations (21) and (20) are exactly the same as the effects of m and p_T on w and p_N in equations (17) and (18). The reason is, of course, that expectations are held constant in both cases.

To analyze the effects of anticipated changes in p_T and in $m - p_T$, break p^e into its components in equation (13) by substituting from equation (7a). This yields:

$$w = (c_1/\sigma_1)p_T + (d_1/\sigma_1)(1-\theta)p_T^e + (c_2/\sigma_1)p_N + d_1/\sigma_1)\theta p_N^e + \sigma_1^{-1}(\epsilon_{LD} - \epsilon_{LS})$$

In the absence of unanticipated shocks, $p_T = p_T^e$, $\epsilon_{LD} = \epsilon_{LS} = 0$, and from equation (19) and (20), $p_N = p_N^e$. Substituting above and simplifying:

$$(22) \quad w = ((c_1 + (1-\theta)d_1)/\sigma_1)p_T^e + ((c_2 + \theta d_1)/\sigma_1)p_N$$

This is the labor market equilibrium condition when $p_N^e = p_N$ - that is, when actual price changes are anticipated, so price level expectations are treated as endogenous. Note that the coefficient of p_N in equation

(22) exceeds its value in equation (13). The reason for this is that an increase in p_N increases the excess demand for labor by a greater amount

when it is anticipated, since the anticipation of higher prices causes an upward shift in the labor supply curve, so that a reduction in labor supply compounds the effects of the increase in demand for labor. Due to the larger impact of a change in p_N on the excess demand for labor, a

larger increase in w is needed to restore labor market equilibrium. Equation (22) is depicted as the locus \tilde{LL} in Figure 2. It passes through the initial point A, but for the reasons just mentioned, its slope is steeper than that of LL. However, since $c_2 + \theta d_1 < \sigma_1 = c_1 + c_2 + d_1$,

its slope is less than 1. Thus \tilde{LL} passes through A and lies between LL and OR. Consider now an anticipated increase in the money supply, given p_T . NN shifts to the right as before (since only the actual change in m matters in the nontraded goods market). However, when the increase

in m is anticipated, the relevant labor market equilibrium locus is $\tilde{L}\tilde{L}$, rather than LL . Thus the new equilibrium is at C , rather than B . Both the nominal wage and the price of nontraded goods are higher in this case than when the increase in m is unanticipated (thus the coefficients of $m^e - p_T^e$ exceed those of $m - m^e$ in equations (20) and (21)). This is, of course, what would be expected from the induced upward shift in the labor supply curve.

Greater price effects of anticipated than of unanticipated aggregate demand shocks are a familiar property of "new classical" models. Less familiar is the proposition that an anticipated change in the money supply has real effects, but that is in fact what happens above. Although w and p_N both increase, the new equilibrium point C is below the ray OR in

Figure 2. Thus the increase in p_N exceeds that in w and the product wage

in the nontraded goods sector falls. Since C lies between OR and a ray from the origin to B , the decrease in $w - p_N$ is smaller in this case than

in the case of an unanticipated monetary change, but it is nevertheless not zero. To see why this is so, notice that for $w - p_N$ to remain

unchanged, C would have to lie on OR --i.e., the slope of $\tilde{L}\tilde{L}$ would have to be unity. On examination of equation (22), it is apparent that the

slope of $\tilde{L}\tilde{L}$ would be unity if $dp_T^e/dp_N = 1$, since the coefficients

of p_T^e and p_N sum to one (recall that $\sigma_1 = c_1 + c_2 + d_1$). But in a small open economy with a fixed exchange rate, p_T is determined exogenously (via equation (9)), so $dp_T^e/dp_N = dp_T/dp_N = 0$. The nonneutrality of anticipated

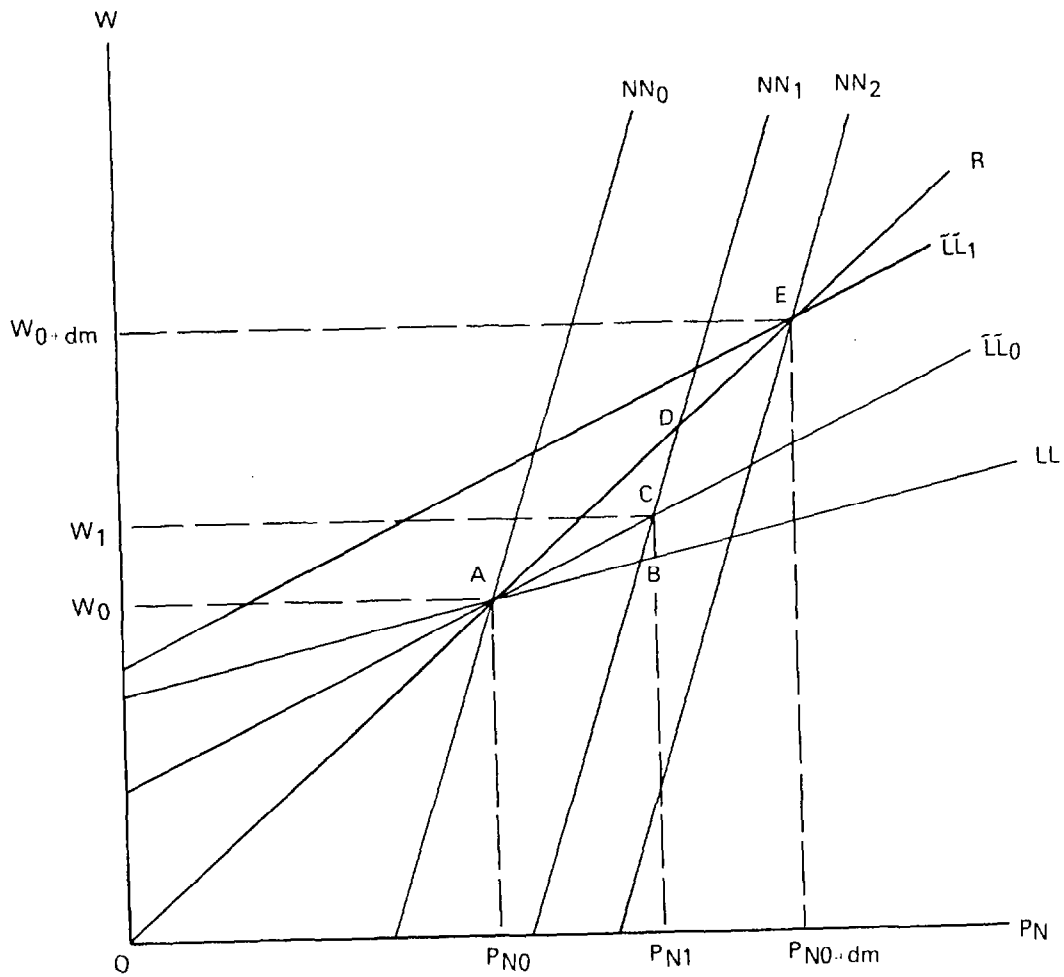
monetary policy therefore arises because, in the absence of an exchange rate change, such policy cannot affect the prices of traded goods. With p_T

fixed, any increase in w will increase the product wage $w - p_T$ in the traded

goods sector. Consequently, to preserve labor market equilibrium the demand for labor must rise in the nontraded sector. This requires that the nominal wage increase less than in proportion to the price of nontraded goods.

Consider now an equal increase in m^e and p_T^e , say by dm , leaving $m^e - p_T^e$ unchanged in equations (20) and (21). Since p_N is homogeneous of degree one in m , p_T , and w in equation (16), increases of dm in both w

FIGURE 2
EFFECTS OF AN ANTICIPATED
INCREASE IN THE MONEY SUPPLY





and p_N would maintain equilibrium in the market for nontraded goods.

Thus, NN_2 must intersect the ray OR at $(w_0+dm, p_{N0}-dm)$, which is labeled E in Figure 2. The locus $\bar{L}\bar{L}$ will shift upward on the other hand, by $((c_1+(1-\theta)d_1)/\sigma_1)dm$, to $\bar{L}\bar{L}_1$. Since w is homogeneous in p_T^e and p_N in equation (22), it follows that $\bar{L}\bar{L}_1$ also passes through E .

Since the two loci therefore intersect at E , this point represents the new equilibrium. With w and p_N both increasing by dm at point E , the product wage $w-p_N$ is unchanged.

Equations (20) and (21) can now be used to derive the reduced-form equations for the product wages in the traded and nontraded sectors. Subtracting p_T from both sides of (21) and rearranging:

$$(23) \quad w-p_T = (\alpha_1 + \alpha_3 \frac{\alpha_4}{1-\alpha_6})(m-p_T^e) + \alpha_1(m-me)-(1-\alpha_2)(p_T-p_T^e) + \epsilon_w$$

Notice that an unanticipated increase in p_T lowers the product wage in traded goods. To derive an expression for $w-p_N$, subtract p_N from both sides of (21), substitute from (20), and simplify:

$$(24) \quad w-p_N = (\alpha_1 - \alpha_4 \frac{1-\alpha_3}{1-\alpha_6 \theta})(m-p_T^e) + (\alpha_1 - \alpha_4)(m-me) + (\alpha_2 - \alpha_5)(p_T-p_T^e) + (\epsilon_w - \epsilon_N).$$

The signs of the coefficients are:

$$\alpha_1 - \alpha_4 \frac{1-\alpha_3\theta}{1-\alpha_6\theta} < 0 \quad \underline{1/}$$

$$\alpha_1 - \alpha_4 = (\beta_1/\phi)(c_2-\sigma_1) = -(\beta_1/\phi)(c_1+d_1) < 0$$

$$\begin{aligned} \alpha_2 - \alpha_5 &= \phi^{-1} [c_1\sigma_2 + c_2(\beta_2-(1-\theta)\beta_1) \\ &\quad - \frac{1-b_1}{b_1} \sigma_1(\beta_2-(1-\theta)\beta_1)] \\ &= \phi^{-1} [c_1(\beta_2 + \theta\beta_1)] - (c_1+d_1)(\beta_2-(1-\theta)\beta_1) \\ &= \phi^{-1} (c_1\beta_1 - d_1(\beta_2-(1-\theta)\beta_1)) = ? \end{aligned}$$

The analytical basis for these signs was discussed in connection with equations (17), (18) and (21) (Figures 1 and 2). Since $0 < \alpha_6 < \alpha_3 < 1$,

the coefficient of $(m^e - p_T^e)$ is smaller in absolute value than that of $(m - m^e)$, as was illustrated in Figure 2. Notice also that if $\beta_2 - (1-\theta)\beta_1 < 0$, the sign of $\alpha_2 - \alpha_5$ will be positive--i.e., an unanticipated increase in the price of traded goods will increase the product wage in the nontraded goods sector.

It is now a small step from equations (23) and (24) to the reduced-form output equations in the traded and nontraded goods sectors. By substituting the labor demand equation (3) into the production function (1), output in the traded goods sector can be expressed as a function of the product wage in that sector. Substituting into this expression and into the corresponding expression for nontraded goods (equation (14)) from the reduced-form product wage equations (23) and (24) yields:

$$(25) \quad y_T = y_{T0} + \pi_1(m^e - p_T^e) + \pi_2(m - m^e) + \pi_3(p_T - p_T^e) + u_T$$

^{1/} After some manipulation, this coefficient can be shown to be equal to $-\beta_1[c_1+d_1(1-\theta)]/\phi(1-\alpha_6\theta)$, which is negative.

where:

$$\pi_1 = - \frac{1-a_1}{a_1} (\alpha_1 + \alpha_3 \frac{\theta}{1-\alpha_6 \theta} \alpha_4) < 0$$

$$\pi_2 = - \frac{\alpha_1 (1-a_1)}{a_1} < 0$$

$$\pi_3 = - \frac{1-a_1}{a_1} (1-\alpha_2) > 0$$

$$u_T = \epsilon_T - \frac{1-a_1}{a_1} \epsilon_w$$

and:

$$(26) \ y_N = y_{N0} + \pi_4 (m_e - p_T^e) + \pi_5 (m - m_e) + \pi_6 (p_T - p_T^e) + u_N$$

where:

$$\pi_4 = - \frac{1-b_1}{b_1} (\alpha_1 - \alpha_4 \frac{1-\alpha_3 \theta}{1-\alpha_6 \theta}) > 0$$

$$\pi_5 = - \frac{1-b_1}{b_1} (\alpha_1 - \alpha_4) > 0$$

$$\pi_6 = - \frac{1-b_1}{b_1} (\alpha_2 - \alpha_5) = ?$$

$$u_n = \epsilon_N - \frac{1-b_1}{b_1} \epsilon_w$$

Equations (25) and (26) are the "dependent economy" generalizations of the familiar Barro-type reduced-form output equation for one-good closed economy "new classical" models. When this model is "closed" by imposing $\gamma = \theta = 1$ and $\beta_2 = 0$, equation (26) reduces to the usual closed-economy

variant in which output depends only on its "normal" level and on unanticipated money. It can be shown that when $\gamma = \theta = 1$ and $\beta_2 = 0$, the parameters α_2 and α_5 vanish and $\alpha_1 = \alpha_4(1-\alpha_3)/(1-\alpha_6)$. Thus (26) collapses to:

$$y_N = y_{N0} + \alpha(m-m^e) + u,$$

where α is a positive number less than unity.

The results of this section and the properties of equations (25) and (26) can be simultaneously summarized in the following five propositions:

1. An unanticipated increase in the money supply increases output in the nontraded goods sector, but decreases output of traded goods.

An increase in $(m-m^e)$ causes NN to shift to the right in Figure 1. As the increased demand for nontraded goods causes p_N to rise, the nominal wage rises to preserve labor market equilibrium. However, since the nominal wage rises less than in proportion to p_N , the product wage in the nontraded sector falls. Simultaneously, with p_T constant, the product wage in the traded goods sector, given by $w-p_T$, rises. Thus nontraded goods output rises while traded goods output falls.

2. An unanticipated increase in the price of traded goods leads to an increase in output of traded goods, but its effect on nontraded goods output is ambiguous.

An increase in $(p_T-p_T^e)$ causes LL to shift upward in Figure 1, as the demand for labor in the traded goods sector increases. If $\beta_2-(1-\theta)\beta_1 < 0$, the increase in p_T reduces demand for nontraded goods and NN shifts left. Since both shifts tend to increase $w-p_N$ (i.e., they move the short-run equilibrium in a counterclockwise direction away from the ray OR), nontraded goods output falls. Output of traded goods rises, since with m and p^e constant, the increase in w is less than that of p_T , so the product

wage in the traded goods sector falls. If $\beta_2 - (1 - \theta\beta_1) > 0$, the increase in p_T could lead to an excess demand for nontraded goods. If so, NN would shift to the right as p_N rises. The net effect on $w - p_N$, and thus on y_N , is ambiguous. On the other hand, y_T will still rise, since it remains true in this case that w rises less than p_T .

3. An anticipated increase in the money supply has real effects in this model--nontraded goods output rises, while traded goods output falls. The increase in output of nontraded goods is smaller in this case than when the increase in money is unanticipated, but the reduction in traded-goods output is larger.

This is the case analyzed in Figure 2. It was shown that $w - p_N$ falls in this case, so output of nontraded goods must rise. Since w rises with p_T unchanged, $w - p_T$ must rise, and traded goods output y_T must fall. The reason that the positive effect on the nontraded-goods sector is smaller and the negative effect on the traded-goods sector is larger in this case is that the anticipation of a future price increase leads to an adverse shift in labor supply, which makes the reduction in the product wage smaller in the nontraded-goods sector and the increase in the product wage larger in the traded-goods sector (Figure 2).

4. An anticipated increase in the price of traded goods has a negative effect on output of nontraded goods, but a positive effect on output of traded goods.

Note that in this case the effect on nontraded goods output is unambiguous, in contrast with the case in which the increase in traded goods prices is unanticipated. To see that this must be so, notice from equation (19) that in the new equilibrium, the (actual and anticipated) price of nontraded goods rises by $(\alpha_5 + \alpha_6 - \alpha_6\theta)/(1 - \alpha_6\theta) < 1$, so

$dp_N < dp_T$. When p_T and p_N rise by different amounts, the increases in p_T and p_N must bracket the increase in w to maintain labor market equilibrium. Thus $w - p_T$ falls, while $w - p_N$ rises, with the output consequences described above. For the same reason as explained under (3), the effect of an anticipated increase in p_T must be less favorable than a similar unanticipated increase in this variable for both the nontraded- and traded-goods sectors.

5. Proportionate anticipated increases in both money and the price of traded goods are neutral.

This follows directly from the product wage equations (23) and (24), since $d(m^e - p_T^e) = d(m - m^e) = d(p_T - p_T^e) = 0$ and the economy moves along the ray OR in Figures 1 and 2. In the absence of changes in product wages, output levels remain at their "normal" levels y_{T0} and y_{N0} .

The main point to be derived from these propositions is that in the "dependent economy" model the authorities control two exogenous (in the short run) nominal variables--the money supply and the price of traded goods--so changes in only one of these at a time will have real effects even if such changes are anticipated, because they are equivalent to a change in an exogenous real variable. The "dependent economy" analogue to an anticipated change in monetary policy in the one-good closed-economy case is an announced equiproportional change in the money supply and in the price of traded goods. However, although the real effects of anticipated nominal shocks are not zero in this model, except in the case of proposition (5) above, they do differ from the effects of similar unanticipated shocks in a way that is amenable to empirical testing.

III. Effects on Aggregate Employment and Output

The previous section solved the model and investigated the sectoral effects of specified shocks. We now turn to an analysis of the aggregate consequences of these shocks. Their implications for aggregate employment and output are of particular interest.

To simplify matters, suppose that the initial equilibrium is one of balanced trade, so traded and nontraded goods are initially produced in the same proportions in which they are demanded domestically--i.e., $(1-\theta)$ and θ respectively. This assumption is useful because, in combination with the choice of units that set the initial real exchange rate equal to one, it has the implication that changes in aggregate employment and output will be monotonically related, so the consequences for real output of a given shock can be inferred from its consequences for aggregate

employment. ^{1/} The discussion that follows is therefore addressed to the aggregate employment effects of various shocks, since aggregate real output will move in the same direction.

Since the labor market is in continuous equilibrium in this model, aggregate employment is equal to the aggregate supply of labor, which is given by equation (6). According to this equation, the supply of labor depends on the expected real wage. Consequently, analyzing the effects of shocks on aggregate employment and output reduces to determining their effects on the expected real wage. The expression for the expected real wage can be derived by subtracting p^e from both sides of the nominal wage equation (21) and substituting from (7b):

$$w - p^e = (\alpha_1 + \alpha_3 \frac{\alpha_4}{1 - \alpha_6 \theta}) (m - p_T^e) + \alpha_1 (m - m^e) + \alpha_2 (p_T - p_T^e) + \theta p_T^e - \theta p_N^e + \varepsilon_w.$$

^{1/} To show this, let E_R denote the real exchange rate, defined as $E_R = P_T/P_N$ (recall that upper-case letters denote levels, not logs of variables). Taking the exponential of equation (7a) we have $P = P_T^{1-\theta} P_N^\theta$ from which $P_T/P = E_R^\theta$ and $P_N/P = E_R^{\theta-1}$. The level of real output, Y , is:

$$Y = (P_T/P) Y_T(L_T, \dots) + (P_N/P) Y_N(LS - L_T, \dots) \\ = E_R^\theta Y_T(L_T, \dots) + E_R^{\theta-1} Y_N(L - L_T, \dots)$$

The effect on Y of a shock S is:

$$\frac{dY}{dS} = \theta Y_T + Y_T' \frac{dL_T}{dS} - (1-\theta) Y_N + Y_N' \left(\frac{dLS}{dS} - \frac{dL_T}{dS} \right),$$

where we have used $E_R = 1$. Noting that this also implies $Y_T' = Y_N'$ (the marginal product of labor is equalized across sectors) and imposing $Y_T = (1-\theta)Y$ and $Y_N = \theta Y$, we have:

$$\frac{dY}{dS} = Y_N' \frac{dLS}{dS}$$

Since Y_N' is positive, this establishes the relationship described in the text.

Using equation (19) to substitute for p_N^e :

$$(27) \quad w - p^e = (\alpha_1 - \frac{\alpha_4 \theta (1 - \alpha_3)}{1 - \alpha_6 \theta}) (m^e - p_T^e) + \alpha_1 (m - m^e) + \alpha_2 (p_T - p_T^e) + \varepsilon_w.$$

Substituting this equation into equation (6) yields the aggregate employment equation:

$$(28) \quad l = l_0 + d_1 (\alpha_1 - \frac{\alpha_4 \theta (1 - \alpha_3)}{1 - \alpha_6 \theta}) (m^e - p_T^e) + \alpha_1 d_1 (m - m^e) \\ + \alpha_2 d_1 (p_T - p_T^e) + (\varepsilon_w + \varepsilon_{LS})$$

Since unanticipated changes in m and p_T do not affect the expected price

level, they affect the expected real wage in (27) only through their effects on the nominal wage. Thus their coefficients are the same as in equation (21). For this reason also, the disturbance terms in equations (27) and (21) are identical. An unanticipated monetary expansion increases the expected real wage and the level of employment in the aggregate, but the effects of an unanticipated change in traded goods prices as well as those of anticipated changes in money or traded goods prices on the expected real wage and therefore on aggregate employment are ambiguous.

As shown in the previous section, the increase in m reduces the product wage and expands employment in the nontraded goods sector, while causing these variables to move in the opposite direction in the traded goods sector. However, the contraction of employment in the traded goods sector only comes about due to the increase in the nominal wage as the economy moves upward along a stable labor supply curve owing to the expansion of employment in the nontraded goods sector. Thus the decrease in employment in the traded goods sector cannot be large enough to offset the increase in the nontraded goods sector. Aggregate employment and the expected real wage must therefore be higher than in the initial equilibrium.

The ambiguous effect on the expected real wage and on aggregate employment of an unanticipated increase in traded goods prices mirrors the ambiguous effect of this variable on output of nontraded goods. Notice from the definition of α_2 (see page 11) that an unanticipated

increase in p_T has a direct effect on w captured by $c_1 \sigma_2 / \phi$ and an

indirect effect which operates through p_N and which is given by the second term in the definition. If an increase in p_T increases demand for non-traded goods (i.e., if $\beta_2 - \beta_1(1-\theta) > 0$), then α_2 will be positive, essentially because the increase in p_T will increase the demand for labor in both sectors. In this case, aggregate employment and output would rise. On the other hand, if β_1 is sufficiently large--i.e., if real balance effects on spending are strong enough--then an unanticipated increase in p_T such as would be brought about, for example, by an unanticipated

devaluation, could have a negative effect on $w-pe$ and thus decrease aggregate employment and output. In this sense, devaluation can have contractionary short-run effects in this model. In this "new classical" model, these effects come about because the devaluation reduces demand for nontraded goods. This causes the price of nontraded goods to fall, and the associated reduction in the demand for labor by this sector overwhelms an increased demand in the traded goods sector brought about by a devaluation-induced reduction in the product wage. The decrease in the aggregate demand for labor causes the nominal wage to fall relative to workers' expectations of the price level. Consequently, the aggregate supply of labor falls, and aggregate employment decreases.

Finally, it is important to emphasize that even an anticipated change in monetary policy will not in general leave aggregate employment and output unaffected in this model. In other words, the coefficient of $(m_e - p_T^e)$ will not in general be zero. Since this result is at variance with the thrust of the "new classical" literature for one-good closed-economy models, it is worthwhile examining this coefficient in more detail.

Using equation (17), the effect on $w-pe$ of an anticipated increase in the money supply can be written:

$$\begin{aligned} \frac{d(w-pe)}{dm_e} &= \alpha_1 + \alpha_2 \frac{dp_T}{dm_e} - (1-\alpha_3) \frac{dpe}{dm_e} \\ &= \alpha_1 + (\alpha_2 - (1-\theta)(1-\alpha_3)) \frac{dp_T^e}{dm_e} - \theta (1-\alpha_3) \frac{dp_N^e}{dm_e}, \end{aligned}$$

where the second equality relies on equation (7b) and on the observation that $dp_T = dp_T^e$ when shocks are anticipated. Since $\alpha_1 + \alpha_2 + \alpha_3 = 1$,

this expression vanishes if $dp_T^e/dm^e = dp_N^e/dm^e = 1$. Furthermore, from equation (19), if $dp_T^e/dm^e = 1$, then $dp_N^e/dm^e = 1$. Thus the nonzero effect of anticipated changes in m on $w-p^e$ arises owing once again to the failure of traded goods prices to change in proportion to the anticipated change in the money supply. In fact, as discussed in the previous section, since p_T is exogenous in the "dependent economy" model under fixed exchange rates, $dp_T^e/dm^e = 0$. Thus the source of the nonneutrality of anticipated monetary changes is the exogeneity of traded goods prices.

To gain some insight into the factors that govern the sign of $d(w-p^e)/dm^e$, substitute for the α 's in the coefficient of $(m^e - p_T^e)$ in equation (27). After some simplification, it can be shown that:

$$\alpha_1 - \alpha_4 \theta \frac{(1-\alpha_3)}{1-\alpha_6 \theta} = \left(\frac{c_2}{c_1+c_2} - \theta \right) \frac{(c_1+c_2)}{\sigma_1} \frac{a_4}{1-\alpha_6 \theta}$$

The last two terms on the right-hand side of this expression are positive and less than one. Thus the sign of the coefficient depends on the first term. This term is likely to be positive when c_2 is large relative to c_1 or when θ is small. In other words, an anticipated monetary expansion is likely to increase aggregate employment and output when the aggregate demand for labor is relatively sensitive to the product wage in the nontraded goods sector and when the aggregate price level is not highly sensitive to the price of nontraded goods. The intuition behind these conditions is the following: an anticipated change in the money supply tends to move the price of nontraded goods and (for given price expectations) the nominal wage in the same direction, with the nominal wage changing less than in proportion to the price of nontraded goods. This causes employment in the nontraded sector to change in the same direction as money, but the change in employment is in the opposite direction in the traded goods sector. Taking into account the effect of changed price expectations on labor supply magnifies the change in the nominal wage, since the labor supply curve will shift upward when p_N is expected to rise, raising the nominal wage, and downward when p_N is

expected to fall, reducing the nominal wage. This further change in the nominal wage tends to reinforce employment effects in the traded goods sector--where employment changes in a direction opposite to the original change in the money supply--but to weaken the impact on the nontraded goods sector, where employment changes in the same direction as the money supply. Aggregate employment changes in the same direction as the money supply when employment effects in the nontraded goods sector remain dominant in spite of the induced shifts in the labor supply curve. This will be the case when these induced shifts are small--i.e., when θ is small so changes in p_N have minor effects on the price level--and when

aggregate labor demand is relatively more sensitive to changes in $w-p_N$ than to changes in $w-p_T$ --i.e., when c_2 is large relative to c_1 .

The preceding discussion also applies to anticipated changes in the price of traded goods--such as an anticipated devaluation--except that the conditions which cause aggregate employment and output to change in the same direction as anticipated changes in money cause these variables

to change in the opposite direction as p_T^e . Thus if the coefficient of $(m^e - p_T^e)$ is positive, an anticipated devaluation reduces aggregate employment and output.

Finally, as was true of sectoral effects, the expected real wage and aggregate employment are neutral with respect to anticipated equiproportionate changes in the money supply and the price of traded goods.

To conclude this section, consider the employment and output effects of "orthodox" stabilization policy. If we characterize such policy as an anticipated monetary contraction coupled with a devaluation, the direction of its short-run employment and output effects is determined by the coefficient of $(m^e - p_T^e)$ in equation (28). Since the policy consists of a

reduction in m^e and an increase in p_T^e , $(m^e - p_T^e)$ will decrease. Thus the direction of change of employment and output is the opposite of the sign of $\alpha_1 - \alpha_4 \theta (1 - \alpha_3) / (1 - \alpha_6 \theta)$. Employment and output may rise if c_2 is sufficiently small relative to c_1 or if θ is large. The key point is

that if the world is "new classical", even the direction of the employment and output effects associated with "orthodox" stabilization policy cannot be established a priori. Whether employment and output rise

or fall will depend on country-specific parameters which determine the relative capital intensities of the traded and nontraded goods sectors and the share of the two types of goods in domestic demand.

V. Empirical Results

In this section, the reduced-form sectoral output equations (25) and (26) are estimated for Mexico during the sample period 1953-75 using indices for prices and outputs of traded and nontraded goods published by Blejer and Fernandez. After a devaluation in April of 1954, the value of the Mexican peso was fixed throughout this period at 12.5 pesos per U.S. dollar, so a fixed-exchange rate model is appropriate over this sample period. The empirical work reported here should be viewed as strictly preliminary. It is intended only to establish whether the simple model of Section II holds empirical promise. The specification is not enriched for empirical purposes, minimal experimentation is undertaken with the prediction equations, and for simplicity, the consistent but inefficient two-step estimation procedure used by Barro (1978) is employed. The results derived in this section are used to address two questions:

a. Is the specification of a "new classical" model for a dependent economy proposed here a viable alternative to the Blejer-Fernandez version?

b. If the model performs at least as well as the Blejer-Fernandez version, what does it suggest about the relevance of "new classical" macroeconomic analysis for Mexico during this period?

Equations (25) and (26) were modified in only one way for the purpose of estimation. In section II, the sectoral capital stocks, which were taken to be constant in the short run, were subsumed into the constant terms y_{T0} and y_{N0} . In the absence of readily available data on sectoral capital stocks, secular increases in these stocks over the sample period are allowed for via the introduction of a linear time trend. Thus the empirical versions of equations (25) and (26) are:

$$(25a) \ y_N = e_{10} + e_{11} t + e_{12} (m - p_T) + e_{13} (m - m_e) + e_{14} (p_T - p_T^e) + v_1$$

$$(26a) \ y_T = e_{20} + e_{21} t + e_{22} (m - p_T) + e_{23} (m - m_e) + e_{24} (p_T - p_T^e) + v_2$$

where t is the time trend and the v 's are disturbance terms.

The first step in the estimation of (25a) and (26a) is the identification of empirical counterparts to the variables contained in these regressions. As indicated previously, estimated indices of traded and nontraded goods prices, as well as output in the traded and nontraded goods sectors, are taken from Blejer and Fernandez (see Table 3 in their Appendix). The stock of money was measured as M1 (the yearly average of end-of-month stocks, from IFS line 34). Calculation of the predicted values of m and p_T was undertaken as described below.

To the extent that the authorities can control the stock of money over the short run, the expected value of m next period depends on the public's perception of the reaction function of the monetary authorities. There is now a rather extensive literature which estimates such reaction functions for Latin American countries (Barro (1979), Hanson (1980), Edwards (1983a and 1983b), Porzekanski (1979), and Sheehy (1984) are examples). Typically the monetary authorities are perceived as either adjusting monetary growth to move some target variable closer to a desired level or as behaving in accomodative fashion (Porzekanski calls these type A and type B monetary authorities). To gauge the extent to which the estimation of equations (25a) and (26a) is sensitive to the specification of the behavior of the Mexican monetary authorities, monetary growth prediction equations of both types were estimated. In the first version, the rate of growth of the money supply was related to its own past values and to past levels of international reserves:

$$(29) \quad Dm = e_{30} + e_{31} Dm_{-1} + e_{32} Dm_{-2} + e_{33} r_{-1} + e_{34} r_{-2} + v_3$$

where D is the first difference operator and r is the log of international reserves (IFS line 1.1.d). A positive value of $e_{33} + e_{34}$ is consistent with adjustment of the Mexican money supply to offset movements of reserves away from some target level. The second version of the money growth prediction equation is:

$$(30) \quad Dm = e_{40} + e_{41} Dm_{-1} + e_{42} Dm_{-2} + e_{43} Dp_{-1} + e_{44} Dp_{-2} + v_4$$

where p is the Mexican consumer price index (IFS line 64). A positive value of $e_{43} + e_{44}$ in this case is consistent with accomodation of past inflation on the part of the Mexican monetary authorities.

Equations (29) and (30) were estimated over the period 1952 to 1975. The results were:

$$(29) \quad D_m = 0.01 + 0.32D_{m-1} - 0.37D_{m-2} + 0.06r_{-1} - 0.03r_{-2}$$

$$(0.03) \quad (0.19) \quad (0.17) \quad (0.03) \quad (0.03)$$

$$R^2 = 0.46, \quad SER = 0.02, \quad Q(5) = 1.27, \quad F(2,19) = 2.73$$

$$(30) \quad D_m = 0.06 + 0.35D_{m-1} - 0.63D_{m-2} + 0.43D_{p-1} - 0.11D_{p-2}$$

$$(0.01) \quad (0.18) \quad (0.18) \quad (0.17) \quad (0.19)$$

$$R^2 = 0.48, \quad SER = 0.02, \quad Q(5) = 2.70, \quad F(2,19) = 3.09.$$

These equations fit the data equally well. Their overall explanatory power, as measured by R^2 or the standard error of the regression, is comparable to that of the monetary reaction functions estimated by Sheehy (1984) for several Latin American countries and to Barro's (1979) M1 growth equation for Mexico. Since these equations are to be used as rational predictors for m , it is important that their residuals at time t be uncorrelated with information available before period t ,

including their own past values. The critical value of the χ^2 distribution with 5 degrees of freedom is 9.24, so the values of the Q statistics in equations (29) and (30) imply that the hypothesis of zero autocorrelation cannot be rejected in either case. The F statistic reported above is for the exclusion restrictions $e_{33}=e_{34}=0$ in equation (29) and $e_{43}=e_{44}=0$

in equation (30). Both restrictions can be rejected at the 90 percent confidence level, since $F(2,19) = 2.59$. Nonetheless, the positive sign of e_{33} in equation (29) (with marginal significance level of 12 percent)

is consistent with "leaning against the wind," whereas the positive sign of e_{43} (marginal significance level of 2 percent) is consistent with

accommodative behavior. Although additional work may shed more light on the behavior of the Mexican monetary authorities during this period, it was decided instead to retain both equations and examine the robustness of the output equations with respect to the specification of the monetary growth prediction equations. 1/

1/ A natural step is to include both sets of variables in a monetary growth prediction equation and test exclusion restrictions on one set at a time. Unfortunately, when r_{-1} and r_{-2} are included, the null hypothesis that the coefficients of D_{p-1} and D_{p-2} are both zero could not be rejected, whereas when D_{p-1} and D_{p-2} are included, the hypothesis that the coefficients of r_{-1} and r_{-2} were both zero also could not be rejected.

With regard to the prediction equation for the price of traded goods, a simple autoregressive scheme was chosen, following Blejer and Fernandez. The estimated equation is:

$$(31) \quad Dp_T = \begin{matrix} 0.01 \\ (0.00) \end{matrix} + \begin{matrix} 0.28 \\ (0.20) \end{matrix} Dp_{T-1}$$

$$Q(3) = 1.19$$

This equation was estimated over the period 1952-1975. The low value of the Q statistic implies failure to reject the hypothesis that the residuals are white noise. ^{1/}

The empirical counterparts of $(m-me)$ and of $(p_T - p_T^e)$ were taken to be the residuals of equations (21) and (30) for the former and of equation (31) for the latter. The variable $(me - p_T^e)$ was measured by:

$$me - p_T^e = (\hat{Dm} + m_{-1}) - (\hat{Dp}_T + p_{T-1})$$

where a hat (^) denotes a fitted value of the relevant variable.

The results of estimating the reduced-form regression for output of nontraded goods (equation (25a)) are given in Table 1. Regressions (i) and (ii) are the OLS estimates of equation (25a) using the money prediction equations (29) and (30), respectively. These regressions provide some support for the model. The overall fit is quite good, and all variables which could be unambiguously signed theoretically have the correct sign and are statistically significant at least at the 90 percent level of confidence. The results are quite robust with respect to the method of predicting monetary growth, since the coefficients are changed only slightly when money prediction equation (30) is substituted in regression (ii) for prediction equation (29).

^{1/} A version of (31) was also estimated which included an additional lag plus U.S. monetary (M1) growth lagged one and two periods, making it comparable to the M1 prediction equations. However, the hypothesis that these additional variables had zero coefficients could not be rejected at reasonable confidence levels. The output equations were also estimated with an AR(2) model for Dp_T and with the particular AR(1) model for Dp_T used by Blejer and Fernandez. The results were qualitatively unaffected by the use of these alternative specifications.

Table 1. Reduced-Form Regressions for Output of Nontraded Goods, 1953-1975 1/

Regression	Constant	t	$m^e - p_T^e$	m^e	p_T^e	$m - m^e$	$p_T - p_T^e$	R^2	SER	D.W.	RHO
(i)	1.28** (0.18)	0.16** (0.00)	0.22** (0.09)			0.18* (0.09)	-0.30** (0.10)	0.99	0.01	1.07	-
(ii)	1.27** (0.19)	0.16** (0.00)	0.16* (0.09)			0.24** (0.10)	-0.33** (0.09)	0.99	0.01	0.97	-
(iii)	1.27** (0.31)	0.16** (0.00)	0.20** (0.07)			0.18 (0.11)	-0.27 (0.17)	0.99	0.01	1.79	0.47
(iv)	1.28** (0.32)	0.13** (0.05)	0.14* (0.07)			0.33** (0.11)	-0.40** (0.16)	0.99	0.01	1.69	0.58
(v)	1.28** (0.18)	0.16** (0.00)		0.25** (0.12)	-0.18 (0.12)	0.17 (0.10)	-0.34** (0.14)	0.99	0.01	1.17	-
(vi)	1.27** (0.20)	0.16** (0.00)		0.17 (0.11)	-0.15 (0.13)	0.24** (0.10)	-0.34** (0.14)	0.99	0.01	0.99	-

1/ Numbers in parenthesis are standard errors. A single asterisk (*) denotes statistical significance at the 90 percent level, while a double asterisk (**) denotes significance at the 95 percent level.

The Durbin-Watson statistics for both regression (i) and (ii) are in the zone of indeterminacy. The regressions were therefore re-estimated with a Cochrane-Orcutt correction for first-order serial correlation, and these results are reported as regressions (iii) and (iv). The stability of the coefficients in the face of this correction enhances confidence in the specification. The most notable changes are increases in the coefficients on unanticipated money and unanticipated traded goods prices in regression (iv) as compared to (iii).

Finally, the model predicts that the coefficients of anticipated money and anticipated traded goods prices should be equal in absolute value, but opposite in sign. This restriction was imposed in (i)-(iv), but is relaxed in (v) and (vi). In both equations, the point estimates

of the coefficients of m^e and p_T^e are in fact quite close in absolute value but of opposite sign. The remaining parameters are little changed from their values in (i) and (ii).

These results are in conflict with the analysis of Blejer and Fernandez in two ways. In summarizing their results, they conclude:

a. "Only unexpected monetary growth raises production in the non-traded sector...This is the equivalent to the output-inflation tradeoff in a closed economy and will vanish when expectations are corrected."

b. "Although we have not found this effect to be significant in our case, real output in an open economy can be affected by foreign price shocks. The effect of unanticipated foreign inflation is to increase the supply of both types of commodity in the short run..." (p.93, emphasis added).

The model developed here, by contrast, suggests that anticipated monetary policy is not neutral, and that the effect of an unanticipated increase in traded-goods prices on output of nontraded goods can be negative if substitution effects in aggregate demand for nontraded goods are sufficiently weak. Both conclusions are strongly supported by the results in Table 1.

The empirical results for output of traded goods are more similar to those of Blejer and Fernandez. These results are reported in Table 2, where regressions (i)-(iv) are the traded-goods counterparts to the similarly numbered regressions in Table 1. These regressions in general fit poorly. The most encouraging result is the negative coefficient on unanticipated money in regressions (i) and (ii). This is in accordance with the models' predictions, and the coefficients are significant at the

Table 2. Reduced-Form Regressions for Output of Traded Goods, 1953-1975 1/

Regression	Constant	t	$m^e - p_T^e$	$m - m^e$	$p_T - p_T^e$	R^2	SER	D.W.	RHO
(i)	1.29** (0.30)	0.04** (0.00)	0.24 (0.14)	-0.32** (0.15)	-0.16 (0.16)	0.99	0.01	1.49	
(ii)	1.29** (0.33)	0.04** (0.01)	0.17 (0.15)	-0.27 (0.17)	-0.24 (0.16)	0.99	0.01	1.56	
(iii)	1.32** (0.41)	0.03** (0.01)	0.16 (0.13)	-0.10 (0.18)	-0.42 (0.25)	0.99	0.01	2.35	0.23
(iv)	1.32** (0.41)	0.03** (0.01)	0.07 (0.14)	0.03 (0.20)	-0.56** (0.24)	0.99	0.01	2.44	0.21

1/ Numbers in parenthesis are standard errors. A single asterisk (*) denotes statistical significance at the 90 percent level, while a double asterisk (**) denotes significance at the 95 percent level.

5 percent level in regression (i), and at the 15 percent level in regression (ii). However, the point estimates of the coefficients of $(p_T - p_T^e)$ and $(m - p_T^e)$ have the wrong signs in all four regressions. Moreover, when the regressions are corrected for first-order serial correlation, all the coefficients change markedly, which is suggestive of a misspecification. The pattern of correct signs and fairly precise estimates for the coefficients of the unanticipated monetary variable in the OLS regressions, coupled with incorrect signs for the coefficient of unanticipated traded goods prices, duplicates the findings of Blejer and Fernandez for the traded goods sector.

These results suggest an answer to the first question posed at the beginning of this section. The model proposed here performs no worse than the Blejer-Fernandez version of a "new classical" model for this type of economy, and where the predictions of the two specifications differ, the empirical results are consistent with the specification presented here.

Turning to the second question, however, the results of this section do not provide strong support for a "new classical" specification for Mexico during this period. Restricting our attention to the relatively successful estimation for the nontraded goods sector, Table 1 reveals two important findings at variance with the predictions of the model:

a. The output effects in the nontraded goods sector of unanticipated changes in money are never significantly larger than those of anticipated changes. Although the point estimates of the effects of unanticipated money are larger when money growth equation (29) is used, the differences are not statistically significant. When money growth equation (30) is used, anticipated money growth has larger effects on output than unanticipated money growth, although again the differences are not statistically significant.

b. A more uniform finding is that unanticipated changes in traded goods prices have larger effects on output of nontraded goods than anticipated changes in such prices, contrary to the predictions of the model. This finding holds true in every regression and is therefore not produced by the restrictions imposed on the coefficients of m and p_T^e in equations (i)-(iv) in Table 1.

Overall, the empirical results are mixed. In view of the simplicity of the theoretical model and of the fact that the estimating procedure was a relatively "clean" one (no ad hoc lags were introduced in the output equations, for example), this is perhaps not surprising. A conservative conclusion might be that the empirical results are sufficiently

interesting to support further development of the particular version of the model developed here and testing against new sets of data.

VI. Summary and Conclusions

"New classical" macroeconomics provides an attractive theoretical underpinning for the notion that the short-run output effects of restrictive demand-management policies associated with stabilization programs in developing countries are less adverse than is commonly supposed. However, the empirical relevance in developing countries of the "policy ineffectiveness" proposition associated with this school of thought remains unestablished. Though tests of the proposition have been conducted in developing countries using the reduced-form output equations pioneered by Barro, these equations have not been grounded in structural models that pay particular attention to the small open economy circumstances that characterize most developing countries.

The recent work by Blejer and Fernandez is an exception to this generalization. This paper builds on their work by constructing a fully simultaneous "new classical" model for a "dependent" economy under fixed exchange rates and deriving the Barro-type reduced-form sectoral output equations implied by this model. The main features of these equations are:

1. Unanticipated increases in the money supply increase output in the nontraded goods sector and decrease it in the traded goods sector.
2. Unanticipated increases in traded goods prices--originating either externally or in a devaluation of the domestic currency--increase output in the traded goods sector, but have an ambiguous effect on output of nontraded goods. The latter will be negative if substitution effects in
3. Anticipated increases in the money supply measured in units of traded goods increase output of nontraded goods, but reduce output of traded goods. These effects, however, are weaker than for the case of an unanticipated increase in the money supply.
4. Anticipated increases in prices of traded goods reduce output of nontraded goods and increase that of traded goods. In both cases, however, movements in real output are less favorable than would have been observed with a similar unanticipated increase in traded goods prices.
5. The counterpart of closed-economy neutral monetary policy is an anticipated change in the money supply, coupled with an anticipated change in traded goods prices (perhaps brought about through a devaluation) in the same proportion.

The sectoral output equations were tested empirically for Mexico during 1953-1975 using data compiled by Blejer and Fernandez. The results gave strong support to this model vis-à-vis that of Blejer and Fernandez, but the relevance of "new classical" analysis for Mexico during this period remains open to question.

Two important conclusions can be drawn from this exercise. The first is that the "dependent economy" version of the simplest "new classical" macroeconomic model generates reduced-form output equations that are quite different from its closed-economy counterpart, so a reformulation of the model such as that presented here is essential before empirical testing can proceed. The second is that even this simple version of a "dependent economy," "new classical" model has proven to be empirically plausible. In view of its important policy implications, it merits further development and empirical testing against a well-formulated realistic alternative in other developing-country settings.

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