JOURNAL OF ECONOMIC DEVELOPMENT 85
Volume 29, Number 1, June 2004

EXCHANGE RATE FLUCTUATIONS AND ECONOMIC ACTIVITY IN DEVELOPING COUNTRIES: THEORY AND EVIDENCE

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This paper examines the effects of exchange rate fluctuations on real output growth and price inflation in a sample of twenty-two developing countries. The analysis introduces a theoretical rational expectation model that decomposes movements in the exchange rate into anticipated and unanticipated components. The model demonstrates the effects of demand and supply channels on the output and price responses to changes in the exchange rate. In general, exchange rate depreciation, both anticipated and unanticipated, decreases real output growth and increases price inflation. The evidence confirms concerns about the negative effects of currency depreciation on economic performance in developing countries.

Keywords: Exchange Rate, Output Growth, Price Inflation, Supply vs. Demand Shifts
JEL classification: F41, F43, E31

1. INTRODUCTION

There has been an ongoing debate on the appropriate exchange rate policy in developing countries. The debate focuses on the degree of fluctuations in the exchange rate in the face of internal and external shocks. Exchange rate fluctuations are likely, in turn, to determine economic performance. In judging the desirability of exchange rate fluctuations, it becomes, therefore, necessary to evaluate their effects on output growth and price inflation. Demand and supply channels determine these effects.

A depreciation (or devaluation) of the domestic currency may stimulate economic activity through the initial increase in the price of foreign goods relative to home goods. By increasing the international competitiveness of domestic industries, exchange rate depreciation diverts spending from foreign goods to domestic goods. As illustrated in Guitian (1976) and Dornbusch (1988), the success of currency depreciation in promoting trade balance largely depends on switching demand in proper direction and amount, as well as on the capacity of the home economy to meet the additional demand by

supplying more goods.[1]

While the traditional view indicates that currency depreciation is expansionary, other theoretical developments have stressed some contractionary effects. This possibility is discussed theoretically in a model by Meade (1951). If the Marshall-Lerner condition is not satisfied, currency depreciation could produce contraction.[2] Hirschman (1949) points out that currency depreciation from an initial trade deficit reduces real national income and may lead to a fall in aggregate demand. Currency depreciation gives with one hand, by lowering export prices, while taking away with the other hand, by raising import prices. If trade is in balance and terms of trade are not changed these price changes offset each other. But if imports exceed exports, the net result is a reduction in real income within the country. Cooper (1971) confirms this point in a general equilibrium model.

Diaz-Alejandro (1963) introduced another argument for contraction following devaluation. Depreciation may raise the windfall profits in export and import-competing industries. If money wages lag the price increase and if the marginal propensity to save from profits is higher than from wages, national savings will go up and real output will decrease. Krugman and Taylor (1978) and Barbone and Rivera-Batiz (1987) have formalized the same views.

Supply-side channels further complicate the effects of currency depreciation on economic performance. Bruno (1979) and van Wijnbergen (1989) postulate that in a typical semi-industrialized country where inputs for manufacturing are largely imported and cannot be easily produced domestically, firms' input cost will increase following a devaluation. As a result, the negative impact from the higher cost of imported inputs may dominate the production stimulus from lower relative prices for domestically traded goods. Gylfason and Schmid (1983) provide evidence that the final effect depends on the magnitude by which demand and supply curves shift because of devaluation.[3]

To summarize, currency depreciation increases net exports and increases the cost of production. Similarly, currency appreciation decreases net exports and the cost of production. The combined effects of demand and supply channels determine the net results of exchange rate fluctuations on real output and prices.[4]

[1] Empirical support of this proposition for Group 7 countries over the 1960-89 period is provided in Mendoza (1992).

[2] The Marshall-Lerner condition states that devaluation will improve the trade balance if the devaluing nation's demand elasticity for imports plus the foreign demand elasticity for the nation's exports exceed 1.

[3] Hanson (1983) provides theoretical evidence that the effect of currency depreciation on output depends on the assumptions regarding the labor market. Solimano (1986) studies the effect of devaluation by focusing on the structure of the trade sector. Age'nor (1991) introduces a theoretical model for a small open economy and distinguishes between anticipated and unanticipated movement in the exchange rate. Examples of empirical investigation include Edwards (1986), Gylfason and Radetzki (1991) and Bahmani (1998).

[4] For an analytical overview, see Lizondo and Montiel (1989), Edwards (1989), and Age'nor and Montiel

This paper revisits the relationship between exchange rate fluctuations and economic activity in developing countries. The theoretical investigation introduces a model that decomposes movements in the exchange rate into anticipated and unanticipated components using rational expectations. In this context, the output supplied varies with unanticipated price movements and the cost of the output produced. Anticipated exchange rate movements determine the cost of the output produced, resulting in long-run effects. In contrast, unanticipated exchange rate movements determine economic conditions, in the short-run, in three directions: net exports, money demand, and the output supplied. Both long-run and short-run effects matter to economic performance. The long-run effect determines output growth over time. Nonetheless, cyclical short-run effects may lead to a crisis, as recent experiences of emerging markets have demonstrated.

The solution of the model demonstrates the effects of demand and supply channels on the output and price responses to unanticipated changes in the exchange rate. Based on theory's solutions, empirical models are formulated for output and price. The models incorporate demand and supply shifts as well as exchange rate shifts. Exchange rate fluctuations are assumed to be randomly and symmetrically distributed around a steady-state stochastic trend over time. This trend varies with agents' observations of macroeconomic fundamentals. Positive shocks to the exchange rate indicate an unanticipated increase in the domestic currency price of foreign currency, i.e., unanticipated currency depreciation (devaluation).[5] A negative shock to the exchange rate represents an unanticipated currency appreciation.[6] Further, the analysis employs new data for the real effective exchange rate in developing countries.[7] These data have the advantage of (i) calculating the exchange rate as a weighted average of bilateral rates according to trade volumes with major trading partners, and (ii) accounting for the relative prices in domestic and foreign economies. The latter channel is particularly important given the high inflationary experience in developing countries. Accordingly, the empirical investigation will combine the nominal exchange rate policy with movements in domestic price inflation relative to that of major trading partners to determine the implications of fluctuations in the real effective exchange rate on economic performance in developing countries.

(1996).

[5] Throughout the paper, depreciation will describe a reduction in the domestic currency price of foreign currency attributed to either market forces, for example an equilibrium adjustment in the context of trade liberalization, or a managed policy, for example devaluation as a result of a currency crisis.

[6] For example, an overvalued peg that cannot be sustained based on rational expectations. As the evidence of Southeast Asian countries demonstrated, unanticipated currency appreciation decreased net exports and money demand, as agents started the process of speculative attacks. Of course, subsequent devaluation further accelerated inflation and reinforced output contraction through the supply-side channel.

[7] The data are constructed following the approach discussed in Bahmani (1995).

The estimation highlights the relative importance of exchange rate fluctuations in determining real output and price in developing countries. Consistent with the results of early research, the evidence indicates that the contractionary effects dominate in determining real output growth in the face of exchange rate depreciation. The contractionary effects do not appear to be positively correlated with the size of the trade deficit in the face of exchange rate fluctuations. Nonetheless, output contraction is explained in the theoretical model by two factors. Domestic currency is expected to return to its steady state value following unexpected depreciation. Agents, therefore, may increase the demand for domestic currency. This channel slows down velocity, decreasing spending and output growth. More importantly, exchange rate depreciation increases the cost of imported intermediate goods, decreasing the output supplied in developing countries. Given the evidence of a higher inflation in the face of currency depreciation, the supply channel appears to be more dominant. The reduction in aggregate supply is consistent with a reduction in output growth and an increase in price inflation in the face of currency depreciation, both anticipated and unanticipated, in various developing countries. This evidence supports the results of earlier research concerning the importance of supply-side channels in determining the effects of exchange rate depreciation on economic performance in developing countries.

The remainder of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 outlines the empirical models. Section 4 presents empirical results. The summary and conclusion are presented in Section 5.

2. THEORETICAL BACKGROUND

In the real world, stochastic uncertainty may arise on the demand or supply sides of the economy. Economic agents are assumed to be rational. Accordingly, rational expectations of demand and supply shifts enter the theoretical model. Economic fluctuations are then determined by unexpected demand and supply shocks impinging on the economic system.

The paper introduces a macroeconomic model that incorporates exchange rate fluctuations. Uncertainty enters the model in the form of disturbances to both aggregate demand and aggregate supply. Within this framework, currency depreciation determines aggregate demand through exports, imports, and the demand for domestic currency, and determines aggregate supply through the cost of imported intermediate goods. The model demonstrates theoretically that the effects of currency depreciation is contractionary via the effect of the supply side. However, the effects on aggregate demand make the final outcome inconclusive.

2.1. Aggregate Demand

The demand side of the economy is specified using standard IS-LM equations with a

modification for an open economy. The demand side of the economy combines equilibrium conditions in the Goods and Money markets. In the specifications below, all coefficients are positive and throughout the paper, lower case denotes the logarithm of the corresponding level variable. The subscript t denotes the current value of the variable.

$$c_t = c_0 + c_1 y_{dt}, \quad 0 < c_1 < 1 \tag{1}$$

$$y_{dt} = y_t - t_t \tag{2}$$

$$t_t = t_0 + t_1 y_t, \quad t_1 > 0 \tag{3}$$

$$i_t = i_0 - i_1 r_t, \quad i_1 > 0 \tag{4}$$

$$\log(R_t) = \log(\frac{S_t P_t^*}{P_t}) = s_t + p_t - p_t^* \tag{5}$$

$$x_t = x_0 - x_1 \log(R_t), \quad x_1 > 0 \tag{6}$$

$$im_t = m_0 + m_1 y_t - m_2 \log(R_t), \quad m_1, m_2 > 0 \tag{7}$$

$$y_t = c_t + i_t + g_t + x_t - im_t \tag{8}$$

$$m_t - p_t = -\lambda[r_t + (E_t p_{t+1} - p_t)] + \phi y_t - \theta(E_t s_{t+1} - s_t), \quad \lambda, \phi, \theta > 0 \tag{9}$$

Equations (1) through (8) describe equilibrium conditions in the Goods market. In Equation (1), real consumption expenditure, c, varies positively with real disposable income, y_d. In Equation (2), disposable income is defined to be the net of real income, y, minus taxes, t. In Equation (3), real taxes are specified as a linear function of real income. In Equation (4), real investment expenditure, i, varies negatively with the real interest rate, r. In Equation (5), let the domestic price level be represented by P and the foreign price level in foreign currency by P^*. The spot price of foreign currency is denoted by S and defined as the number of domestic currency units per units of foreign currency. R is the price of foreign produced goods and services relative to the prices of domestically produced goods and services, i.e., the real effective exchange rate of the foreign currency. When R increases, the domestic currency depreciates in real terms. The value of R measures the degree of competitiveness of foreign produced

goods and services relative to those produced domestically.[8] In Equation (6), real exports are related to an autonomous element, x_0, which rises when the income level abroad rises, and to relative prices. The positive relationship between R and x, in (6), refers to the fact that when the foreign price is higher relative to domestic goods, exports will increase. In Equation (7), real imports, im, are assumed to rise with the level of real income and decrease with the real effective exchange rate of the foreign currency. Equation (8) describes the equilibrium condition in the goods market. Real government spending, g, is assumed to be exogenous. The total expenditure by domestic residents in real terms (y) is the sum of real consumption expenditure (c), real investment (i), real government spending (g), and net exports (the real value of exports, x, minus the real value of imports, im).

After substituting all equations into the equilibrium condition for the goods market, we obtain the expression for real income which is a function of the exchange rate, the domestic price level, the foreign price level, and the domestic interest rate. This expression is the IS equation which describes the negative relationship between real income and the real interest rate (See APPENDIX A).

In Equation (9), equilibrium in the money market is obtained by equating the demand and supply of real money balances. The real money supply is equal to an exogenously determined nominal balances, m, deflated by price, p. The demand for real money balances is positively related to real income and inversely related to the nominal interest rate. The nominal interest rate is defined as the sum of the real interest rate and inflation expectation at time t. $E_t s_{t+1}$ is the expected future value of the foreign currency at time t. Agents in each country must hold domestic money for transactions purposes but they may speculate by holding foreign money.[9] An unexpected depreciation of the domestic currency in period t would lead to speculation of appreciation in period $t+1$ to restore the steady-state normal trend of the exchange rate, i.e., $E_t s_{t+1} - s_t < 0$.[10] Consequently, agents increase the speculative demand for domestic currency, establishing a negative relationship between the demand for real money balances and agents' expectation of the future value of the domestic currency relative to its current value.

The LM equation is determined by the equilibrium condition in the money market, establishing a positive relationship between real income and the real interest rate. Solving for the interest rate, r, from the LM equation and substituting the result into the IS equation gives us the equation for aggregate demand (See APPENDIX A).

[8] For a similar definition, see Shone (1989).

[9] For a similar discussion, see Buiter (1990).

[10] Agents are reluctant to dispose of domestic currency given expectations of future appreciations in its value.

2.2. Aggregate Supply

On the supply side, output is produced using a production function that combines labor, capital, energy and imported intermediate goods. When the currency depreciates, it is more expensive to buy intermediate goods from abroad. The price of energy is paid in domestic currency to isolate this variable from exchange rate fluctuations.

To illustrate, the level of gross domestic output, Q, is produced using a production function that combines imported intermediate goods, N, labor, L, and the capital stock, K. The production function is Cobb-Douglas in N and L, assuming fixed capital stock.[11] In addition, the production function is dependent on changes in the energy price, Z. Accordingly, the supply-side of this economy can be summarized in Equations (10) through (14) as follows:

$$Q_t = L_t^{\delta} N_t^{1-\delta} e^{-Z_t} \tag{10}$$

$$Y_t = Q_t - R_t N_t \tag{11}$$

$$l_t^d = n_t - \eta\{w_t - p_t + z_t - \log\delta\}, \quad \eta = \frac{1}{1-\delta} > 0 \tag{12}$$

$$n_t = l_t + \frac{1}{\delta}\{\log(1-\delta) - z_t - \log(R_t)\} \tag{13}$$

$$l_t^s = \eta \log\delta + \omega\{w_t - E_{t-1}p_t\}, \quad \omega > 0 \tag{14}$$

Equation (10) specifies the level of gross domestic output produced, assuming complementary relation between the labor input and imported intermediate goods. Equation (11) defines domestic value added (output supplied) or the difference between gross domestic output and the amount of real intermediate imports.[12]

The demand for inputs is derived by calculating the marginal product of L and N and equating the results with the real cost of labor (the real wage) and the real price in domestic currency of imported intermediate goods (the real exchange rate). Taking log transformation of the first-order conditions and rearranging produces Equations (12) and (13). The demand for labor varies negatively with the real wage and positively with

[11] To exclude the possibility that depreciation may increase labor productivity by stimulating capital accumulation, the capital stock is assumed to be fixed. Alternatively, changes in the capital stock may not affect output if the marginal product of additional capital units equals the marginal cost.

[12] This definition follows Age'nor (1991) where he introduces a model and assumes intermediate goods are necessary for the production process and cannot be produced domestically.

imported intermediate goods. Similarly, the demand for imported intermediate goods increases with the labor input. Exchange rate depreciation increases the real price of imported intermediate goods and, hence, decreases the demand for these goods. Further, a rise in the energy price decreases the demand for labor and imported intermediate goods.

Equation (14) hypothesizes a positive log-linear relationship between labor supply and the expected real wage. The supply of labor increases with an increase in the nominal wage relative to workers' expected price at time $t-1$.

Equating labor demand and labor supply results in the nominal wage. Substituting the result into labor demand produces employment and, in turn, imported intermediate goods. Substituting for l and n into the log transformation of Equation (10), results in gross domestic output supplied (see APPENDIX A). Substituting the result into the log transformation of Equation (11) yields an equation for aggregate supply of domestic value added (See APPENDIX A).

Aggregate supply has a direct positive relationship with output price surprises. Workers decide on labor supply based on their expectation of the aggregate price level. An increase in aggregate price relative to workers' expectations increases the demand for labor and, hence, the nominal wage. A rise in the expected real wage increases employment and, hence, the output supplied. In addition, aggregate supply moves negatively with the domestic price of foreign currency. Depreciation increases the cost of imported goods and decreases the output supplied. Further, the output supplied varies negatively with changes in the energy price.

2.3. Market Equilibrium

Internal balance requires that aggregate demand for domestic output be equal to aggregate supply of domestic output at full employment. It is assumed that demand and supply shifts in the model are constructed of two components: anticipated (steady-state) component and an unanticipated (random) component (See APPENDIX A). The combination of demand and supply-side channels indicates that real output depends on unanticipated movements in the exchange rate, the money supply, government spending, and the energy price.[13] In addition, supply-side channels establish that output varies with anticipated changes in the exchange rate and the energy price.

Given demand-side channels, aggregate demand increases with an unexpected increase in government spending or the money supply, creating positive price surprises and, hence, increasing output and price in the short-run. Changes in the energy price, both anticipated and unanticipated, increase the cost of the output produced, decreasing

[13] Shocks to these variables are assumed to fluctuate in response to domestic conditions or in response to external vulnerability, e.g., capital mobility or fluctuations in foreign reserves.

output and raising prices.[14]

The effects of real exchange rate fluctuations on the price level and output are complicated by demand and supply channels as follows:

1. In the goods market, an unexpected depreciation of the domestic currency will make exports less expensive and imports more expensive. As a result, the competition from foreign markets will increase the demand for domestic products, increasing domestic output and price.

2. In the money market, an unexpected depreciation of the domestic currency, relative to its anticipated future value, prompts agents to hold more domestic currency and increases the interest rate. This channel moderates the positive effect of the exchange rate shock on aggregate demand, output, and price.[15]

3. On the supply side, changes in the exchange rate, both anticipated and unanticipated, determine the cost of imported intermediate goods. As the domestic currency depreciates, producers are inclined to decrease imports of intermediate goods, decreasing domestic output and increasing the cost of production and, hence, the aggregate price level.

3. EMPIRICAL MODELS

The empirical investigation analyzes annual time-series data of real output and price for a sample of developing countries.[16] The sample period for investigation varies according to data availability (see APPENDIX C for details). Over time, it is assumed that real output growth and price inflation fluctuate in response to aggregate domestic demand shocks, energy price shocks and exchange rate shocks. Shocks are randomly distributed over the time span under investigation. Exchange rate shocks are distributed around an anticipated stochastic steady-state trend. This trend varies with agents' observations of macro-economic fundamentals that are likely to determine the exchange

[14] The price level may rise unexpectedly in response to energy price shocks, creating incentives to increase the output produced. This channel moderates the reduction in output and the rise in price in response to energy price shocks. For a detailed theoretical illustration, see Kandil and Woods (1997). The moderating effect of the rise in price is further reinforced in this paper's model through the reduction in the real effective exchange rate, reducing the real cost of intermediate imported goods.

[15] The speculative effect of money demand is likely to be important in developing countries, where agents' incentives to hedge against potential fluctuations in the exchange rate are high.

[16] For an analysis of the implications of the theoretical model using sectoral data in the United States, see Kandil and Mirzaie (2002).

rate.[17] Detailed econometric methodology is provided in APPENDIX B. Detailed description and sources of all data are described in APPENDIX C.

Empirical models are formulated to approximate the solutions of output and price in the theoretical model. Accordingly, the empirical model of real output is specified as follows:

$$Dy_t = A_0 + A_1 E_{t-1} Dz_t + A_2 (Dz_t - E_{t-1} Dz_t) + A_3 E_{t-1} Dm_t + A_4 E_{t-1} (Dm_t - E_{t-1} Dm_t)$$

$$+ A_5 E_{t-1} Dg_t + A_6 E_{t-1} (Dg_t - E_{t-1} Dg_t) + A_7 E_{t-1} Ds_t + A_8 (Ds_t - E_{t-1} Ds_t) + v_t^y \qquad (15)$$

The model specification is based on the results of the test for non-stationarity of real output.[18] The test results are consistent with non-stationary real output for all countries under investigation. Given these results, the empirical model of real output is specified in first-difference form where $D(.)$ is the first-difference operator.[19] Accordingly, all variables in the model enter in first-difference form.[20] The unexplained residual is denoted by v_t^y.

Theory predicts that output varies with unanticipated demand shifts in the economy. Agents are expected to negotiate higher wages in anticipation of expansionary demand shifts, neutralizing the effects of these shifts on output.[21] Nonetheless, anticipated

[17] The theoretical model does not determine the exchange rate or other policy variables endogenously. Instead, the model is solved for the reduced forms that determine the responses of variables to exogenous policy shocks. In theory, shocks approximate unanticipated components of policy variables based on rational expectations. Econometrically, the anticipated component varies with agents' observations of macro-economic fundamentals, as described in APPENDIX B. Random shocks capture exogenous fluctuations around the moving trend over time.

[18] For details, see Kwiatkowski *et al*. (1992). Test results are available upon request. The non-stationary output is not jointly co-integrated with the non-stationary variables on the right-hand side. Hence, the empirical model does not include an error correction term.

[19] Given the non-stationarity of the estimated dependent variables, the empirical models are estimated in first-difference form. Hence, the anticipated component measures anticipated change in the policy variable. Shocks approximate unanticipated change (growth) in the policy variable.

[20] Test results indicate the non-stationarity of the energy price, the money supply, government spending, and the exchange rate. Nonetheless, the nonstationary component of these variables, the anticipated component, is not jointly co-integrated with the non-stationary dependent variables. Hence, the empirical models are estimated in first-difference form, without an error correction term.

[21] In the real world, institutional rigidity may interfere with agents' ability to adjust fully to anticipated demand shifts. In the labor market, contracts may be longer than one year, preventing wages at time t from adjusting fully to anticipated demand shifts at time $t-1$. Accordingly, anticipated demand shifts are not absorbed fully in price. Alternatively, institutional rigidity may be attributed to price rigidity in the product

demand shifts may determine real output through their effects on anticipated real effective exchange rate.[22] Consequently, anticipated demand shifts may increase real output.

To illustrate, let z_t be the log value of the energy price. Agents' expectation of a variable at time t based on information available at time $t-1$ is denoted by E_{t-1}. Based on theory's forecast, output growth is expected to vary negatively with changes in the energy price, both anticipated and unanticipated, at time $t-1$. Accordingly, A_1, $A_2 < 0$.[23] These predictions assume energy is an input into the production process. If a country is an energy producer, higher energy prices stimulate output growth.

Two sources of domestic policies, government spending and the money supply, approximate demand shifts in the model. The log values of government spending and the money supply are denoted by g_t and m_t. Unanticipated growth in government spending and the money supply increase aggregate demand, creating positive price surprises. Hence, A_4, $A_6 > 0$. Anticipated growth in government spending and the money supply may also increase real output growth. Accordingly, A_3, $A_5 > 0$.

Finally, anticipated depreciation of the real exchange rate determines the cost of the output supplied. Let s_t be the log value of the real effective exchange rate (a weighted average of the real domestic currency price of foreign currencies for major trading partners).[24] As producers anticipate a higher cost of imported intermediate goods, they decrease the output supplied. Accordingly, $A_7 < 0$. Unanticipated change in the exchange rate is likely, however, to determine both aggregate demand and supply. The higher cost of buying intermediate imports decreases the output supplied. However, demand-side channels render the effect of exchange rate fluctuations indeterminate. Accordingly, $A_8 \geq 0$ or $A_8 < 0$.

To demonstrate fluctuations in output price, an empirical model is specified as follows:

market. Given the cost of adjusting prices, producers may resort to adjusting prices at specific intervals over time. Hence, anticipated demand shifts at time $t-1$ may determine real output growth in the short-run. For a discussion of the implications of sticky-wage and sticky-price models, see Kandil (1996).

[22] Anticipated demand shifts increase price, decreasing anticipated real effective exchange rate. This channel moderates anticipated increase in the real cost of imported intermediate goods.

[23] The energy price is measured by the international energy price. For oil exporting countries, changes in the oil price are likely to contribute positively to output growth. The increased capacity is likely to slow down price inflation.

[24] Empirically, the exchange rate is measured by the real effective exchange rate (see APPENDIX C). This measure captures shifts attributed to the nominal exchange rate, s, and the foreign price of imports, p^*, in theory.

$$Dp_t = B_0 + B_1 E_{t-1} Dz_t + B_2 (Dz_t - E_{t-1} Dz_t) + B_3 E_{t-1} Dm_t + B_4 E_{t-1} (Dm_t - E_{t-1} Dm_t)$$

$$+ B_5 E_{t-1} Dg_t + B_6 E_{t-1} (Dg_t - E_{t-1} Dg_t) + B_7 E_{t-1} Ds_t + B_8 (Ds_t - E_{t-1} Ds_t) + v_t^p \qquad (16)$$

Test results indicate that the output price is non-stationary for the various countries under investigation. The dependent variable is differenced to achieve stationarity.[25]

For countries in which energy is an input into the production function, energy price shifts, both anticipated and unanticipated, increase the cost of the output produced and, hence, prices. Accordingly, B_1, $B_2 > 0$. Both anticipated and unanticipated demand shifts increase price inflation. Accordingly, B_3, B_4, B_5, $B_6 > 0$. If a country is an energy producer, higher energy price may stimulate output growth and, hence, lower price inflation.

Given the effect of anticipated currency depreciation in decreasing the output supply, $B_7 > 0$. In contrast, an unanticipated depreciation decreases the output supply and may expand (goods market effect) or contract (money demand effect) aggregate demand. The former two channels are inflationary while the latter decreases price inflation.

4. EMPIRICAL RESULTS

The results of estimating the empirical model of real output are presented in Table 1 for the sample of developing countries under investigation. Table 2 contains the results of estimating the empirical models of price.

4.1. The Output Equation

Table 1 summarizes the evidence of estimating the empirical model of real output for the various countries under investigation. The non-neutral effects of anticipated monetary shifts are evident by the positive and statistically effect on real output growth in Algeria, Colombia, Cyprus, Ecuador, Guatemala, Honduras, India, Malaysia, and Peru (41% of the sample). The non-neutral effects of anticipated government spending shifts are evident by the positive and statistically significant effect on real output growth in Guatemala, Iran, and Syria (14% of the sample). That is, output growth increases as agents anticipate expansion in aggregate demand. Nominal rigidity in labor and/or product markets may prevent agents from adjusting fully to anticipated demand shifts, creating long-lasting non-neutral effect on real output growth. In addition, anticipated

[25] Test results are available upon request. For some countries, the series was differenced twice to achieve stationarity. The non-stationary price is not jointly cointegrated with non-stationary variables on the right-hand side. Hence, the empirical model does not include an error correction term.

demand shifts increase the price level, decreasing the real effective exchange rate, which has an expansionary effect on the output supplied.

The exchange rate is measured by the real domestic price of foreign currency. Accordingly, a rise in the exchange rate indicates real depreciation of the domestic currency. Anticipated depreciation increases the cost of imported goods, decreasing output growth. The contractionary effects of anticipated currency depreciation are evident by the statistically significant negative response of real output growth in Costa Rica, Iran, Malaysia, and Peru (18% of the sample).

A rise in the price of energy increases the cost of producing output, decreasing the output supplied in oil-importing countries. This is evident by the negative and statistically significant response of output growth in Cyprus and Iran (9% of the sample).[26] It is likely, however, that a rise in the energy price increases the output supplied in oil-producing countries. This is evident by the positive and statistically significant response of real output growth to an anticipated rise in the energy price in Algeria.

Unanticipated demand shifts are likely to be distributed between real output growth and price inflation in the short-run. The flatter the aggregate supply curve, the bigger is the response of real output growth to unanticipated demand shifts.[27] The short-run expansionary effect of monetary shocks is evident by the positive and statistically significant response of output growth in Algeria, Colombia, Cyprus, Ecuador, Guatemala, Iran, Malaysia, and Morocco (36% of the sample). Similarly, evidence of the expansionary effect of government spending shocks is consistent with the positive and statistically significant response in Guatemala, and Iran (9% of the sample).

Unanticipated depreciation of the domestic currency affects the demand and supply sides of the economy. Specifically, depreciation decreases the output supplied with an indeterminate effect on aggregate demand. The contractionary effects of an unanticipated depreciation are evident by the negative and statistically significant response of output growth in Costa Rica, India, Iran, Malaysia, and Turkey (23% of the sample). Nonetheless, the expansionary effect of an unanticipated depreciation is evident by the positive and statistically significant response of output growth in Colombia (4% of the sample).

Finally, unanticipated energy price shocks are likely to increase the cost of production, decreasing real output growth. The contractionary effect of energy price

[26] It is rather surprising that output is adversely affected by the energy price shock in Iran, an oil-producing country. This may be the result of domestic pricing policies.

[27] In theory, the short-run response of output to policy shocks is determined by two factors. First, is the size of the output price surprise in response to a policy shock, which is determined, in part, by the elasticity of aggregate demand with respect to the policy shock. Second, is the slope of the aggregate supply curve, which is determined by the elasticity underlying the supply side, i.e., conditions in the labor market as well as the output elasticity with respect to a change in the labor input.

shocks is evident by the negative and statistically significant response of output growth in Cyprus, India, Iran, and Jordan (18% of the sample). In oil-producing countries, however, energy price shocks may have a positive effect on real output growth, as evident by the positive and statistically significant response for Algeria.

4.2. The Price Equation

Table 2 summarizes the evidence of estimating the empirical models of price for the various countries under investigation. Anticipated monetary changes induce inflationary effects, as evident by the positive and statistically significant response of price in Cyprus, Ghana, Honduras, Iran, Jordan, Malaysia, and Sri Lanka (32% of the sample). The inflationary effect of anticipated government spending shifts is also evident in Algeria, Costa Rica, Greece, Honduras, Korea, Peru, and Turkey (32% of the sample).

Anticipated currency depreciation increases the cost of imported raw materials and, hence, price inflation. This is evident by the positive and statistically significant response in Costa Rica, Ecuador, Guatemala, India, Morocco, Peru, Syria, and Turkey (36% of the sample).

Anticipated increase in the energy price increases the price of the output produced and, hence, price inflation. The inflationary effect of anticipated energy price is evident in Ecuador, Honduras, Jordan, Morocco, Nepal, Sri Lanka, and Turkey (32% of the sample). There is, however, evidence of deflation in the face of anticipated energy price shifts in Algeria. As noted above, higher energy price increases output growth in Algeria. Output expansion moderates price inflation in the face of energy price shocks.

Depending on the slope of the short-run supply curve and demand elasticity, price inflation rises in the face of policy shocks. The inflationary effect of monetary shocks is evident by the positive and statistically significant response of price inflation in Cyprus, Ecuador, Ghana, Guatemala, Jordan, and Peru (27% of the sample). Similarly, the effect of government spending shocks is positive and statistically significant on price inflation in Algeria, Costa Rica, Ghana, Honduras, and Turkey (23% of the sample).

The combined effects of demand and supply channels determine the response of price inflation to unanticipated currency depreciation. The evidence of price inflation in the face of depreciation shocks is consistent with the positive and statistically significant response in Costa Rica, Ghana, India, and Turkey (18% of the sample). That is, combining demand and supply channels, the inflationary effect of an unanticipated currency depreciation more than offsets the deflationary effect.

The inflationary effect of energy price shocks is evident by the positive and statistically significant response in Cyprus, Ecuador, Guatemala, Honduras, India, Jordan, Morocco, Sri Lanka, and Turkey (41% of the sample).

Overall, exchange rate depreciation appears to induce contractionary effects that slow down output growth and raise price inflation in the majority of developing countries under investigation. Output contraction is particularly pronounced in Costa Rica, India, Iran, Malaysia, Peru, and Turkey. Price inflation is particularly pronounced

in Costa Rica, Ecuador, Ghana, Guatemala, India, Morocco, Peru, Syria, and Turkey.

Table 3 illustrates the average time-series for three measures of openness in various countries: the ratio of imports to GNP or GDP, the ratio of exports to GNP or GDP, and the ratio of the sum of exports and imports to GNP or GDP. Countries that are most vulnerable to exchange rate fluctuations are not characterized with a pronouncedly higher degree of openness compared to other countries in the sample. Earlier research has suggested, however, that the effects of devaluation are likely to depend on the trade account. The contractionary effect of devaluation on real output growth is likely to be more pronounced the larger the deficit of the trade account.[28] Table 3 presents the difference between exports and imports as a share of GNP or GDP. The effects of exchange rate fluctuations on output and price do not vary systematically with the share of the trade deficit of nominal income. As illustrated theoretically, structural parameters on the demand or supply sides are likely to differentiate the response of output growth and price inflation to exchange rate fluctuations across countries. The higher the dependency of the output supplied on intermediate imported goods the bigger are the adverse effects of currency depreciation on economic performance in developing countries.

V. SUMMARY AND CONCLUSION

This investigation has focused on the effect of exchange rate fluctuations on economic performance in developing countries. Towards this investigation, the paper presents a theoretical model that decomposes movements in the exchange rate into anticipated and unanticipated components. Anticipated exchange rate depreciation determines the cost of imported intermediate goods and, hence, the output supplied. In contrast, unanticipated currency fluctuations determine aggregate demand through exports, imports, and the demand for currency, and determine aggregate supply through the cost of imported intermediate goods. The first channel increases aggregate demand; currency depreciation increases exports and decreases imports. The second channel decreases aggregate demand. An unexpected depreciation of the domestic currency, relative to its anticipated steady-state value, increases the demand for domestic currency. On the supply side, currency depreciation increases the cost to buy intermediate goods and decreases the output supplied. The combined effects of the three channels are indeterminate on output and price.

Let the exchange rate be the real domestic currency price of a composite of foreign currency for major trading partners. Anticipated movement in the exchange rate is assumed to vary with agents' observations of macro-economic fundamentals that

[28] Devaluation increases the cost of imports which may not be offset by an increase in the value of exports.

determine changes in the exchange rate over time. The unanticipated component of the exchange rate captures fluctuations in its realized value compared to agents' anticipation.

The paper investigates the effects of exchange rate fluctuations (both anticipated and unanticipated) using output and price data for a sample of twenty-two developing countries. The long-run impact is measured by the significant reduction of output growth and the significant increase in price inflation in the face of anticipated exchange rate shifts. In contrast, the short-run effects capture fluctuations in output growth and price inflation in the face of unanticipated exchange rate shifts. Given demand and supply channels, there is evidence of a significant contraction of output growth in the face of unanticipated currency depreciation. Consistently, demand expansion and supply contraction determine price inflation in the face of unanticipated currency depreciation.

To conclude: for a varying degree of openness, exchange rate fluctuations generate adverse effects on economic performance in a variety of developing countries. These effects are evident by output contraction and price inflation in the face of currency depreciation. Indeed, concerns about the adverse effects of exchange rate depreciation on economic performance are supported by the evidence of macroeconomic performance for a sample of twenty-two developing countries.

For policy implications, higher variability of exchange rate fluctuations, around its anticipated value, exacerbates adverse effects on economic performance in developing countries. Given this evidence, exchange rate policies should aim at minimizing unanticipated currency fluctuations to insulate economic performance from the adverse effects of this variability in developing countries. To that end, the paper's empirical evidence establishes the desirability of stabilizing the exchange rate at a level that is consistent with variation in macroeconomic fundamentals over time.

The desirability of managed exchange rate regimes should not imply that the paper's findings are in support of the currency peg as the exchange rate regime for developing countries. The recent experience of emerging market countries, e.g., the Southeast Asian countries and Mexico, demonstrated that the major underlying problem that probably triggered the financial crises in these countries was the currency peg. The paper's findings are consistent with the lessons of recent experiences: developing countries cannot and should not sustain a peg that is inconsistent with underlying macroeconomic fundamentals. Instead, exchange rate policy should aim at managing the rate over time in line with macroeconomic fundamentals to avoid the adverse effects implied by the analysis of this paper.

APPENDIX A

Theory Appendix

Substituting Equations (1)-(7) into the equilibrium condition for the goods market (8) results in the expression for real income. Real income is a function of the exchange rate, the domestic price level, the foreign price level, and the domestic interest rate:

$$y_t = \frac{1}{1 - c_1(1 - t_t) + m_t}\{c_0 - c_1 t_0 + i_0 + g_t + x_0 - m_0 + (m_2 + x_1)\log(R_t) - i_1 r_t\}$$

This expression is the IS equation describing the relationship between real income and the real interest rate.

Solving for the interest rate, r, from the LM Equation (9) and substituting the result into the IS equation gives us the equation for aggregate demand as follows:

$$y_t = A\left\{c_0 - c_1 t_0 + i_0 + g_t + x_0 - m_0 + (m_2 + x_1)\log(R_t) + \frac{i_1}{\lambda}(m_t - p_t)\right.$$

$$\left. + i_1(E_t p_{t+1} - p_t) + \frac{i_1\theta}{\lambda}(E_t s_{t+1} - s_t)\right\}$$

where, $A = \dfrac{1}{1 - c_1(1 - t_t) + m_t + \dfrac{i_1\theta}{\lambda}} > 0$

and $\log(R) = p^* + s - p$.

Solving for l and n from (12) and (13) and substituting the results into the log transformation of Q in (10), we obtain gross domestic output supplied as follows:

$$q_t = (\omega + \eta)\log\delta + \frac{\omega + \eta(1 - \delta)}{\eta\delta}\log(1 - \delta) + \omega(p_t - E_{t-1}p_t)$$

$$- \frac{\omega + \eta(1 - \delta)}{\eta\delta}\log(R_t) - \frac{\eta + \omega + \omega\eta\delta}{\eta\delta}z_t$$

Substituting the result into the log transformation of Equation (11),

$$y_t = \log(Q_t - R_t N_t)$$

Applying Taylor expansion and substituting for l and n, we obtain the equation for aggregate supply of domestic value added as follows:

$$y_t = (\omega + \eta)\log\delta + \frac{\omega}{\eta\delta}\log(1-\delta) + \omega(p_t - E_{t-1}p_t) - \frac{\omega}{\eta\delta}\log(R_t) - \frac{\omega\eta + \delta + \omega}{\eta\delta} z_t$$

Sources of demand and supply shifts are assumed to follow the following processes:

$$g_t = \overline{g} + \varepsilon_{tg}$$

$$m_t = \overline{m} + \varepsilon_{tm}$$

$$z_t = \overline{z} + \varepsilon_{tz}$$

$$s_t = \overline{s} + \varepsilon_{ts}$$

$$p_t^* = \overline{p^*} + \varepsilon_{tp^*}$$

where $\overline{g}$, $\overline{m}$, $\overline{z}$, $\overline{s}$, and $\overline{p^*}$ are anticipated (steady-state) changes and ε_{tg}, ε_{tm}, ε_{tz}, ε_{ts}, and ε_{tp^*} are random unanticipated changes that have zero means and constant variances.

Equating aggregate demand and supply yields the price of output. Taking expectation of the resulting expression at time t results in $E_t p_{t+1}$. Substituting for $E_t p_{t+1}$ back into the equilibrium condition, taking expectation at time $t-1$ and subtracting the results from the original condition results in the expression for output price surprises:

$$p_t - E_{t-1}p_t = \frac{\eta\delta\lambda A}{B + \omega\eta\delta\lambda}\varepsilon_{tg} + \frac{\eta\delta\lambda A i_1}{B + \omega\eta\delta\lambda}\varepsilon_{tm} + \frac{\omega\lambda + \omega\eta\delta}{B}\varepsilon_{tz}$$

$$+ \frac{BC}{B + \omega\eta\delta\lambda}\varepsilon_{tp^*} + \frac{BC\lambda - A i_1\eta\theta\delta\lambda}{(B + \omega\eta\delta\lambda)\lambda}\varepsilon_{ts}$$

where, $B = \lambda\omega + A\eta\delta\lambda(x_1 + m_2) + A i_1\eta\delta + A i_1\eta\delta\lambda > 0$

and, $C = \dfrac{A\eta^2\delta^2\lambda(x_1 + m_2) + \omega\eta\delta\lambda}{\eta\delta B} > 0$

A positive shock to ε_{tg} or ε_{tm} increases the demand for domestic output, creating positive price surprises. A positive shock to ε_{tz} increases the cost of the output produced, creating positive price surprises. A positive shock to ε_{tp^*} increases the demand for domestic goods and increases the cost of imported intermediate goods, creating positive price surprises. In contrast, a positive shock to ε_{ts} has an indeterminate effect on price through demand and supply channels.

Substituting the solution for output price surprises into the equilibrium conditions, the solutions for output and price are obtained as follows:

$$p_t = constant_p + \frac{B + i_1\eta\delta\lambda}{B}\left\{\frac{A\eta\delta\lambda}{B}\overline{g} + \frac{Ai_1\eta\delta\lambda}{B}\overline{m} + c\,\overline{p^*} - c\overline{s} + \frac{\omega + \omega\eta\delta}{B}\overline{z}\right\}$$

$$+ \frac{A\eta\delta\lambda}{B + \omega\eta\delta\lambda}\varepsilon_{tg} + \frac{Ai_1\eta\delta\lambda B}{B(B + \omega\eta\delta\lambda)}\varepsilon_{tm} + \frac{BC}{B + \omega\eta\delta}\varepsilon_{tp^*}$$

$$+ \frac{(\omega + \omega\eta\delta)\lambda}{B + \omega\eta\delta\lambda}\varepsilon_{tz} + \frac{BC - Ai_1\theta\eta\delta - C\omega\eta\delta\lambda}{B + \omega\eta\delta\lambda}\varepsilon_{ts}$$

$$y_t = constant_y + \left\{\frac{AB\omega\lambda + \omega i_1\eta\delta\lambda^2 A}{B^2}\right\}\overline{g} + \left\{\frac{B\omega Ai_1\eta + A\omega i_1^2\eta\delta\lambda^2}{B^2}\right\}\overline{m}$$

$$+ \left\{\frac{\omega(B + i_1\eta\delta\lambda) - B\omega}{B\eta\delta}\right\}\overline{p^*} + \left\{\frac{C\omega(B + i_1\eta\delta\lambda) - \omega B}{B\eta\delta}\right\}\overline{s}$$

$$+ \left\{\frac{\omega\eta\delta(B + i_1\eta\delta\lambda)(\omega + \omega\eta\delta) - (\omega\eta\delta + \omega)B^2}{B^2\eta\delta}\right\}\overline{z}$$

$$+ \left\{\frac{\omega\eta\delta\lambda A + A\lambda\omega}{B + \omega\eta\delta\lambda}\right\}\varepsilon_{tg} + \left\{\frac{Ai_1\eta\delta\lambda\omega + Ai_1\lambda\omega}{B + \omega + \eta\delta\lambda}\right\}\varepsilon_{tm}$$

$$+ \left\{\frac{B^2C\omega\eta\delta + C\omega(B + i_1\eta\delta\lambda)(B + \omega\eta\delta\lambda) - \omega B(B + \omega\eta\delta\lambda)}{(B + \omega\eta\delta + \lambda)\eta\delta B}\right\}\varepsilon_{tp^*}$$

$$+\left\{\frac{\eta\omega(B+\omega\eta\delta\lambda)(\omega^2\eta\delta+\omega^2\lambda)-B(B+\omega\eta\delta\lambda)(\omega\eta\delta+\omega)+(\omega\eta\delta\lambda+\omega\lambda)\omega B}{B\eta\omega(B+\omega\eta\delta\lambda)}\right\}\varepsilon_{tz}$$

$$+\left\{\frac{+BC\omega\eta\delta-Ai_1\eta^2\delta^2\theta\omega-\omega(B+\omega\eta\delta\lambda)+\omega BC-Ai_1\theta\eta\delta-C\omega\eta\delta\lambda}{\eta\delta(B+\omega\eta\delta\lambda)}\right\}\varepsilon_{ts}$$

where $constant_y$ and $constant_p$ are determined by constant terms on the demand and supply sides of the economy. Based on the model's solutions, the following observations can be made:

- Anticipated changes in government spending and the money supply, $\overline{g}$, $\overline{m}$, shift aggregate demand, increasing price. Given a constant level of nominal effective exchange rate, the rise in domestic price decreases the real effective exchange rate, reducing the real cost of imported intermediate goods. Accordingly, $\overline{g}$, and $\overline{m}$ have positive effects on real output.

- Anticipated changes in imports price, $\overline{p^*}$, the energy price, $\overline{z}$, and the exchange rate, $\overline{s}$, enter the production function. A rise in imports price, the energy price, and the exchange rate increase the cost of the output produced, decreasing output and increasing price. The rise in price decreases the real effective exchange rate, moderating the reduction in real output in the face of $\overline{p^*}$, $\overline{z}$, and $\overline{s}$.

- Unanticipated demand shifts in the face of government spending and the money supply, ε_{tg}, ε_{tm}, increase output and price in the short-run. The rise in price decreases the real effective exchange rate, reinforcing output expansion in the face of ε_{tg} and ε_{tm}.

- Unanticipated increase in imports price, ε_{tp^*}, increases demand and decreases supply. Accordingly, the price rises with an indeterminate effect on output.

- An unanticipated increase in the energy price, ε_{tz}, decreases output supply. The rise in price decreases the real effective exchange rate, moderating the reduction in real output in the face of ε_{tz}.

- Finally, ε_{ts}, enters the demand and supply sides of the economy. Specifically, ε_{ts} decreases the output supplied and results in an indeterminate effect on aggregate demand (an increase in net exports and an increase in money demand). Hence, the

effects of ε_{ts} are indeterminate on output and price.

APPENDIX B

Econometric Methodology

The surprise terms that enter models (15) and (16) are unobservable, necessitating the construction of empirical proxies before estimation can take place. Thus, the empirical models include equations describing agents' forecast of demand growth, the change in energy price, and the change in the real domestic price of weighted foreign currencies for major trading partners (the real effective exchange rate).

To decide on variables in the forecast equations for each of the demand and supply shifts, a formal causality test is followed. Each variable is regressed on two of its lags as well as two lags of all variables that enter the model: the change in the log value of the energy price, real output, price, the real effective exchange rate, government spending, and the money supply. The joint significance of the lags is tested for each variable. Accordingly, the forecast equations account for the lags of variables proven to be statistically significant.

Obtaining a proxy for ex-ante forecasts of the energy price is complicated by the assumption that the generating process experienced a structural change between 1973 and 1974. This assumption is supported by the results of a formal test suggested in Dufour (1982). For both the period 1955-73 and the period 1974-95, the generating process is modelled as described above. Where test results support structural break, dummy variables are included in the equations describing agents' forecasts of other variables. Upon accounting for these dummy variables, testing for structural break in the estimated empirical models for output and price proved insignificant.

Subtracting the above forecasts from the actual change in the variable results in surprises that enter the empirical model. In order to obtain efficient estimates and ensure correct inferences (i.e., to obtain consistent variance estimates), the empirical models are estimated *jointly* with the equation that determines the proxy variables following the suggestions of Pagan (1984 and 1986). To account for the endogeneity of forecasted variables, instrumental variables are used in the estimation of the empirical models. The instrument list includes three lags for each of the first-difference of the log value of the energy price, the exchange rate, the money supply, government spending, real output, and price.

Following the suggestions of Engle (1982), the results of the test for serial correlation in simultaneous equation models are consistent with the presence of first-order autoregressive errors for some countries. To maintain comparability, it is assumed in all models that the error term follows an AR(1) process. The estimated models are transformed, therefore, to eliminate any possibility for serial correlation. The estimated residuals from the transformed models have zero means and are serially

independent.

The qualitative results remain robust upon varying variables or the lag length in the forecast equations and/or the instruments list. Details are available upon request.

APPENDIX C

Data Sources

The sample period for investigation varies according to data availability as follows: Algeria, Colombia, Cyprus, Ecuador, Ghana, Guatemala, Honduras, Jordan, Korea, Malawi, Nepal, Peru, Sri Lanka, Syria, Turkey, 1955-1995. Morocco, 1957-1995. Egypt, Iran, Malaysia, 1959-1995. Costa Rica, India, 1960-1995. Kenya, 1964-1995.

Annual data for the above countries are described as follows:

1. Real Output: Real output of GDP or GNP measured in terms of 1982 dollars.

2. The Price Level: The deflator for GDP or GNP.

3. The Real Energy Price: the price of Venezuelan Petroleum deflated by the GDP/GNP deflator for each country. The empirical models were also estimated using an alternative series for the real energy price that is measured by deflating the price of Saudi Arabian Petroleum by the GNP/GDP deflator for each country. The qualitative results of the estimated models are similar to that reported in the paper.

4. Short-Term Interest Rate: Representatives of short-term market rates for the various countries, i.e., rates at which short-term borrowing is affected between financial institutions or rates at which short-term government paper is issued or traded in the market.

5. Government Spending: Nominal values of all payments by the government.

6. Money Supply: the sum of currency plus demand deposits.

7. Real Effective Exchange Rate: Real value of weighted exchange rate with major trading partners (the domestic price of foreign currency).

Sources: 1 through 6 are taken from the *International Financial Statistics*, year books issued by the International Monetary Fund, Washington, D.C. 7 is from Bahmani (1995) and Bahmani and Mirzaie (2000), as well as other details from the authors.

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Manuscript received October, 2002; final revision received July, 2003.