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The Asymmetric Effects of Exchange Rate Fluctuations: Theory and Evidence from Developing Countries

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Abstract

The paper examines the asymmetric effects of exchange rate fluctuations on real output and price in developing countries. The theoretical model decomposes movements in the exchange rate into anticipated and unanticipated components. Unanticipated currency fluctuations determine aggregate demand through exports, imports, and the demand for domestic currency, and determine aggregate supply through the cost of imported intermediate goods. The evidence indicates that the supply channel leads to output contraction and price inflation in the face of unanticipated currency depreciation. In contrast, the reduction in net exports determines output contraction without reducing price inflation in the face of unanticipated currency appreciation.

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Contents Page

I. 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.[2]

While the traditional view indicates that currency depreciation creates output expansion, other theoretical developments have stressed some contractionary effects. Meade (1951) discusses this theoretical possibility. If the Marshall-Lerner condition is not satisfied, currency depreciation could produce contraction.[3] 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 the contractionary effects of 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) formalize the same views.

Supply-side channels further complicate the effects of currency depreciation on economic performance. Bruno (1979) and 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 devaluation. As a result, the negative impact from the higher cost of imported inputs may dominate the production stimulus from lower relative

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

[3] 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.

prices for domestically traded goods. Gylfson and Schmid (1983) provide evidence that the final effect depends on the magnitude by which demand and supply curves shift because of devaluation.[4]

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 price.[5]

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. Anticipated movement in the exchange rate is assumed to vary with agents' observations of macro-economic fundamentals, which determine changes in the exchange rate over time. Deviation in the realized exchange rate from its anticipated value captures the unanticipated component of the exchange rate.

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. In contrast, unanticipated exchange rate movements determine economic conditions in three directions: net exports, money demand, and the output supplied.

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. Through these channels, it is possible to establish factors that determine asymmetry in the effects of unanticipated currency appreciation and depreciation on real output and price.[6] The investigation focuses on the implications of the asymmetric effects of exchange rate fluctuations on economic performance in developing countries.

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

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[4] 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. Agenor (1991) introduces a theoretical model for a small open economy and distinguishes between anticipated and unanticipated movement in the exchange rate. Examples of empirical investigations include Edwards (1986), Gylfason and Radetzki (1991) and Bahmani (1998).

[5] For an analytical overview, see Lizondo and Montiel (1989).

[6] The analysis of asymmetry in the face of demand shocks has gained attention recently. For evidence of asymmetry in the face of monetary shocks, see Kandil (1995). Asymmetry in the face of aggregate demand shocks is investigated in Kandil (1996), (1998), and (1999). Evidence of asymmetry in the face of government spending shocks is in Kandil (forthcoming). For evidence of asymmetry using exchange rate shocks in the analysis of disaggregated data in the United States, see Kandil and Mirzaie (forthcoming).

assumed to be randomly and symmetrically distributed around a steady-state stochastic trend over time. This trend varies over time with agents' observations of macro-economic fluctuations. Positive shocks to the exchange rate indicate an unanticipated increase in the domestic currency price of foreign currency, i.e., unanticipated currency depreciation (devaluation). A negative shock to the exchange rate represents an unanticipated currency appreciation.[7] Further, the analysis employs new data for the real effective exchange rate in developing countries.[8] These data have the advantage of (i) calculating the exchange rate as an 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.

The remainder of the paper is organized as follows. Section II presents the theoretical model. Section III outlines the empirical models. Section IV presents empirical results. Section V discusses the implications. The summary and conclusion are presented in Section VI.

II. 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 macro-economic model that incorporates exchange rate fluctuations of the domestic currency. Fluctuations are realized around a steady-state trend that is consistent with variation in macro-economic fundamentals over time. Uncertainty enters the model in the form of disturbances to both aggregate demand and aggregate supply. Within this framework, aggregate demand is affected by currency depreciation through exports, imports, and the demand for domestic currency, and aggregate supply is affected through the cost of imported intermediate goods. The model demonstrates theoretically that unanticipated currency depreciation decreases real output growth, via the effect on the supply side. However, the relationship between unanticipated currency depreciation and aggregate demand makes the final outcome inconclusive.

A. Aggregate Demand

The demand side of the economy is specified using standard IS-LM equations with a modification for an open economy. The specifications below describe equilibrium conditions in the Goods and Money markets. All coefficients are positive and throughout the paper, lower case denotes the logarithm of the corresponding variable. The subscript t denotes the current value of the variable.

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[7] For example, an overvalued peg that cannot be sustained based on rational expectations.

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

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

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

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

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

$$R_t = \frac{S_t P_t^*}{P_t} \tag{5}$$

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

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

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

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

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^*. S denotes the spot price of foreign currency. It measures 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.[9] 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.

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

After substituting all equations into the equilibrium condition for the goods market, the expression of real income is realized. It 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.[10]

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 determined by 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. It is assumed that citizens in each country must hold domestic money for transactions purposes but they may speculate by holding foreign money.[11] An unexpected temporary 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., $(E_t s_{t+1} - s_t) < 0$.[12] Consequently, agents increase the speculative demand for domestic currency, establishing a negative relationship between the demand of real money balances and agents' expectation of the exchange rate relative to the current value of the currency.

The LM equation is determined by the equilibrium condition in the money market. It establishes 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 results in the equation for aggregate demand.

B. 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 (or is devalued), it is more expensive to buy intermediate goods from abroad. The price of energy is paid in dollars in order to isolate this variable from fluctuations in the exchange rate.

To illustrate, the level of gross domestic output, Q, is produced using a production function that combines imported intermediate goods, U, labor, L, and the capital stock, K. The production function is Cobb-Douglas in U and L, assuming fixed capital stock.[13] In addition, the production function is dependent on the energy price, Z. Accordingly, the supply-side of this economy can be summarized in (10) through (14) as follows:

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[10] Detailed theoretical derivations are available upon request.

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

[12] Agents are reluctant to dispose of domestic currency following unexpected depreciation.

[13] Fixing the capital stock excludes the possibility that depreciation may increase labor productivity by stimulating capital accumulation.

$$Q_t = L_t^{\delta} U_t^{1-\delta} e^{-Z_t} \qquad (10)$$

$$Y_t = Q_t - R_t U_t \qquad (11)$$

$$l_t^d = u_t - \eta\{w_t - p_t + z_t - \log\delta\},\ \eta = \frac{1}{1-\delta} > 0 \qquad (12)$$

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

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

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.[14]

To derive the demand for inputs, the marginal product of L and U is calculated and the results are equated 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 (12) and (13). The demand for labor varies negatively with the real wage and positively with imported intermediate goods. Similarly, the demand for imported intermediate goods increases with the labor input. The depreciation of currency increases the real price of imported intermediate goods and, hence, decreases the demand for these goods. Furthermore, a rise in the energy price decreases the demand for labor and imported intermediate goods.

Equation (14) hypothesizes a positive log-linear relationship between the supply of labor 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*.

The nominal wage solution is obtained by equating labor demand and labor supply. Substituting the nominal wage into labor demand results in the solutions for employment and imported intermediate goods. Substituting for l and u into the log transformation of equation (10), results in an equation for gross domestic output supplied. Aggregate supply of domestic value added is realized upon substituting the result into the log transformation of equation (11).

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. A rise in aggregate price relative to workers' expectations increases the demand for labor. The nominal wage increases, as a result. A rise in expected real wage increases employment and, hence, the output supplied. In addition, aggregate supply moves negatively with the domestic price of foreign currency. Currency

[14] This definition follows Agenor (1991) where he introduces a model and assumes intermediate goods are necessary for the production process and cannot be produced domestically.

depreciation increases the cost of imported goods and decreases the output supplied. Further, the output supplied varies negatively with changes in the energy price.

C. 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. The combination of demand and supply channels indicates that real output depends on unanticipated movements in the exchange rate, the money supply, government spending, and the energy price.[15] 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 output and raising prices.[16]

The complexity of demand and supply channels may determine asymmetry in the face of exchange rate fluctuations. These channels are as follows:

- In the goods market, a positive shock to the exchange rate of the domestic currency (an unexpected depreciation) 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.

  A negative shock to the exchange rate of the domestic currency (an unexpected appreciation) will make exports more expensive and imports less expensive. As a result the demand for foreign products will increase, decreasing domestic output and price.

- In the money market, a positive shock to the domestic currency (an unexpected temporary depreciation) relative to anticipated value, prompts agents to hold more domestic currency and increases the interest rate. This channel moderates the expansion of aggregate demand and, therefore, the rise in output and price in the face of a positive exchange rate shock.

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

[16] 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 the theoretical model of this paper through the reduction in the real effective exchange rate, reducing the real cost of intermediate imported goods.

A negative shock to the domestic currency (an unexpected temporary appreciation) relative to anticipated value, prompts agents to hold less domestic currency and decreases the interest rate. This channel moderates demand contraction and, therefore, the reduction in output and price in the face of a negative exchange rate shock.

- On the supply side, a positive shock to the exchange rate (an unanticipated depreciation) increases the cost of imported intermediate goods, decreasing domestic output and increasing the cost of production and, hence, the aggregate price level.

  A negative shock to the exchange rate (an unanticipated appreciation) decreases the cost of imported intermediate goods, increasing domestic output and decreasing the cost of production and, hence, the aggregate price level.

III. Empirical Models

The empirical investigation analyzes annual time-series data of real output and price in twenty-two developing countries. The sample period for investigation varies according to data availability (see Appendix B 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. To investigate asymmetry, exchange rate shocks are symmetrically 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 rate.[17] Positive shocks to the domestic currency price of foreign currency represent unanticipated depreciation around this trend. Negative shocks represent unanticipated appreciation of the domestic currency around its steady-state trend. Over the time span under investigation, these shocks are assumed to occur with equal probability around the stochastic moving trend. Detailed econometric methodology is provided in Appendix A. Detailed description and sources of all data are described in Appendix B.

The model specification of real output is based on the results of the test for non-stationarity as follows:[18]

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[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 to exogenous policy shocks. In theory, shocks approximate unanticipated components of policy shocks based on rational expectations. Econometrically, the anticipated component varies with agents' observations of macro-economic fundamentals, as described in Appendix A. Random shocks capture exogenous fluctuations around the moving trend over time.

[18] For details, see Kwiatkowski et. al. (1992). That is, real output follows a random walk process. Upon first-differencing, the resulting series is stationary, which is the domain of demand and supply shifts as specified in theory.

$$Dy_t = A_0 + A_1 E_{t-1} Dz_t + A_2 (Dz_t - E_{t-1} Dz_t) + A_3 E_{t-1} Dm_t + A_4 (Dm_t - E_{t-1} Dm_t) + A_5 E_{t-1} Dg_t + A_6 (Dg_t - E_{t-1} Dg_t) + A_7 E_{t-1} Drs_t + A_{8p} pos_{rst} + A_{8n} neg_{rst} + \upsilon_t^y \quad (15)$$

The test results are consistent with non-stationary real output for all countries under investigation. Given these results, the empirical model for 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 of the model is denoted by υ_t^y.

Agents are expected to negotiate higher wages in anticipation of demand expansion. In turn, anticipated demand shifts are neutral.[21] Nonetheless, anticipated demand shifts may determine real output through their effects on anticipated real effective exchange rate.[22] Consequently, anticipated demand shifts may increase real output.

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]

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[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 market. Given the cost of adjusting prices, producers may resort to adjusting prices at specific intervals over time. Given price rigidity, 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 oil price are likely to contribute positively to output growth. The increased capacity in the wake of a rise in the energy price is likely to slow down price inflation.

Two sources of domestic policies, government spending and the money supply, approximate demand shifts, where g_t and m_t denote the log values of government spending and the money supply. 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, i.e., A_3, $A_5>0$.

Finally, anticipated depreciation of the real exchange rate determines the cost of the output supplied. Let rs_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. Unanticipated currency depreciation, a positive shock to the exchange rate, pos_{rst}, increases the cost of buying intermediate goods, decreasing the output supplied. Concurrently, pos_{rst} increases net exports and the demand for domestic currency. The final effect of pos_{rst} is indeterminate on aggregate demand, output, and price. Similarly, the combined effects of unanticipated currency appreciation, neg_{rst}, are indeterminate on aggregate demand, output and price.

To establish robustness, the empirical model in (15) is re-estimated, replacing specific demand shifts (government spending and the money supply) with a broad measure of aggregate demand (nominal GDP or GNP) as follows:[25]

$$Dy_t = A_0 + A_1 E_{t-1} Dz_t + A_2 (Dz_t - E_{t-1} Dz_t) + A_3 E_{t-1} Dn_t + A_4 (Dn_t - E_{t-1} Dn_t) + A_7 E_{t-1} Drs_t + A_{8p} pos_{rst} + A_{8n} neg_{rst} + \upsilon_t^y \quad (16)$$

Here, n_t denotes the log of the nominal value of Gross National or Domestic Product. This broad measure combines a variety of demand shifts stemming from the goods or money markets. Accordingly, A_3, and $A_{4>0}$. Model estimation will then determine how important exchange rate fluctuations are, given all other demand shocks impinging on the aggregate economy.

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

$$Dp_t = B_0 + B_1 E_{t-1} Dz_t + B_2 (Dz_t - E_{t-1} Dz_t) + B_3 E_{t-1} Dm_t + B_4 (Dm_t - E_{t-1} Dm_t) + B_5 E_{t-1} Dg_t + B_6 (Dg_t - E_{t-1} Dg_t) + B_7 E_{t-1} Drs_t + B_{8p} pos_{rst} + B_{8n} neg_{rst} + \upsilon_t^p \quad (17)$$

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

[25] This measure is likely to vary with a variety of shocks underlying aggregate demand: the money supply, government spending, velocity, consumption, investment, and external shocks attributed to fluctuations in the current and capital accounts.

Based on test results, output price is non-stationary for the various countries under investigation. Accordingly, the empirical model is specified in first-difference form.

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, $B_3, B_4, B_5, B_6 > 0$.

Given the effect of anticipated currency depreciation in decreasing the output supplied, price inflation increases and $B_7 > 0$.[26] An unanticipated depreciation of the domestic currency (a positive shock to the exchange rate) decreases the output supplied and may expand (net exports effect) or contract (money demand effect) aggregate demand. The former two channels are inflationary while the latter decreases price inflation. Similarly, demand and supply channels render the effects of neg_{rst} indeterminate on price inflation.

To establish robustness, the empirical model of price inflation is modified, replacing specific demand shifts with a broad measure of aggregate demand, nominal GNP/GDP shifts, as follows:

$$Dp_t = B_0 + B_1 E_{t-1} Dz_t + B_2 (Dz_t - E_{t-1} Dz_t) + B_3 E_{t-1} Dn_t + B_4 (Dn_t - E_{t-1} Dn_t) + B_7 E_{t-1} Drs_t + B_{8p} pos_{rst} + B_{8n} neg_{rst} + \upsilon_t^p \qquad (18)$$

Price inflation varies positively in the face of aggregate demand shifts, both anticipated and unanticipated. Accordingly, $B_3 > 0$ and $B_4 > 0$.

IV. Empirical Results

The results of estimating the empirical models 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.

A. The Output Equation

Table 1 summarizes the evidence of estimating the empirical models of real output for the various countries under investigation. For each country, the table contains two entries. The first entry is for the empirical model (15), employing monetary shocks and government spending shocks. The second entry is for the empirical model (16), employing nominal GNP or GDP shocks.

Detailed Estimation Results

This section discusses the validity of theory's predictions concerning variables' fluctuations in the face of demand and supply shifts.

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[26] Anticipated shifts in the real effective exchange rate are function of lagged values of variables that enter the forecast equation, including its own lags. Hence, only lagged values of domestic price are captured in anticipated currency shifts.

In the empirical model (15), the non-neutral effects of anticipated monetary shifts are evident by the positive and statistically significant effect on real output growth in Algeria, Cyprus, Guatemala, Malaysia, and Peru. The non-neutral effect of anticipated government spending shifts is evident by the positive and statistically significant response of real output growth in Guatemala, Iran, Morocco, and Syria. In the empirical model (16), the non-neutrality of anticipated aggregate demand shifts is evident by the positive and statistically significant response of output growth for Algeria, Cyprus, Ecuador, Egypt, Guatemala, Honduras, Iran, Jordan, Korea, Malaysia, Morocco, and Nepal. 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 to demand anticipation. Hence, anticipated demand shifts have long-lasting non-neutral effect on real output growth. In addition, anticipated demand shifts increase the price level, decreasing the real effective exchange rate and expanding the output supplied.

A rise in the real price of energy increases the cost of producing output, decreasing the output supplied. In model (15), this is evident by the negative and statistically significant response of output growth in Cyprus and Iran.[27] Similarly, in model (16), output contraction, in the face of anticipated energy price shifts, is evident by the negative response for Honduras, Kenya, and Korea. 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 anticipated rise in the energy price in Algeria, in model (15), and in Algeria and Syria, in model (16).[28]

Unanticipated demand shifts are likely to be distributed between real output growth and price inflation in the short-run. The flatter the supply curve, the bigger is the response of real output growth to unanticipated demand shifts.[29] In the empirical model (15), output expansion in the face of monetary shocks is evident by the positive and statistically significant response of output growth in Algeria, Cyprus, Ecuador, Guatemala, and Malaysia. Similarly, evidence of output expansion in the face of government spending shocks is consistent with the positive and statistically significant response in Guatemala, Iran, Malawi, and Morocco. In the empirical model (16), evidence of a flat supply curve is consistent with the positive and statistically significant response of real output

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[27] 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.

[28] Syria has strong ties with neighboring Arab oil-producing countries. Accordingly, the empirical evidence indicates a spill-over positive effect on output growth in the face of an anticipated rise in the energy price.

[29] 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 the 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.

growth to unanticipated demand shifts in Algeria, Cyprus, Ecuador, Egypt, Ghana, Honduras, India, Iran, Jordan, Korea, Malaysia, Morocco, Nepal, and Sri Lanka.

Finally, unanticipated energy price shocks are likely to increase production cost, decreasing real output growth. In the empirical model (15), output contraction in the face of energy price shocks is evident by the negative and statistically significant response in Cyprus, and Iran. In model (16), output contraction in the face of energy price shocks is evident by the negative and statistically significant response in Cyprus, Ecuador, Honduras, India, Iran, Kenya, and Korea. 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 in (15) and (16).

Exchange Rate Shifts and Real Output Growth

The exchange rate is measured by the real domestic price of foreign currency. Accordingly, a rise in the exchange rate indicates real depreciation (devaluation) of the domestic currency.[30]

Anticipated depreciation in the value of the domestic currency increases the cost of imported goods, decreasing output growth. In model (15), output contraction in the face of anticipated currency depreciation is evident by the statistically significant negative response in Costa Rica, Iran, and Peru. Similarly, in model (16), output contraction in the face of anticipated currency depreciation is evident by the negative and statistically significant response in Costa Rica, Ecuador, Kenya, Morocco, and Peru.

Unanticipated fluctuations of the domestic currency affect the demand and supply sides of the economy. A positive shock to the exchange rate of the domestic currency (an unanticipated depreciation) decreases the output supplied and increases money demand and net exports. The first two channels cause output contraction, while the latter causes output expansion. Output contraction in the face of unanticipated depreciation appears to be dominant in various countries. In model (15), this is evident by the negative response of output growth to positive shocks of the exchange rate in fifteen countries, which is statistically significant in Costa Rica, India, Iran, Malaysia, and Turkey. In model (16), output contraction in the face of an unanticipated depreciation of the exchange rate is evident by the negative response in sixteen countries, which is statistically significant in Costa Rica, Ecuador, Ghana, India, and Malaysia. Accordingly, output contraction appears to be pervasive in the face of unanticipated exchange rate depreciation of the domestic currency.

An unanticipated appreciation of the domestic currency (a negative shock to the exchange rate) increases the output supplied, and decreases the demand for money, and net exports. The first two channels cause output expansion, while the latter causes output contraction. The evidence indicates that output contraction appears more dominant in the face of negative shocks to the exchange rate. In model (15), this is evident by the positive response of output growth to negative exchange rate shocks, which is statistically significant in Malawi. In Model (16), output contraction in the face of

[30] Throughout the paper, depreciation will describe reduction in the domestic currency price of foreign currency attributed to either market forces or managed policy.

unanticipated exchange rate appreciation is evident by the positive and statistically significant response in Egypt, Ghana, Malawi, and Nepal.

Overall, output contraction is pronounced in the face of currency depreciation (via supply-side and money demand channels) and in the face of currency appreciation (via net exports channel). Asymmetry in the effects of exchange rate fluctuations on output growth is formalized by the difference in the response of output growth to positive and negative shocks. In model (15), the difference is negative and statistically significant for Ecuador, Egypt, Ghana, India, Jordan, Malawi, and Nepal. In model (16), this difference is negative and statistically significant for Ecuador, Egypt, Ghana, India, Iran, Jordan, Malaysia, Malawi, and Nepal. In general, output contraction in the face of unanticipated currency depreciation is not offset by expansion in the face of unanticipated currency appreciation.

B. The Price Equation

Table 2 summarizes the evidence of estimating the empirical models of price for the various countries under investigation. For each country, the table contains two entries. The first entry is for the empirical model (15), employing monetary shocks and government spending shocks. The second entry is for the empirical model (16), employing nominal GNP or GDP shocks.

Detailed Estimation Results

Price inflation increases in response to anticipated aggregate demand shifts. In the empirical model (17), anticipated monetary changes increase price inflation significantly in Cyprus, Ghana, Honduras, Jordan, Malaysia, and Sri Lanka. Similarly, anticipated changes in government spending increase price inflation significantly in Algeria, Costa Rica, Honduras, Jordan, Korea, Peru, and Turkey. In the empirical model (18), anticipated changes in aggregate demand increase price inflation in Algeria, Colombia, Costa Rica, Egypt, Ghana, Guatemala, Honduras, India, Kenya, Korea, Malaysia, Malawi, Morocco, Nepal, Peru, Sri Lanka, Syria, and Turkey.

Anticipated higher energy prices increase the price of the output produced and, hence, price inflation. In the empirical model (17), the inflationary effect of energy price shocks is evident by the positive and statistically significant response in Colombia, Honduras, Morocco, Nepal, Sri Lanka, and Turkey. In model (18), the inflationary effect of anticipated energy price shifts is evident by the positive and statistically significant response in Honduras, Kenya, and Korea. Nonetheless, where the increased oil price is consistent with an expansion in the output produced, the increased capacity moderates price inflation. In the empirical model (17), there is evidence of deflation in the face of anticipated energy price shifts in Algeria. Similarly, in the empirical model (18), price deflation is evident in the face of anticipated energy price in Algeria and Syria.

Depending on the slope of the short-run supply curve, price inflation rises in the face of aggregate demand shocks. In the empirical model (17), the inflationary effect of monetary shocks is evident by the positive and statistically significant response of price inflation in Cyprus, Ghana, Guatemala, Jordan, and Peru. Similarly, the effect of government spending shocks is positive and statistically significant on price inflation in Algeria, Costa Rica, Ghana, Honduras, and Turkey. In the empirical model (18) price inflation responds positively and significantly to aggregate demand shocks in

Algeria, Colombia, Costa Rica, Ecuador, Egypt, Ghana, Guatemala, Honduras, India, Kenya, Korea, Malaysia, Malawi, Morocco, Nepal, Peru, Sri Lanka, Syria, and Turkey.

In the empirical model (17), the inflationary effect of energy price shocks is evident by the positive and statistically significant response in Colombia, Cyprus, Ecuador, Guatemala, Honduras, India, Iran, Morocco, Sri Lanka, and Turkey. In the empirical model (18), the inflationary effect of energy price shocks is evident by the positive and statistically significant response in Cyprus, Ecuador, Honduras, India, Kenya, and Korea. Nonetheless, price deflation in the face of energy price shocks is evident by the negative and statistically significant response in Algeria. As noted above, higher energy price increases output growth and moderates price inflation.

Exchange Rate Shifts and Price Inflation

Anticipated currency depreciation increases the cost of imported production inputs and price inflation. In model (17), this is evident by the positive and statistically significant response in Costa Rica, India, Jordan, Peru, and Syria. In model (18), the inflationary effect of anticipated depreciation is evident by the positive and statistically significant response of price inflation in Costa Rica, Ecuador, Kenya, Morocco, and Peru.

The combined effects of demand and supply channels determine the response of price inflation to unanticipated exchange rate fluctuations. A positive shock to the exchange rate (unanticipated currency depreciation) may decrease the output supplied, increase net exports, and increase money demand. The former two channels are inflationary while the latter channel decreases price inflation. In model (17), price inflation increases in the face of positive exchange rate shocks in Costa Rica, Ghana, India, Jordan and Turkey. In model (18), the response of price inflation to unanticipated currency depreciation is positive and statistically significant in Costa Rica, Ecuador, Ghana, India, and Malaysia. That is, the inflationary channel dominates in the face of unanticipated currency depreciation.

A negative shock to the exchange rate (an unanticipated currency appreciation) may increase the output supplied, decrease net exports, and decrease money demand. The former two channels decrease price inflation while the latter is inflationary. In model (17), the response of price inflation to unanticipated appreciation is negative and statistically significant in Colombia, and Malawi. That is, price inflation is rising despite currency appreciation. In general, the insignificant response of price inflation in the face of negative exchange rate shocks is consistent with asymmetry. That is, price inflation in the face of currency depreciation is not offset by deflation in the face of currency appreciation.[31] Asymmetry of price inflation in the face of exchange rate shocks is even more pronounced in model (18). The response of price inflation to unanticipated currency appreciation is negative and statistically significant in Egypt, Ghana, Malawi, and Nepal.

Asymmetry is formalized by the difference in the response of price inflation to positive and negative exchange rate shocks. In model (17), this difference is positive and statistically significant

[31] One exception is in the case of Costa Rica, where price inflation responds positively and significantly to positive and negative exchange rate shocks.

for Colombia, Ecuador, Ghana, Jordan, Malawi, Morocco, Peru, and Turkey. In model (18), this difference is positive and statistically significant in Ecuador, Egypt, Ghana, India, Jordan, Malaysia, Malawi, and Nepal. That is, the inflationary effect, in the face of unanticipated currency depreciation, dominates deflation in the face of unanticipated currency appreciation. Exceptions are for Costa Rica, Honduras, and Korea, where price deflation in the face of currency appreciation dominates inflation in the face of depreciation.

V. IMPLICATIONS

Overall, unanticipated currency depreciation (positive shocks to the exchange rate) appears to slow down output growth and raise price inflation in the majority of developing countries under investigation. Output contraction is particularly pronounced in Costa Rica, Ecuador, Ghana, India, Iran, Malaysia, and Turkey. Price inflation is particularly pronounced in Costa Rica, Ecuador, Ghana, India, Jordan, Malaysia, and Turkey. This evidence is consistent with an increase in the cost of imported inputs, decreasing output growth and increasing price inflation.

Unanticipated currency appreciation (negative shocks to the exchange rate) decreases output growth with minimal price deflation. This evidence is consistent with a decrease in net exports. Output contraction in the face of currency appreciation is particularly evident in Egypt, Ghana, Malawi, and Nepal. Price deflation in the face of currency appreciation is particularly evident in Costa Rica. Price inflation in the face of currency appreciation is particularly evident in Colombia, Egypt, Ghana, Malawi and Nepal. Despite output contraction (the reduction in net exports) price deflation appears to be rigid in the face of exchange rate appreciation. Agents' desire to decrease money demand, in the face of unanticipated currency appreciation, contributes to an increase in velocity, which proves inflationary.[32]

Given asymmetry, the variability of exchange rate shocks differentiates the effects of currency depreciation and appreciation on output growth and price inflation. Based on the time-series effects, the contribution of exchange rate shocks to average (steady-state) output growth can be approximated as follows:

$$\begin{aligned} E(Dy)_{rs} &= Con_{posrs} + Con_{negrs} \\ &= A_{8p}E(pos_{rs}) + A_{8n}E(neg_{rs}) \end{aligned} \qquad (19)$$

E(.) is the mathematical expectation operator. The subscript *rs* denotes the component of average real output growth that varies with exchange rate shocks. The terms Con_{posrs} and Con_{negrs} denote the contributions of positive and negative exchange rate shocks to average real output growth. The coefficients on the right-hand side measure the response of real output growth to positive and negative exchange rate shocks in (15) or (16).

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[32] The empirical evidence during the Asian crisis indicates that several economies suffered from output contraction and price inflation, as agents perceived domestic currencies to be overvalued and started the process of speculative attacks. Of course, subsequent devaluation further accelerated inflation and reinforced output contraction through the supply-side channel.

Similarly, the contribution of exchange rate shocks to average price inflation can be approximated as follows:

$$E(Dp)_{rs} = Con_{posrs} + Con_{negrs} = B_{8p}E(pos_{rs}) + B_{8n}E(neg_{rs}) \quad (20)$$

The coefficients on the right-hand side measure the response of price inflation to positive and negative exchange rate shocks in (17) or (18).

The procedure followed to calculate $Epos_{rs}$ and $Eneg_{rs}$ is described in Appendix A. Mathematical expectation varies with the variability of exchange rate shocks. The larger the variability of the shocks, the larger is the effect of asymmetry on trend real output growth and price inflation. Variability measures are provided in Table 3.

A. Exchange Rate Variability and Trend Real Output Growth

Table 3 summarizes the contributions of exchange rate shocks to average real output growth using the parameter estimates from the empirical model in (15). Trend output growth is summarized in Table 3.

Consistent with the dominant negative effect of exchange rate shocks in model (15), the net contribution of these shocks is negative, decreasing output growth, on average, in the majority of countries (14 out of 22). The largest reduction is evident in Syria.[33] On average, annual real output growth is expected to decrease by -4.4%, given variability of exchange rate shocks that equals 0.18 over time. The smallest reduction is evident in Peru,[34] where annual real output growth is expected to decrease, on average, by -0.43%, given variability of exchange rate shocks that equals 0.22 over time.[35]

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[33] Given the size of output contraction in the face of unanticipated currency appreciation and depreciation, the net contribution of exchange rate fluctuations is negative and large in absolute magnitude. Also, the variability of the realized exchange rate compared to its anticipated value is relatively large in Syria.

[34] Despite large output contraction in the face of unanticipated currency depreciation in Peru, there is a very moderate expansion in the face of unanticipated currency appreciation. Nonetheless, the variability of the realized exchange rate around its anticipated value is quite large in Peru.

[35] Details using estimates from the empirical model in (16) are available upon request. Consistent with the dominant negative effect of exchange rate shocks in model (16), the net contribution of these shocks is negative, decreasing output growth, on average, in the majority of countries (15 out of 22). The largest reduction is evident in Ghana where annual real output growth is expected to decrease, on average, by -2.8%, given variability of exchange rate shocks that equals 0.45. The smallest reduction is evident in Cyprus where annual real output growth is expected to decrease, on average, by -0.18%, given variability of the exchange rate that equals 0.04 over time.

B. Exchange Rate Variability and Trend Price Inflation

Table 3 summarizes the contributions of exchange rate shocks to average price inflation, using the parameter estimates from the empirical models in (17). Trend price inflation is summarized in Table 3.

Using the estimates of the price equation in model (17), the net contribution of exchange rate shocks is positive, increasing price inflation, on average, in the majority of countries (16 out of 22).[36] The highest increase is evident in Turkey where annual price inflation is expected to increase by 7.9%, on average, given variability of exchange rate shocks, 0.23, over time. The smallest increase is evident in Jordan, where annual price inflation is expected to increase by 0.12%, given variability of exchange rate shocks that equals 0.015 over time.[37]

VI. Summary and Conclusion

The analysis has focused on asymmetry in the effects of exchange rate fluctuations on economic conditions in developing countries. Towards this investigation, the paper presents a theoretical model that decomposes movements in the exchange rate into anticipated and unanticipated components. 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.

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, determining changes in the exchange rate over time. A positive shock to the exchange rate, an unanticipated depreciation of the domestic currency, increases net exports and money demand and decreases the output supplied. Similarly, a negative shock to the exchange rate, an unanticipated appreciation of the domestic currency, decreases net exports and money demand and increases the output supplied. The combined effects of demand and supply channels may establish asymmetry in the face of positive and negative shocks to the exchange rate.

The paper investigated asymmetry in the effects of exchange rate fluctuations using output and price data for a sample of twenty-two developing countries. Given demand and supply channels,

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[36] Across countries, the result of regressing trend price inflation on exchange rate variability yields a positive coefficient (0.22) with a t-ratio (1.66) that is statistically significant at the 11% level.

[37] Details using estimates from the empirical model in (18) are available upon request. Consistent with the dominant inflationary effect of exchange rate shocks in model (18), the net contribution of these shocks is positive, increasing price inflation, on average, in the majority of countries (14 out of 22). The largest increase is evident in Ghana where annual price inflation is expected to increase, on average, by 3.4% given variability of exchange rate shocks that equals 0.45 over time. The smallest increase is evident in Colombia and Sri Lanka where annual price inflation is expected to increase, on average, by 0.21%, given variability of exchange rate shocks that equals 0.16 in Colombia and 0.11 in Sri Lanka.

there is evidence of a significant contraction in output growth, coupled with a significant increase in price inflation in the face of unanticipated currency depreciation. That is, the reduction in the output supplied is a dominant factor in determining the results of unanticipated currency depreciation. Similarly, there is evidence of output contraction coupled with price inflation in the face of unanticipated currency appreciation. That is, demand-side channels dominate supply-side channels (cheaper cost of imported inputs) in determining the effects of unanticipated currency appreciation. The reduction in net exports determines output contraction. Nonetheless, agents' desire to hold less domestic currency (capitalize on currency appreciation) contributes to price inflation.

Higher variability of exchange rate fluctuations, around its anticipated value, generates, therefore, adverse effects on economic performance in various developing countries. These effects are evident by output contraction and price inflation in the face of currency fluctuations (both depreciation and appreciation). Given asymmetry, the variability of unanticipated currency fluctuations decreases real output growth and increases price inflation, on average, in the majority of countries under investigation.

Table 1 . Results of Estimating the Empirical Model for Real Output

Country	En	*Em*	Eg	*Ers*	*Ez*	*ns*	*ms*	*gs*	pos_{rs}	neg_{rs}	*zs*	R^2	*Asym*
Algeria		0.49*	0.015	0.076	0.20*		0.35*	0.13	0.40	-0.032	0.24*	0.96	0.43
		(4.01)	(0.10)	(0.66)	(6.92)		(1.97)	(0.76)	(0.53)	(-0.08)	(9.07)		(0.57)
	0.37**			-0.086	0.14*	0.58*			-0.17	-0.082	0.11*	0.96	-0.088
	(1.79)			(-0.66)	(3.11)	(4.12)			(-0.39)	(-0.38)	(3.41)		(-0.20)
Colombia		0.49	0.19	0.50*	-0.014		0.38	0.11	0.096	0.19	-0.012	0.73	-0.094
		(1.50)	(1.42)	(2.10)	(-0.58)		(1.63)	(1.43)	(1.07)	(1.50)	(-0.64)		(-1.048)
	-0.036			0.094	-0.014	-0.06			0.0013	0.035	0.002	0.52	-0.034
	(-0.15)			(0.94)	(-0.55)	(-0.34)			(0.02)	(0.42)	(0.12)		(-0.52)
Costa Rica		0.024	-0.049	-0.17*	-0.016		0.0056	-0.014	-0.061*	-0.083	0.00084	0.72	0.022
		(0.25)	(-0.41)	(-3.60)	(-0.70)		(0.08)	(-0.08)	(-2.24)	(-0.83)	(0.04)		(0.81)
	0.0094			-0.16*	-0.024	0.047			-0.053*	-0.11	-0.0034	0.72	0.057*
	(-0.11)			(-3.48)	(-1.19)	(0.48)			(-2.13)	(-1.28)	(-0.19)		(2.29)
Cyprus		0.86*	-0.28	0.36	-0.21*		0.52*	-0.13	0.56	0.014	-0.086**	0.73	0.55
		(3.03)	(-1.29)	(0.57)	(-3.78)		(2.44)	(-1.55)	(1.16)	(0.02)	(-1.76)		(1.13)
	0.93*			0.088	-0.036	0.92*			0.099	-0.012	-0.041*	0.96	0.11
	(13.31)			(0.55)	(-1.61)	(17.89)			(0.92)	(-0.08)	(-2.81)		(1.03)
Ecuador		0.83	-0.29	-0.14	0.021		0.64*	-0.29	-0.30	0.39	-0.017	0.48	-0.69*
		(1.59)	(-1.15)	(-1.16)	(0.17)		(1.99)	(-1.33)	(-1.66)	(1.07)	(-0.19)		(-3.82)
	0.62*			-0.17**	-0.13	0.58*			-0.23**	0.19	-0.12*	0.52	-0.42*
	(2.42)			(-1.69)	(-1.39)	(3.67)			(-1.92)	(0.84)	(-2.20)		(-3.51)
Egypt		0.31	0.055	0.075	-0.033		0.24	0.16	0.10	0.30	-0.00075	0.55	-0.20*
		(1.20)	(0.15)	(0.40)	(-0.54)		(1.16)	(0.96)	(1.10)	(0.85)	(-0.02)		(-2.20)
	0.71*			0.12	-0.0023	0.74*			0.041	0.43**	-0.0096	0.75	-0.39*
	(4.88)			(1.04)	(-0.07)	(5.59)			(0.82)	(1.87)	(-0.37)		(-7.78)
Ghana		-0.019	0.17	-0.053	-0.074		0.012	0.12	-0.032	0.11	-0.0023	0.43	-0.14*
		(-0.15)	(1.36)	(-1.32)	(-1.26)		(0.14)	(1.67)	(-1.14)	(1.51)	(-0.06)		(-5.058)
	0.16			-0.04	-0.038	0.21*			-0.05*	0.14*	0.012	0.52	-0.19*
	(1.42)			(-1.12)	(-0.86)	(2.77)			(-2.03)	(2.22)	(0.37)		(-7.71)
Guatemala		0.52*	0.27*	-0.043	0.032		0.21*	0.24*	0.72	-0.20	0.028	0.86	0.92*
		(6.40)	(2.86)	(-0.21)	(1.25)		(2.49)	(2.18)	(1.46)	(-0.28)	(1.00)		(1.86)
	0.37*			-0.37	-0.01	0.14			-0.14	0.91	-0.012	0.57	-1.05
	(3.26)			(-0.66)	(-0.18)	(1.50)			(-0.19)	(1.10)	(-0.25)		(-1.43)
Honduras		0.076	0.077	-0.17	-0.048		0.011	0.071	-0.092	-0.13	-0.041	0.58	0.038
		(0.31)	(0.37)	(-0.96)	(-1.07)		(0.11)	(0.45)	(-0.43)	(-0.33)	(-1.26)		(0.18)
	0.61*			0.012	-0.07*	0.57*			0.097	-0.13	-0.031*	0.79	0.23*
	(5.49)			(0.12)	(-3.81)	(5.45)			(0.89)	(-0.74)	(-2.28)		(2.08)
India		0.21	0.15	-0.028	-0.016		-0.021	0.027	-0.17*	0.12	-0.034	0.61	-0.29*
		(1.60)	(1.03)	(-0.41)	(-0.82)		(-0.16)	(0.21)	(-1.99)	(0.45)	(-1.33)		(-3.39)
	0.35			-0.08	-0.018	0.50*			-0.13**	0.14	-0.057*	0.64	-0.27*
	(1.17)			(-0.85)	(-0.61)	(3.00)			(-1.85)	(0.80)	(-2.30)		(-3.84)
Iran		0.17	0.88*	-2.19*	-0.53*		0.41	1.28*	-1.83*	-1.20	-0.56*	0.85	-0.63
		(0.82)	(6.06)	(-2.49)	(-5.34)		(1.44)	(4.76)	(-2.30)	(-0.37)	(-4.39)		(-0.79)
	0.67*			-0.27	-0.11	0.58*			-0.84	1.037	-0.12**	0.69	-1.87*
	(3.37)			(-0.29)	(-1.39)	(3.42)			(-1.11)	(0.46)	(-1.77)		(-2.48)
Jordan		0.30	-0.10	1.27	-0.068		-0.23	0.044	-0.02	2.37	-0.084	0.68	-2.39*
		(0.82)	(-0.34)	(0.68)	(-0.76)		(-0.72)	(0.23)	(-0.02)	(0.67)	(-0.80)		(-2.39)
	0.56*			2.70	-0.057	0.83*			0.53	4.56	0.055	0.64	-4.03*
	(2.48)			(1.53)	(-0.77)	(3.80)			(0.41)	(1.02)	(0.55)		(-3.12)
Kenya		0.076	0.077	-0.17	-0.048		0.011	0.071	-0.092	-0.13	-0.041	0.58	0.038
		(0.31)	(0.37)	(-0.96)	(-1.07)		(0.11)	(0.45)	(-0.43)	(-0.33)	(-1.26)		(0.18)
	0.029			-0.21**	-0.043**	0.011			-0.12	-0.15	-0.036**	0.46	0.03
	(0.32)			(-1.76)	(-1.75)	(0.32)			(-0.66)	(-0.42)	(-1.70)		(0.17)

Table 1: Results of Estimating the Empirical Model for Real Output (cont'd.)

Country	En	*Em*	Eg	*Ers*	*Ez*	*ns*	*ms*	*gs*	pos_{rs}	neg_{rs}	*zs*	R^2	*Asym*
Korea		0.11	-0.0041	-0.068	-0.048		0.011	-0.076	0.024	-0.12	-0.016	0.49	0.14*
		(1.36)	(-0.04)	(-1.08)	(-1.10)		(0.16)	(-0.71)	(0.56)	(-0.92)	(-0.54)		(3.36)
	0.28*			-0.045	-0.09*	0.29*			-0.0022	-0.14	-0.048*	0.54	0.14*
	(2.52)			(-0.73)	(-3.01)	(2.54)			(-0.06)	(-1.16)	(-2.13)		(3.76)
Malaysia		0.21**	-0.11	-0.30	0.016		0.24**	-0.015	-0.58*	-0.29	0.015	0.95	-0.29
		(1.88)	(-1.00)	(-1.18)	(0.55)		(1.84)	(-0.21)	(-2.57)	(-1.08)	(0.50)		(-1.29)
	0.27*			-0.12	0.00059	0.26*			-0.41*	-0.073	-0.0078	0.98	-0.34*
	(4.07)			(-1.51)	(0.05)	(5.42)			(-3.79)	(-0.78)	(-0.78)		(-3.12)
Malawi		-0.082	0.13	0.03	-0.019		-0.046	0.27**	-0.14	0.82*	0.011	0.54	-0.96*
		(-0.59)	(0.69)	(0.13)	(-0.33)		(-0.58)	(1.92)	(-0.62)	(2.43)	(0.27)		(-4.25)
	0.082			0.12	0.012	0.072			0.14	0.81*	0.056	0.47	-0.67*
	(0.33)			(0.61)	(0.23)	(0.38)			(0.81)	(2.51)	(1.10)		(-3.88)
Morocco		0.22	0.27*	0.057	-0.04		0.36	0.40**	0.18	-0.33	0.00012	0.55	0.51
		(1.17)	(1.96)	(0.48)	(-1.07)		(1.19)	(1.79)	(0.47)	(-0.62)	(0.00)		(1.33)
	0.23**			-0.18*	-0.018	0.58*			-0.15	0.047	-0.049	0.73	-0.20
	(1.79)			(-2.25)	(-0.86)	(4.37)			(-0.89)	(0.15)	(-1.67)		(-1.17)
Nepal		0.13	0.04	0.068	0.00021		-0.043	0.023	-0.078	0.47	0.0017	0.48	-0.55*
		(1.22)	(0.55)	(0.59)	(0.01)		(-0.46)	(0.46)	(-0.66)	(1.54)	(0.07)		(-2.02)
	0.41*			-0.015	-0.033	0.35*			-0.021	0.39**	0.019	0.61	-0.41*
	(2.87)			(-0.20)	(-1.39)	(3.99)			(-0.24)	(1.77)	(1.03)		(-4.69)
Peru		0.19*	-0.11	-0.11*	0.00096		0.058	-0.16	-0.051	-0.028	0.00096	0.65	-0.023
		(2.18)	(-1.02)	(-2.12)	(0.03)		(1.02)	(-1.50)	(-0.63)	(-0.20)	(0.03)		(-0.28)
	0.10			-0.16*	0.00092	0.12			-0.11	-0.0071	0.039	0.54	-0.10
	(1.51)			(-3.02)	(0.03)	(1.09)			(-1.28)	(-0.04)	(1.23)		(-1.16)
Sri Lanka		-0.19	0.14	0.081	-0.027		-0.15	0.019	0.021	0.12	-0.01	0.24	-0.099
		(-1.42)	(1.14)	(0.87)	(-1.11)		(-1.23)	(0.18)	(0.26)	(0.57)	(-0.42)		(-1.23)
	0.085			-0.016	-0.017	0.20**			-0.053	-0.0052	-0.017	0.22	-0.048
	(0.82)			(-0.24)	(-0.57)	(1.78)			(-0.98)	(-0.03)	(-0.57)		(-0.88)
Syria		-0.28	0.37**	0.089	0.11		0.012	0.18	-0.30	0.30	0.0014	0.70	-0.60
		(-1.58)	(1.75)	(0.44)	(1.35)		(0.05)	(0.85)	(-0.37)	(0.61)	(0.02)		(-0.74)
	-0.048			0.29	0.18*	-0.17			0.092	0.0018	0.047	0.58	0.09
	(-0.19)			(0.96)	(2.52)	(-0.56)			(0.82)	(0.00)	(0.86)		(0.80)
Turkey		0.19	-0.17	-0.049	-0.0076		0.14	-0.10	-0.091**	-0.025	-0.0087	0.25	-0.066
		(1.35)	(-1.00)	(-0.71)	(-0.27)		(1.19)	(-0.88)	(-1.80)	(-0.15)	(-0.32)		(-1.31)
	0.071			-0.099	-0.02	0.064			-0.084	-0.10	-0.016	0.21	0.016
	(0.75)			(-1.45)	(-0.61)	(0.60)			(-1.47)	(-0.67)	(-0.53)		(0.28)

- *En* and *ns*: expected and unexpected nominal GNP/GDP growth, $E_{t-1}Dn_t$, $(Dn_t-E_{t-1}Dn_t)$.
- *Em* and *ms*: expected and unexpected monetary growth, $E_{t-1}Dm_t$, $(Dm_t-E_{t-1}Dm_t)$.
- *Eg* and *gs*: expected and unexpected growth of government spending, $E_{t-1}Dg_t$, $(Dg_t-E_{t-1}Dg_t)$.
- *Ers*: expected depreciation in the real exchange rate, $E_{t-1}Drs_t$.
- *Ez* and *zs*: expected and unexpected change in the energy price, $E_{t-1}Dz_t$, $(Dz_t-E_{t-1}Dz_t)$.
- pos_{rs}: positive shocks to the exchange rate, an unanticipated currency depreciation.
- neg_{rs}: negative shocks to the exchange rate, an unanticipated currency appreciation.
- *Asym*: the difference between the output response to positive and negative exchange rate shocks.
- T ratios are in parentheses. * and ** denote statistical significance at the five and ten percent levels.

Table 2. Results of Estimating the Empirical Model for Price

Country	*En*	*Em*	*Eg*	*Ers*	*Ez*	*ns*	*ms*	*gs*	pos_{rs}	neg_{rs}	*zs*	R^2	*Asym*
Algeria		-0.13	0.56*	0.031	-0.053**		-0.17	0.43*	-0.20	0.071	-0.023	0.70	-0.27
		(-0.95)	(3.93)	(0.25)	(-1.75)		(-1.27)	(2.81)	(-0.35)	(0.24)	(-0.94)		(-0.47)
	0.63*			0.086	-0.14*	0.42*			0.17	0.082	-0.11	0.71	0.088
	(3.02)			(0.66)	(-3.11)	(3.03)			(0.39)	(0.38)	(-3.41)		(0.20)
Colombia		-0.31	-0.17	-0.075	0.087**		-0.092	-0.047	0.10	-0.45**	0.09*	0.81	0.55*
		(-0.20)	(-0.70)	(-1.64)	(1.91)		(-0.21)	(-0.32)	(0.58)	(-1.85)	(2.48)		(3.19)
	1.04*			-0.093	0.014	1.06*			-0.0013	-0.035	-0.002	0.91	0.034
	(4.29)			(-0.94)	(0.55)	(5.99)			(-0.02)	(-0.42)	(-0.12)		(0.52)
Costa Rica		-0.037	0.81*	0.38*	0.017		-0.028	0.78*	0.14*	0.40*	-0.003	0.94	-0.26*
		(-0.20)	(3.55)	(4.96)	(0.40)		(-0.26)	(3.31)	(3.24)	(2.35)	(-0.08)		(-6.02)
	1.01*			0.16*	0.024	0.95*			0.053*	0.11	0.0034	0.98	-0.06*
	(12.22)			(3.48)	(1.19)	(9.74)			(2.13)	(1.28)	(0.19)		(-2.29)
Cyprus		0.24*	-0.049	0.041	0.031		0.17*	-0.02	-0.014	0.16	0.035*	0.83	-0.17
		(2.29)	(-1.17)	(0.22)	(1.58)		(2.28)	(-1.36)	(-0.10)	(1.03)	(2.57)		(-1.24)
	0.071			-0.088	0.036	0.08			-0.099	0.012	0.041*	0.79	-0.11
	(1.03)			(-0.55)	(1.61)	(1.55)			(-0.92)	(0.08)	(2.81)		(-1.03)
Ecuador		0.63	-0.13	0.16	0.14		0.43	-0.11	0.22	-0.16	0.14*	0.89	0.38*
		(1.62)	(-0.62)	(1.45)	(1.58)		(1.61)	(-0.60)	(1.32)	(-0.51)	(2.45)		(2.28)
	0.38			0.17**	0.13	0.42*			0.23**	-0.19	0.12*	0.90	0.42*
	(1.46)			(1.69)	(1.39)	(2.63)			(1.92)	(-0.84)	(2.20)		(3.51)
Egypt		-0.15	0.30	0.063	0.0092		-0.11	0.072	-0.032	-0.11	0.013	0.75	0.078
		(-0.72)	(1.18)	(0.56)	(0.20)		(-0.67)	(0.67)	(-0.51)	(-0.58)	(0.41)		(1.24)
	0.29*			-0.12	0.0023	0.26*			-0.041	-0.43**	0.0096	0.77	0.39*
	(2.03)			(-1.04)	(0.07)	(2.01)			(-0.82)	(-1.87)	(0.37)		(7.78)
Ghana		0.44**	0.21	0.10	0.038		0.31**	0.27*	0.13*	-0.055	0.0011	0.87	0.19*
		(1.74)	(0.97)	(1.39)	(0.37)		(1.94)	(2.18)	(2.70)	(-0.44)	(0.02)		(3.84)
	0.84*			0.039	0.038	0.79*			0.05*	-0.14*	-0.012	0.96	0.19*
	(7.56)			(1.12)	(0.86)	(10.26)			(2.03)	(-2.22)	(-0.37)		(7.71)
Guatemala		0.28	0.43	1.32	0.0028		0.61*	0.0047	1.79	-0.54	0.19*	0.59	2.33
		(0.92)	(1.28)	(1.56)	(0.03)		(2.14)	(0.01)	(1.24)	(-0.29)	(2.02)		(1.66)
	0.63*			0.37	0.01	0.86*			0.14	-0.91	0.012	0.89	1.05
	(5.51)			(0.66)	(0.18)	(9.20)			(0.19)	(-1.10)	(0.25)		(1.43)
Honduras		0.17*	0.24*	-0.031	0.059*		0.084	0.19*	-0.033	0.14	0.026**	0.82	-0.17
		(2.16)	(2.82)	(-0.37)	(3.11)		(1.40)	(3.65)	(-0.29)	(0.70)	(1.69)		(-1.52)
	0.39*			-0.012	0.07*	0.43*			-0.098	0.13	0.031*	0.77	-0.23*
	(3.48)			(-0.12)	(3.81)	(4.05)			(-0.89)	(0.74)	(2.28)		(-2.07)
India		-0.079	-0.11	0.25*	0.042		0.024	-0.07	0.16*	0.21	0.087*	0.65	-0.05
		(-0.43)	(-0.53)	(2.22)	(1.20)		(0.17)	(-0.48)	(2.06)	(0.80)	(2.86)		(-0.64)
	0.65*			0.08	0.018	0.49*			0.13**	-0.14	0.058*	0.76	0.27**
	(2.20)			(0.85)	(0.61)	(2.92)			(1.85)	(-0.80)	(2.30)		(1.78)
Iran		-0.0017	0.069	-0.76	0.19		0.21	-0.19	0.61	-0.17	0.29*	0.82	0.78
		(-0.00)	(0.17)	(-0.70)	(1.04)		(0.53)	(-0.58)	(0.76)	(-0.06)	(2.09)		(0.97)
	0.28			0.25	0.19	0.30			0.64	0.95	0.15	0.56	-0.31
	(1.00)			(0.17)	(1.62)	(1.20)			(0.53)	(0.27)	(1.45)		(-0.26)
Jordan		0.35*	0.18**	1.26**	0.05		0.35*	0.049	0.75**	-1.33	0.024	0.93	2.08*
		(2.88)	(1.80)	(1.74)	(1.68)		(3.08)	(0.75)	(1.75)	(-0.96)	(0.60)		(4.85)
	0.25			-2.72	0.053	-0.05			-0.59	-4.75	-0.058	0.50	4.16*
	(1.14)			(-1.62)	(0.73)	(-0.22)			(-0.48)	(-1.05)	(-0.58)		(3.38)
Kenya		0.53	-2.15	-0.32	0.15		-0.25	-1.01	-1.15	2.94	-0.046	0.45	-0.39
		(0.29)	(-0.90)	(-0.26)	(0.66)		(-0.29)	(-0.58)	(-0.50)	(0.59)	(-0.17)		(-0.72)
	0.97*			0.21**	0.043**	0.99*			0.12	0.15	0.036**	0.99	-0.03
	(1.77)			(1.76)	(1.75)	(28.97)			(0.66)	(0.42)	(1.70)		(-0.17)

Table2: Results of Estimating the Empirical Model for Price (cont'd)

Country	*En*	*Em*	*Eg*	*Ers*	*Ez*	*ns*	*ms*	*gs*	pos_{rs}	neg_{rs}	*zs*	R^2	*Asym*
Korea		-0.11	0.27**	-0.01	0.095		-0.14	0.13	0.078	0.10	0.074	0.73	-0.022
		(-1.04)	(1.78)	(-0.12)	(1.48)		(-1.64)	(0.92)	(1.39)	(0.62)	(1.60)		(-0.39)
	0.72*			0.045	0.09*	0.71*			0.002	0.14	0.048*	0.88	-0.14*
	(6.45)			(0.73)	(3.01)	(6.12)			(0.06)	(1.16)	(2.14)		(-4.14)
Malaysia		0.52**	-0.20	0.40	0.009		0.21	-0.16	-0.40	0.39	0.018	0.91	-0.79
		(1.89)	(-0.63)	(0.49)	(0.14)		(0.50)	(-1.00)	(-0.83)	(0.47)	(0.27)		(-1.64)
	0.73*			0.12	-0.0006	0.74*			0.41*	0.073	0.0078	0.99	0.34*
	(10.96)			(1.51)	(-0.05)	(15.36)			(3.79)	(0.78)	(0.78)		(3.12)
Malawi		0.42	0.22	-0.61	0.041		0.23	-0.14	-0.36	-1.27*	0.055	0.57	0.91*
		(1.64)	(0.72)	(-1.54)	(0.42)		(1.64)	(-0.59)	(-0.98)	(-2.29)	(0.76)		(2.45)
	0.92*			-0.12	-0.012	0.93*			-0.14	-0.81*	-0.056	0.79	0.67*
	(3.71)			(-0.61)	(-0.23)	(4.94)			(-0.81)	(-2.52)	(-1.09)		(3.88)
Morocco		0.43	-0.13	0.32	0.087*		0.13	-0.27**	0.39	-0.33	0.11*	0.69	0.072*
		(1.39)	(-0.77)	(1.68)	(2.16)		(0.58)	(-1.76)	(1.63)	(-1.07)	(3.38)		(3.01)
	0.77*			0.18*	0.018	0.42*			0.15	-0.047	0.049	0.79	0.20
	(6.01)			(2.25)	(0.86)	(3.19)			(0.89)	(-0.15)	(1.68)		(1.19)
Nepal		0.14	0.084	0.089	0.10*		-0.087	0.15	-0.19	-0.34	-0.0078	0.73	0.15
		(0.61)	(0.39)	(0.37)	(2.23)		(-0.57)	(0.82)	(-1.00)	(-0.75)	(-0.19)		(0.79)
	0.60*			0.014	0.033	0.66*			0.02	-0.39**	-0.018	0.93	0.41*
	(4.27)			(0.18)	(1.61)	(7.62)			(0.24)	(-1.81)	(-1.02)		(4.92)
Peru		0.045	0.68*	0.32*	0.014		0.22**	0.38	0.23	-0.036	-0.019	0.96	0.27**
		(0.29)	(3.47)	(3.38)	(0.21)		(1.83)	(1.65)	(1.46)	(-0.12)	(-0.29)		(1.69)
	0.87*			0.19*	0.0029	0.90*			0.14	-0.0037	-0.044	0.99	0.14
	(12.88)			(3.43)	(0.09)	(7.48)			(1.57)	(-0.02)	(-1.31)		(1.61)
Sri Lanka		0.66*	0.015	-0.024	0.13*		0.31	-0.051	-0.072	-0.26	0.097*	0.77	0.19
		(2.44)	(0.07)	(-0.15)	(2.43)		(1.53)	(-0.37)	(-0.55)	(-1.06)	(2.57)		(1.44)
	0.92*			0.016	0.016*	0.80*			0.052	0.0037	0.027	0.90	0.048
	(8.82)			(0.25)	(0.54)	(7.17)			(0.97)	(0.02)	(1.05)		(0.90)
Syria		0.45	0.049	0.74**	0.014		0.0031	0.11	0.012	-0.067	0.11	0.60	0.079
		(0.97)	(0.18)	(1.75)	(0.15)		(0.01)	(0.44)	(0.01)	(-0.09)	(1.39)		(0.066)
	1.049*			-0.29	-0.18*	1.17*			-0.092	-0.0017	-0.047	0.69	-0.09
	(4.21)			(-0.96)	(-2.52)	(3.80)			(-0.82)	(-0.00)	(-0.86)		(-0.80)
Turkey		-0.35	1.28*	0.11	0.092*		-0.31	0.77*	0.47*	-0.39	0.12*	0.94	0.86*
		(-1.61)	(4.59)	(1.00)	(2.25)		(-1.42)	(4.06)	(5.57)	(-1.33)	(2.62)		(10.19)
	0.93*			0.099	0.02	0.94*			0.084	0.10	0.016	0.97	-0.016
	(9.84)			(1.45)	(0.61)	(8.78)			(1.47)	(0.67)	(0.55)		(-0.28)

- *En* and *ns*: expected and unexpected nominal GNP/GDP growth, $E_{t-1}Dn_t$, $(Dn_t\text{-}E_{t-1}Dn_t)$.
- *Em* and *ms*: expected and unexpected monetary growth, $E_{t-1}Dm_t$, $(Dm_t\text{-}E_{t-1}Dm_t)$.
- *Eg* and *gs*: expected and unexpected growth of government spending, $E_{t-1}Dg_t$, $(Dg_t\text{-}E_{t-1}Dg_t)$.
- *Ers*: expected depreciation in the real exchange rate, $E_{t-1}Drs_t$.
- *Ez* and *zs*: expected and unexpected change in the energy price, $E_{t-1}Dz$, $(Dz_t\text{-}E_{t-1}Dz_t)$.
- pos_{rs}: positive shocks to the exchange rate, an unanticipated currency depreciation.
- neg_{rs}: negative shocks to the exchange rate, an unanticipated currency appreciation.
- *Asym*: the difference between the price response to positive and negative exchange rate shocks.
- T ratios are in parentheses. * and ** denote statistical significance at the five and ten percent levels.

Table 3. The Contribution of Exchange Rate Variability to Trend Real Output Growth and Price Inflation

Country	σ_{rs}	1. con_{rsp} $A_{8p}(0.399\sigma_{rs})$	2. con_{rsn} $A_{8n}(-0.399\sigma_{rs})$	1+2 con_{rs}	3. con_{rsp} $B_{8p}(0.399\sigma_{rs})$	4. con_{rsn} $B_{8n}(-0.399\sigma_{rs})$	3+4 con_{rs}	Trend Output Growth	Trend Price Inflation
Algeria	0.074	0.012	0.00094	0.013	-0.0059	-0.0021	-0.008	0.063	0.082
Colombia	0.16	0.0061	-0.012	-0.0059	0.0064	0.029	0.035	0.045	0.19
Costa Rica	0.23	-0.0056	0.0076	0.002	0.013	-0.037	-0.024	0.046	0.13
Cyprus	0.04	0.0089	-0.00022	0.0087	-0.00022	-0.0026	-0.0028	0.054	0.056
Ecuador	0.13	-0.016	-0.02	-0.036	0.011	0.0083	0.019	0.11	0.018
Egypt	0.16	0.0064	-0.019	-0.0126	-0.002	0.007	0.005	0.052	0.18
Ghana	0.45	-0.0057	-0.020	-0.0257	0.023	0.0098	0.033	0.045	0.081
Guatemala	0.022	0.0063	0.0018	0.0081	0.016	0.0047	0.021	0.047	0.094
Honduras	0.051	-0.0019	0.0026	0.0007	-0.00067	-0.0028	-0.0035	0.039	0.046
India	0.090	-0.0061	-0.0043	-0.0104	0.0057	-0.0075	-0.0018	0.041	0.075
Iran	0.02	-0.015	0.0096	-0.0054	0.0049	0.0014	0.0063	0.047	0.12
Jordan	0.015	-0.00012	-0.014	-0.01412	0.0045	0.0080	0.0012	0.042	0.08
Kenya	0.051	-0.0019	0.0026	0.0007	0.012	0.0035	0.0155	0.053	0.078
Korea	0.17	-0.0062	0.0088	0.0026	0.0053	-0.0068	-0.0015	0.074	0.14
Malaysia	0.042	-0.0097	0.0049	-0.0048	-0.0067	-0.0065	-0.013	0.077	0.047
Malawi	0.055	-0.0031	-0.018	-0.021	-0.0079	0.028	0.02	0.050	0.085
Morocco	0.049	0.0035	0.0065	0.01	0.0076	0.0065	0.014	0.044	0.065
Nepal	0.094	-0.0029	-0.018	-0.021	-0.0071	0.013	0.0059	0.022	0.073
Peru	0.22	-0.0045	0.00025	-0.00425	0.020	0.030	0.05	0.035	0.28
Sri Lanka	0.11	0.00092	-0.0053	-0.0044	-0.0032	0.011	0.0078	0.047	0.066
Syria	0.18	-0.022	-0.022	-0.044	0.00086	0.0048	0.0057	0.062	0.095
Turkey	0.23	-0.0084	0.0023	-0.0061	0.043	0.036	0.079	0.051	0.20

- σ_{rs} is the standard deviation of unanticipated shocks to the exchange rate of the currency.
- con_{rsp} is the contribution of positive shocks to the exchange rate (unanticipated currency depreciation) to trend real output growth or trend price inflation. A_{8p} and B_{8p} are the effects of the positive shock on real output growth and price inflation from the empirical models (15) and (17).
- con_{rsn} is the contribution of negative shocks to the exchange rate (unanticipated currency appreciation) to trend real output growth or trend price inflation. A_{8n} and B_{8n} are the effects of the negative shock on real output growth and price inflation from the empirical models (15) and (17).
- Con_{rs} is the contribution of exchange rate variability, both positive and negative shocks, to trend real output growth or trend price inflation.

Econometric Methodology

The surprise terms that enter (15) through (18) are unobservable, necessitating the construction of empirical proxies before estimation can take place. Thus, the empirical models include equations describing agents' forecast of aggregate or specific demand growth, the change in energy price, and the change in the average real domestic price of 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, nominal GNP or GDP, 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.

The positive and negative components of exchange rate shocks are defined for joint estimation, following the suggestions of Cover (1992), as follows:

$$neg_{rst} = -\frac{1}{2}\{abs(rs_t) - rs_t\}$$

$$pos_{rst} = \frac{1}{2}\{abs(rs_t) + rs_t\}$$

rs_t is the shock to the change in exchange rate compared to agents' expectations of anticipated change, based on their observations of major macro-economic fundamentals. neg_{rs} and pos_{rs} are its negative and positive components.

To calculate $Epos_{rs}$ and $Eneg_{rs}$ in (19) and (20), exchange rate shocks, rs, are assumed to be symmetrically (normally) distributed around a steady-state stochastic trend. Observations are randomly distributed around the stochastic trend with mean zero and variance σ_{rs}^2. Accordingly,

$$E(pos_{rs}) = \int_0^{\infty} rsf(rs)drs$$

$$= \sigma_{rs}/(2\pi)^{0.5} \approx 0.399\sigma_{rs},$$

$$E(neg_{rs}) = -\sigma_{rs}/(2\pi)^{0.5} \approx -0.399\sigma_{rs}$$

Accordingly,

$$E(pos_{rs}) \approx 0.399\sigma_{rs},$$
$$E(neg_{rs}) \approx -0.399\sigma_{rs}$$

where *f(rs)* is the normal probability distribution function for the policy shock. Given this distribution, the average (expected value) of the shock can be expressed using the standard deviation of the shock, σ_{rs}, where π=3.14159.

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 1974-96, the generating process is modeled 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 endogenous variables, instrumental variables are used in the estimation of the empirical models. The instrument list includes two lags for each of the first-difference of the log value of the energy price, the exchange rate, the money supply, government spending, and nominal GDP or GNP.

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 auto-regressive 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.

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, 1957-1996; Egypt, Iran, Malaysia, 1959-1996; Costa Rica, India, 1960-1996; Kenya, 1964-1996.

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 GDP or GNP deflator.

3) The Real Energy Price: The value of 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 the price of Saudi Arabian Petroleum deflated 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: Representative 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 constructed following the procedure described in Bahmani (1995) and Bahmani and Mirzaie (forthcoming) as well as other details from the authors.

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