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THE ADVERSE EFFECTS OF REAL EXCHANGE RATE VARIABILITY IN LATIN AMERICA AND THE CARIBBEAN

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The paper examines the pros and cons of anticipated appreciation and the asymmetric effects of short-term exchange rate fluctuations in a sample of countries in Latin America and the Caribbean. On the demand side, exchange rate depreciation increases competitiveness and export growth, expanding output growth. On the supply side, depreciation increases the cost of imported inputs, increasing output capacity constraints and accelerating price inflation. The time-series evidence indicates that output expansion (contraction) and price deflation (inflation) predominate with anticipated currency appreciation (depreciation). The cross-country results show that exchange rate variability exacerbates the variability of economic activity across countries. Short-term fluctuations of the exchange rate may reflect the adverse effects of unanticipated currency fluctuations. Therefore, more flexibility towards aligning the real effective exchange rate with the underlying fundamentals could help mitigate the adverse effects of higher cost of imports and loss of competitiveness on real growth, and ease inflationary pressures.

JEL classification codes: F1, F4
Key words: exchange rate, supply and demand channels, asymmetric fluctuations

I. Introduction

Recent developments in the world economy have drawn attention to the appropriate exchange rate policy in developing countries. Many of these countries have opted to peg their exchange rate to the US dollar to hedge against inflationary pressure in light of their exposure to frequent external shocks and inadequate monetary instruments for liquidity management. Continued fluctuations in the US dollar relative to other major currencies have increased the risk of a pegged

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exchange rate and exposed countries to frequent inflationary pressures and loss of competitiveness. Accordingly, many of these countries have considered revising their exchange rate policy to establish a weighted scheme for the peg, reflecting major shares of significant trading partners.

The traditional view has emphasized the expansionary effect of currency depreciation (see, e.g., Meade 1951). 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 one (see Hirschman 1949). By lowering export prices, currency depreciation helps export competitiveness towards boosting real growth. Through the supply side channel, depreciation may result in higher cost of intermediate goods for production in developing countries (see, e.g., Bruno 1979 and van Wijnbergen 1989). Domestic substitutes for imported production inputs, particularly capital goods, are not readily available in many developing countries. As a result, the output supply may shrink on account of a higher cost of imported inputs. The net result on real output and price will depend on the magnitudes by which the demand and supply curves shift following devaluation (for details, see Gylfason and Schmid 1983 and Lizondo and Montiel 1989).[1]

Currency depreciation from an initial trade deficit could lead to further deterioration by reducing aggregate demand and, therefore, real national income. A larger trade deficit signifies high dependency on imports that would reinforce the negative effect of currency depreciation on the output supply and raise price inflation. However, if trade is in balance and terms of trade are not changed, price changes in response to currency depreciation would offset each other through the export and import channels (see Cooper 1971).

Other studies have illustrated alternative channels for contraction following currency devaluation. By increasing relative competitiveness, 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 would go up and real output would

[1] 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), Rogers and Wang (1995), Hoffmaister and Vegh (1996), Bahmani (1991), and Kamin and Rogers (2000).

decrease (for illustration, see, e.g., Krugman and Taylor 1978 and Barbone and Rivera-Batiz 1987).

Kandil and Mirzaie (2002) introduce a theoretical model that decomposes movements in the exchange rate into anticipated and unanticipated components using rational expectations. The impact of exchange rate volatility on macroeconomic variables has become a subject of increasing debate in recent decades, in both developing and advanced countries. Advocates of fixed exchange rate argue that exchange rate stability enhances exports and provides an attractive environment for the flows of international capital like foreign direct investment (FDI), and eventually stimulates economic growth. In their view, volatile and unpredictable exchange rate may lead to many harmful macroeconomic consequences such as, volatility of prices and output, deterioration of total exports, as well as worsening the external competitiveness (Gylfason 2000, Rose 2000, Frankel and Rose 2002 and De Grauwe and Schnabl 2004). On the other hand, proponents of floating exchange rate regime believed that exchange rate flexibility helps balance of payment adjustment in response to external shocks and positively influences the trade volume and economic growth (Friedman 1953, Fischer 2001, and Edwards and Levy-Yeyati 2003).

The relationship between exchange rate volatility and economic growth has received relatively little attention from both theoretical and empirical perspectives. This is because the exchange rate is considered as nominal variable and not related to the long-term real growth performance (see, e.g., Levy-Yeyati and Sturzenegger 2002, Bayoumi and Eichengreen 1994, and Grier and Hernandez-Trillo 2004). However, the general consensus between economists is that the impact of exchange rate volatility on economic growth depends on the type of the exchange rate regime which the economy adopts. Economists who are in favor of fixed exchange rate regime (e.g. McKinnon 1963, Mundell 1973, Rose 2000 and Frankel and Rose 2002) argue that exchange rate stability is conducive to economic growth through its positive impact on trade and investment. In their view, a stable exchange rate reduces price uncertainty and real interest rates volatility by increasing the efficiency of price mechanisms at the international level; hence, contributing significantly to economic stability and growth (De Grauwe and Schnabl 2004). By contrast, the supporters of flexible exchange rate (e.g. Meade 1951, Friedman 1953, Fischer 2001, and Levy-Yeyati and Sturzenegger 2002) argued that the volatility of exchange rate reduces the negative impact of real asymmetric shocks on local and external disequilibrium. That is, in a case of real asymmetric shocks, if prices

and wages adjust slowly, flexible exchange rates can adjust relative international prices to compensate for output losses (Mundell 1961 and Arratibel et al. 2011). Moreover, Ghosh et al. (1996) show that a pegged exchange rate may distort price signals in the economy by creating misalignment of the real exchange rate, and in turn leads to inefficient allocation of resources across sectors.

Empirical evidence on the other hand, also offers mixed findings regarding the impact of exchange rate volatility on growth. For example, Ghosh et al. (1997) studied the growth performance under alternative regimes in 145 IMF-member countries and found that there are no significant differences in output growth across exchange regimes. They argued that pegged regimes increase investment and volatility of growth and employment but reduce productivity growth and inflation. Previous investigations have considered the impact of exchange rate fluctuations in developing countries, demonstrating varying effects of the anticipated and unanticipated components on real growth and price inflation (see, e.g., Kandil 2004).

Developing countries in Latin America and the Caribbean are subject to high variability of the exchange rate due to movements in bilateral nominal exchange rates and/or relative price inflation compared to major trading partners**.** Regardless of the exchange rate system, fluctuations in the exchange rate capture movements in relative prices and market-driven or pegged-induced movements in the nominal exchange rate. The paper contributes to the existing literature on the subject by drawing on the theoretical implications to study possible asymmetry in the effects of exchange rate fluctuations on the macro-economy based on demand and supply transmission channels.[2] Focusing on the experiences of countries in Latin America and the Caribbean, the paper investigates the potential cyclical biases of exchange rate variability on macroeconomic performance. The evidence will contribute to the debate regarding the pros and cons of exchange rate flexibility and the role of policy makers in managing expectations and limiting the adverse effects of deviations in the exchange rate from the steady-state equilibrium.

The remainder of the paper is organized as follows**:** Section II presents the theoretical background. Section III outlines the empirical models and estimation methodology. Section IV presents time-series results. Section V discusses cross-section implications. The summary and conclusion are presented in Section VI.

[2] For evidence of the impact of exchange rate shocks on disaggregated data in the United States, see Kandil and Mirzaie (2002) and (2003).

II. Theoretical background

The paper builds on the theoretical macroeconomic model in Kandil and Mirzaie (2002) that incorporates exchange rate fluctuations of the domestic currency. Agents' rational expectations are in line with variation in macroeconomic fundamentals over time. Unexpected fluctuations are realized around the steady-state equilibrium values.

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 multiple relationships between unanticipated currency depreciation and the demand and supply sides of the economy make the final outcome on output inconclusive.

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, and government spending.[3] In addition, supply-side channels establish that output varies with anticipated changes in the exchange rate that guide producers' decisions on the cost of output.[4]

The complexity of demand and supply channels may determine asymmetry in the face of exchange rate fluctuations.[5] In the goods market, a positive shock to the exchange rate of the domestic currency (an unexpected appreciation) will make exports more expensive and imports less expensive. Based on competitiveness,

[3] Shocks are assumed to fluctuate in response to domestic economic conditions or in response to external vulnerability, e.g., capital mobility or fluctuations in the current account balance.

[4] Recently, a growing body of the literature has focused on the financial channel of exchange rate volatility, specifically the balance sheet effects (see, e.g., Bleakey and Cowan (2002), Crespedes, Chang and Velasco (2004), Galindo, Panizza and Schiantarelli (2003), Berganza and Garcia-Herrero (2004), Gertler, Gilchrist and Natalucci (2003), and Galindo, Izquierds and Matero (2007). When a significant portion of debt is dominated in foreign currency, depreciation can lead to a larger financial burden, posing two problems: (i) higher debt services and liquidity shortfall, and (ii) a net worth reduction due to currency mismatch (see, e.g., Gertler, Gilchrist, and Natalucci 2003). Due to data constraints, exploring these channels was not feasible in the context of this investigation.

[5] Asymmetry is expected in the face of unanticipated exchange rate fluctuations that affect demand and supply. In contrast, theory predicts that anticipated exchange rate impacts the economy with clear effects on the output supply and the cost of production.

foreign demand of exports will decrease and domestic demand for imports will increase. As net external demand decreases, the reduction in aggregate demand will have a negative effect on output and price.

In the money market, a positive shock to the domestic currency (an unexpected temporary appreciation) prompts agents to hold less domestic currency. Excess money supply decreases the interest rate and stimulates aggregate demand. This channel moderates the negative effects of the reduction in net exports on aggregate demand, output and price.

On the supply side, a positive shock to the exchange rate decreases the cost of imported intermediate goods, increasing domestic output and decreasing the cost of production and the aggregate price level. Under a scenario where imported and domestic inputs are complements, the demand for imports is inelastic, forcing an increase in the cost of production and the price of the output supply.

III. Empirical models and methodology

Business cycles are fluctuations that develop randomly around the trend component of economic variables. The trend progresses over time in line with underlying fundamentals that include endowed resources of labor, capital, and technological advances. In contrast, cyclical fluctuations generate transitory deviations around stochastic trends.

The approach of this paper relies on a filtering technique to extract the cycle (stationary component) from the trend (non-stationary component) of the dependent variables. Further, the paper develops an empirical model of the cycle, differentiating between the effects of supply and demand shocks and modeling asymmetry in short-term adjustments to expansionary and contractionary shocks.

Demand shocks are assumed to follow a symmetric distribution along a stable supply curve. In addition the model accounts for control variables to capture factors that may potentially shift the supply curve over time. Specifically, the empirical model accounts for the energy price and structural break dummies.

Nominal GDP is used as a proxy for aggregate demand. Fluctuations in nominal GDP are decomposed into steady-state growth trend and a random cyclical component. The steady-state component corresponds to movements in the underlying fundamentals in full-equilibrium. The unanticipated residual in the forecast equation measures shocks to aggregate demand growth. Aggregate demand shocks have a symmetric distribution, where positive shocks identify

periods of economic booms and negative shocks identify periods of recessions. If variables' responses to these shocks are symmetric, cyclical fluctuations cancel out over time. A significant response to anticipated demand shifts implies lagged variables underlying agents' forecasts of aggregate demand could potentially possess a persistent effect.

By construction, the real effective exchange rate accounts for openness to major trading partners. A depreciation of the domestic currency increases the price of imports and boosts competitiveness. The net effect on the trade balance will depend on the elasticity of imports and exports with respect to changes in the exchange rate. The former channel will depend on availability of domestic goods to substitute for imports and the latter will depend on other indicators of competitiveness, e.g., quality as well as the capacity of the home economy to meet the additional demand by supplying more goods (see, e.g., Guitian 1976 and Dornbusch 1988).

Agents' forecasts of the exchange rate vary with macroeconomic fundamentals that are available with a lag.[6] Positive shocks to the real price of domestic currency in foreign currency represent unanticipated appreciation (or an over-valued currency) around this trend. Negative shocks represent unanticipated depreciation (or an under-valued currency) around steady-state trend. Over the time span under investigation, these shocks are assumed to occur with equal probability around the stochastic moving trend.

The test results are consistent with non-stationary real output for all countries under investigation.[7] Given these results, the empirical model of real output is specified in first-difference form as follows:

$$\begin{aligned} Dy_t = {} & \beta_{0y} + \beta_{1y} E_{t-1} Dn_t + \beta_{2y} E_{t-1} Dh_t + \beta_{3y} E_{t-1} Do_t \\ & + \beta_{4yp} posn_t + \beta_{4yn} negn_t + \beta_{5yp} posh_t + \beta_{5yn} negh_t + \beta_{6yp} poso_t + \beta_{6yn} nego_t + \eta_t . \end{aligned} \tag{1}$$

[6] In theory, shocks approximate unanticipated components of policy shifts based on rational expectations. For example, an overvalued exchange rate represents an unanticipated currency appreciation around agents' expectation of what the exchange rate should be.

[7] For details, see Kwiatkowski et.al. (1992). Upon first-differencing, the resulting series are stationary.

$D(.)$ is the first-difference operator, where y is the log value of real output.[8] All variables in the model enter in first-difference form.[9] The unexplained residual of the model is denoted by η_t with zero mean and constant variance. Three determinants of output growth are included in equation (1): the growth of aggregate demand Dn_t,[10] exchange rate appreciation Dh_t, and the change in oil price, Do_t. Each determinant enters the equation in three pieces, the anticipated component, the positive shock, and the negative shock. The first piece determines real growth in steady state, where the latter two pieces capture cyclical fluctuations that may have asymmetric effects on real growth.

Let n_t be the log value of nominal GDP, a proxy for aggregate demand. E_{t-1} denotes expectation at time t-1. Producers adjust prices fully to anticipated demand shifts, eliminating their transmission to output.[11] Nonetheless, institutional rigidity may prevent full adjustment of prices to iron out anticipated demand shifts. Consequently, anticipated growth in aggregate demand may increase real output growth and $\beta_{1y} > 0$.

Faced with aggregate demand shocks, producers resort to output expansion in the short-run. Cyclical fluctuations in the face of expansionary and contractionary aggregate demand shocks are denoted by *posn* and *negn*. Accordingly, β_{4yp} and $\beta_{4yn} > 0$. The direction and degree of asymmetry is measured by the statistical significance of the difference in the response of the dependent variable to the positive and negative aggregate demand shocks.

Higher price of oil increases the cost of the output supplied and decreases real growth. The reduction in output with respect to anticipated increase in the oil price is measured by $\beta_{3y} < 0$. Output fluctuations in the face of positive and negative shocks are denoted by $poso_t$ and $nego_t$. Hence, β_{6yp} and $\beta_{6yn} < 0$.

[8] Given non-stationarity of the estimated dependent variables, the empirical models are estimated in first-difference form. As anticipated variables are function of lagged variables in the forecast equation, there is no need to account for a lagged dependent variable in the empirical model.

[9] Test results confirm non-stationarity of nominal GDP, the oil price, and the exchange rate in the empirical models. Nonetheless, real output is not jointly co-integrated with right-hand side variables.

[10] Nominal GDP is a used as a proxy for aggregate demand shifts in the economy that includes domestic policies, government spending and the money supply, that impact domestic demand and external demand, i.e., exports. Aggregate demand is allocated between real shifts, i.e., an increase in the output supply, which is measured in equation (1) and higher inflation, reflecting capacity constraints, which is measured in equation (2). The theoretical basis can be found in Kandil and Mirzaie (2002).

[11] 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. Alternatively, institutional rigidity may be attributed to price rigidity in the product market. To reduce menu costs, producers may resort to adjusting prices at specific intervals over time. Given wage and/or price rigidity, producers expand the output supplied in the short run in anticipation of demand shifts at time t-1. For a discussion of the implications of sticky-wage and sticky-price models, see Kandil (1996).

Anticipated appreciation of the real exchange rate determines the cost of intermediate imports and, therefore, the output supplied. Let h_t be the log value of the real effective exchange rate. As producers anticipate exchange rate appreciation, they expand the output supplied on account of a lower cost of production inputs. Accordingly, $\beta_{2y} > 0$.

An unanticipated currency appreciation, $posh_t$, decreases the cost of buying intermediate goods and facilitates expansion in the output supplied. Concurrently, $posh_t$ decreases net exports and the demand for domestic currency. Similarly, the combined effects of unanticipated currency depreciation are indeterminate on output growth.

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

$$Dp_t = \beta_{0p} + \beta_{1p} E_{t-1} Dn_t + \beta_{2p} E_{t-1} Dh_t + \beta_{3p} E_{t-1} Do_t + \beta_{4pp} posn_t + \beta_{4pn} negn_t + \beta_{5pp} posh_t + \beta_{5pn} negh_t + \beta_{6pp} poso_t + \beta_{6pn} nego_t + \eta_t . \quad (2)$$

Based on test results, output price is evident to be non-stationary for the various countries under investigation and the empirical model is specified in first-difference form.[12]

Anticipated growth in aggregate demand is likely to be absorbed in price inflation, absent any constraints on price adjustment. Hence, $\beta_{1p} > 0$. Short-term inflationary fluctuations in the face of expansionary and contractionary aggregate demand shocks are measured by β_{4pp} and β_{4pn}.

Higher uncertainty increases the opportunity cost of fixing wages and/or prices, resulting in a steeper supply curve. Recent research has attracted attention, however, to possible asymmetry in the effects of aggregate demand shocks on economic activity.[13] Upward price flexibility, β_{4pp}, may be different than downward flexibility, β_{4pn}.

[12] Price is not jointly co-integrated with right-hand side variables.

[13] Asymmetry may be induced by institutional constraints that increase nominal flexibility, e.g., in response to positive demand shocks, compared to negative shocks. Alternatively, higher uncertainty and/or higher trend price inflation may increase agents' incentives for upward nominal flexibility compared to downward flexibility (see, e.g., Cover and Van Hoose 1993, and Ball and Mankiw 1994).

Given the positive effect of anticipated currency appreciation on the output supplied, cheaper production cost decreases price inflation and $\beta_{2p} < 0$.[14] An unanticipated appreciation of the domestic currency increases the output supplied and may decrease (net exports effect) or increase (money demand effect) aggregate demand. The former two channels are deflationary while the latter increases price inflation. Similarly, demand and supply channels render the effects of $negh_{ht}$ indeterminate on price inflation.

Higher price of oil increases the cost of output supplied and price inflation. The inflationary effect of anticipated increase in the oil price is measured by β_{3p}, while short-term inflationary and deflationary effects of fluctuations in the oil price are measured by β_{6pp} and β_{6pn}.

As to the empirical methodology to estimate the empirical models (1) and (2), forecast equations are necessary to form empirical proxies. Changes in aggregate demand and the exchange rate are endogenous, according to the results of Engle's (1982) test. To form a proxy of agents' forecasts, predicted variables are regressed on the lags of selected variables following a formal causality test. The list of variables includes lagged variables of real output growth, price inflation, the growth of the money supply, the growth of government spending, the change in real effective exchange rate, the change in international reserves, and the change in the oil price. Dummy variables are introduced following the results of a formal test suggested by Dufour (1982).

Anticipated shifts filter out information available to agents at time *t*-1. Having filtered out forecasts, the residuals are the domain of random exogenous shocks. By construction, shocks are independent, identically distributed and orthogonal to variables in the forecast equation. Shocks are distributed symmetrically around the steady state forecasted trend. Following the suggestions of Cover (1992), positive and negative shocks are defined for the joint estimation as follows:

$$\begin{aligned} neg_t &= -\frac{1}{2}\{abs(shock_t) - shock_t\}, \\ &\cdot \\ pos_t &= \frac{1}{2}\{abs(shock_t) + shock_t\}, \end{aligned} \tag{3}$$

[14] Anticipated shifts in the real effective exchange rate are function of lagged values of variables that determine agents' forecasts, including its own lags.

where a*bs*(.) is the absolute value operator and *shock* is the surprise component of the specific variable, as described above.

The energy price is exogenous**.** Accordingly, agents' forecast of the energy price is modeled as a second-order autoregressive or AR(2). Energy price shocks have a zero mean and a constant variance.

The model is estimated using 3SLS. Pagan (1984, 1986) showed that the use of regression proxies requires an adjustment of the covariance matrix of estimators of the parameters of the model containing constructed variables. As suggested by Mishkin (1982), a simple alternative is to estimate the expectation equation jointly with the equation explaining the dependent variables.

To account for endogeneity of nominal GDP and the exchange rate as explanatory variables, instrumental variables are introduced. The instrument list includes two lags of the log first-difference of real growth, price inflation, the energy price, the real effective exchange rate, government spending, international reserves, and the money supply.

The error term of the empirical model follows an autoregressive model of order one for some countries, according to the results of Engle's (1982) test. For these countries, the estimated empirical models are multiplied through by the filter $(1-\rho L)$, where ρ is the serial correlation parameter and L is the lag operator.

IV. Empirical results

The empirical investigation analyzes annual time-series data of real output and price in 32 developing countries in Latin America and the Caribbean: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay and Venezuela.[15]

The sample of countries is diverse in many respects that include the choice of the exchange rate system and endowed resources. The paper analyzes variation

[15] Data description and sources are in the Appendix.

in the effects of exchange rate fluctuations across countries.[16] The sample period extends from 1981-2007.[17] In the interest of space limitation, the discussion will focus on the effects of fluctuations in the exchange rate.[18]

Table 1. Effects of exchange rate variations in 32-country sample

Variable		Output growth	Price inflation
Anticipated change	Significantly positive	8	1
	Insignificant	21	23
	Significantly negative	3	8
Unanticipated appreciation	Significantly positive	4	4
	Insignificant	24	23
	Significantly negative	4	5
Unanticipated depreciation	Significantly positive	1	3
	Insignificant	29	28
	Significantly negative	2	1

Note: Numbers refer to significant, positive, insignificant or negative parameters in the sample of 32 countries. Detailed country-by-country estimates are available from the publisher in the Online Appendix.

A positive response to anticipated exchange rate shifts indicates an increase in the dependent variable over time. In contrast, responses to positive and negative shocks are of transitory nature that captures the effects of exchange random fluctuations on dependent variables. A positive response to a positive exchange rate shock would indicate an increase in response to unanticipated appreciation. In contrast, a negative response to a negative exchange rate shock would indicate an increase in the dependent variable with respect to unanticipated depreciation. This combination would indicate an increase in the trend dependent variable with higher exchange rate variability. In contrast, a positive response to both positive and negative shocks would indicate offsetting effects of unanticipated appreciation

[16] This approach is preferred to a panel estimation that would disguise the specific features of country coefficients given the diverse sample of countries under investigation.

[17] The sample period excludes the period spanning the global financial crisis to drive the implications, avoiding excessive fluctuations in the global economy.

[18] Details of parameter estimates for output growth and price inflation are available in Online Appendix, available from the publisher, and summarized in Table 1. Other results are available upon request.

and depreciation, increasing and decreasing growth in the dependent variable, rendering the effect of exchange rate variability neutral on trend variables over time. Accordingly, the difference between the variables' responses to positive and negative shocks indicates asymmetry with respect to currency appreciation and depreciation. A larger response to positive or negative shocks would determine the direction of the net effect of exchange rate variability on variables' trends over time.

In regard to real growth and price inflation, the statistical significance of estimated parameters spells out potential long-term positive effects of anticipated appreciation on the economies under consideration. Moreover, asymmetric effects point to potential adverse effects of excessive exchange rate variability in the short-run.

Long term effects: The composite evidence suggests that anticipated appreciation could have an expansionary effect on the output supply, increasing real growth and decreasing price inflation, via a cheaper cost of intermediate imports. A reduction in the cost of imports in response to anticipated appreciation could also enhance the domestic welfare function, increasing capacity to consume and save. Moreover, anticipated appreciation, by reducing the cost of production, could increase incentives for private investment, which is likely to have a long-lasting positive effect on capacity building and, therefore, the welfare function of future generations.

Short term effects: Asymmetric effects point to potential adverse effects of excessive exchange rate variability in the short-run. Exchange rate variability may have, however, a net negative effect on real growth over time, as the contractionary effect of unanticipated currency appreciation or depreciation on real growth dominates expansion with respect to currency depreciation or appreciation**.** Trend price inflation is likely to accelerate in response to exchange rate variability as the inflationary effect of unanticipated currency depreciation may not be offset by deflation with respect to currency appreciation.

V. Cross-section analysis

In general, the time-series evidence indicates that the supply channel may lead to output contraction and price inflation in the face of unanticipated exchange rate depreciation. To formalize the evidence, the analysis considers the effects of exchange rate variability on the trends of variables under consideration.

Table 2 summarizes the coefficients measuring the relationship across the sample of 32 countries in Latin America and the Caribbean. In addition to exchange rate variability, the cross-section regression includes an interactive dummy for variability in countries with floating exchange rate systems. The coefficient of the interactive dummy measures the effect of variability in the exchange rate in countries that adhere to a floating exchange rate regime. The classification of countries according to the exchange rate system is based on the annual report which has been published by the IMF since 1950.[19] It draws on information available to the IMF from a number of sources, including that provided in the course of official staff visits to member countries, and has been prepared in close consultation with national authorities. The report provides detailed information on the "de jure" and the "de facto" exchange rate arrangements of member countries. The "de facto" classification is based on the information available on members' "de facto" arrangements, as analyzed by the IMF staff, which may differ from countries' officially announced "de jure" arrangements. The methodology and the characteristics of the categories are described in the Compilation Guide. The report includes a description of exchange rate systems based on significant developments. The categories of exchange rate arrangements are (1) hard pegs comprising (a) exchange rate arrangements with no separate legal tenders and (b) currency board arrangements; (2) soft pegs consisting of (a) conventional pegged arrangements, (b) pegged exchange rates within horizontal bands, (c) crawling pegs, (d) stabilized arrangements, and (e) crawl-like arrangements; (3) floating regimes, under which the exchange rate is market determined and characterized as (a) floating or (b) free floating; and (4) a residual category, other managed arrangements. The categories

[19] Appendix Table A1 contrasts average indicators across countries based on the exchange rate system. Classification of countries according to the exchange rate system is based on IMF (2011) and previous issues. A continuous variable is established to classify countries as floating or pegged exchange rate systems. However, in the cross-section regression, each country gets a dummy of zero or one based on the bulk of the exchange rate classification over the sample period. As countries have resorted to some free floating episodes, but the dominant observations of pegged exchange rate system prevails, its exchange rate variability is far less pronounced compared to countries that have subscribed to a free floating for the bulk of the sample period. Hence, the two groups are differentiated based on the dominant distribution of pegged or free floating exchange rate system over the sample period to establish a benchmark on whether the variability of the exchange rate could be further exacerbated under a free floating system, reinforcing the effect of the variability on trends and variability of economic variables. While indicative, it is used to differentiate between two groups of countries, those who have adhered to a pegged system and those that have subscribed to a higher degree of flexibility in managing the exchange rate for most of the sample period under investigation.

are based on the degree of flexibility of the arrangement and the way it operates in practice. The analysis distinguishes between two groups based on the "de facto" regime, those subscribing to some form of exchange rate pegs, and those who have allowed for some degree of flexibility in managing the exchange rate (category 3). Countries in category (1) and (2) have maintained this classification over most of the sample period under investigation. In contrast, countries in the remaining category have introduced some degree of flexibility in managing the exchange rate over most of the sample period under investigation. The interactive dummy is introduced in the cross-section regression to indicate whether the exchange rate system reinforces the impact of exchange rate variability on trends and variability of economic variables. A robustness test that leaves out dummy variables in the regression suggests that the effects of exchange rate variability on trends and variability of variables are robust and that the exchange rate classification, as it is accounted for based on a systematic distribution criterion, further reinforces the theoretical channels of exchange rate variability on trends and variability of economic variables.

Consistent with dominant inflationary effects, exchange rate variability increases trend price inflation significantly across countries. The dominant contractionary effect on real output growth is consistent with a significant reduction in trend real output growth with respect to exchange rate variability across countries. Both channels are exacerbated in countries with floating exchange rate regimes, implying nominal flexibility is an important channel of transmitting exchange rate variability to the macro-economy.

In most regressions, the evidence suggests that the degree of exchange rate flexibility has reinforced the associated increase in aggregate uncertainty with respect to exchange rate variability. Table 2 presents coefficients that summarize the effects of exchange rate variability on the variability of economic variables across countries. Higher variability of the exchange rate has a significant positive effect that increases the variability of price inflation and real growth across countries. Countries with floating exchange rate systems exhibit even higher variability of price inflation compared to countries with pegged systems. The implication is that nominal flexibility exacerbates real exchange rate variability and aggregate uncertainty.[20]

[20] Graphs that track movements in trends and variability of real growth and inflation with the variability of exchange rate shocks across the sample of 32 countries in Latin America and the Caribbean are available from the publisher in the Online Appendix.

Table 2. Variation in indicators of macroeconomic performance with variability of exchange rate shocks across countries

Dependent variable	Explanatory variables			Explanatory variables		
	Constant	Exchange rate variability	Interactive dummy	Constant	Exchange rate variability	Interactive dummy
Trend price inflation	0.082*	0.20*	0.89*			
	(2.69)	(3.60)	(3.23)			
Variance of price inflation				0.076	0.52*	1.60*
				(1.15)	(4.28)	(2.70)
Trend real growth	0.039*	-0.009*	-0.04*			
	(16.35)	(-2.00)	(-2.03)			
Variance of real growth				0.04	0.013*	0.0034
				(14.81)	(2.64)	(0.14)

Notes: Trend: average time-series. Variance: standard deviation of time series. Interactive dummy captures relative variability in countries with flexible exchange rate systems. Coefficients measure the relationship across 32 countries in Latin America and the Caribbean. Exchange rate variability: standard deviation of shocks to real effective exchange rate, misalignment relative to equilibrium. t-ratio is in parantheses. * and ** denote statistical significance at the five and ten percent levels.

VI. Summary and conclusion

Exchange rate variability is a major determinant of macroeconomic performance in developing countries. The relative effects of exchange rate variability on the demand and supply sides may vary, however, with structural constraints and underlying fundamentals of each economy. Anticipated exchange rate shifts develop over time in response to agents' forecasts of underlying macroeconomic fundamentals. An unexpected movement in the exchange rate may vary with the exchange rate system. Under a flexible system, the domestic currency may exhibit an unexpected appreciation or depreciation in response to market forces, relative to major trading partners. Under a pegged system, economic agents may adjust expectations of the exchange rate in response to developments in underlying macroeconomic fundamentals.

The analysis evaluates the effects of anticipated and unanticipated movements in the real effective exchange rate in a sample of 32 developing countries in Latin America and the Caribbean. Consistent with higher cost of imports and

reduction in the output supply, the time-series evidence indicates that output expansions (contractions) are pervasive in the face of anticipated currency appreciation (depreciation) and price inflation (deflation) is pervasive in the face of anticipated exchange rate depreciation (appreciation). Anticipated exchange rate appreciation may have an expansionary effect on the output supply, increasing real growth, decreasing price inflation, and increasing capacity to consume and save. Additionally, anticipated appreciation could increase incentives for private investment, contributing to productive capacity and the welfare function of future generations.

Short-term fluctuations of the exchange rate may highlight adverse effects of unanticipated currency fluctuations. On the demand side, the loss of export competitiveness may result in output contraction with respect to unanticipated currency appreciation in the short-run. On the supply side, unanticipated depreciation renders the cost of imported intermediate goods higher and increases capacity constraints. Higher cost of imports, constraints on output supply, and higher demand for exports may increase inflationary pressures with respect to unanticipated currency depreciation. Further, unanticipated currency appreciation could accelerate price inflation as agents decrease money demand to capitalize on temporary exchange rate gains. The composite evidence indicates that output contraction dominates expansion, resulting in a net reduction in trend real growth the higher the variability of the real effective exchange rate across countries. Further, price inflation dominates deflation, resulting in a net increase in trend price inflation the higher the variability of the real effective exchange rate across countries. These channels appear more pronounced in countries with floating exchange rate systems. The combined evidence points to the importance of exchange rate fluctuations to economic performance in Latin America and the Caribbean.

Appendix

Table A1. Averages of economic indicators across countries based on exchange rate regime

	Pegged	Floating
Trend inflation	0.12	0.24
Trend growth	0.04	0.03
Output variability	0.21	0.36
Price variability	0.04	0.04

Notes: pegged includes Antigua & Barbuda, Argentina, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Honduras, Nicaragua, Panama, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, and Trinidad & Tobago; floating includes Bolivia, Brazil, Chile, Colombia, Costa Rica, Guatemala, Guyana, Haiti, Jamaica, Mexico, Paraguay, Peru, Suriname, Uruguay, and Venezuela.

Data Sources: The sample period for investigation is 1981-2007. Annual data for the above countries are described as follows:

Real Output: gross domestic product, constant prices, WEO, WNGDP.
Price Level: the deflator for GDP, WEO, NGDP_D.
Government Spending: nominal values of all payments by the government.
Money Supply: broad money, WEO, WMB.
Private Consumption: current prices of private consumption expenditure in national currency, WEO, WNCP.
Private Investment: current prices of private investment expenditure in national currency, WEO, WNFIP.
Exports of Goods and Services: current prices, WEO, WNX.
Imports of Goods and Services: current prices, WEO, WNM.
Exchange Rate: real effective exchange rate, INS.
Interest Rate: Deposit rate, IFS, 60L.zF., Discount rate, IFS, 60..zF.
Oil Price: crude oil (petroleum), 2005=100, simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh, W001POILAPSPW.

Sources: *World Economic Outlook* (*WEO*), *Information Notice System (INS),* and *International Financial Statistics* (*IFS*) data banks available from the International Monetary Fund, Washington D.C.

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