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ABSTRACT

In this paper we analyze empirically the effect of terms of trade shocks on economic performance under alternative exchange rate regimes. We are particularly interested in investigating whether terms of trade disturbances have a smaller effect on growth in countries with a flexible exchange rate regime, than in countries with a more rigid exchange rate arrangement. We also analyze whether negative and positive terms of trade shocks have asymmetric effects on growth, and whether the magnitude of these asymmetries depends on the exchange rate regime. We find evidence suggesting that terms of trade shocks get amplified in countries that have more rigid exchange rate regimes. We also find evidence of an asymmetric response to terms of trade shocks: the output response is larger for negative than for positive shocks. Finally, we find evidence supporting the view that, after controlling for other factors, countries with more flexible exchange rate regimes grow faster than countries with fixed exchange rates.

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I. Introduction

During the last few years economists' views on exchange rate regimes have evolved significantly. Fixed-but-adjustable regimes have lost adepts, while hard-pegs and floating rates have gained in popularity. The discussion on the relative merits of these two contrasting exchange rate systems has come to be known as the "two corners" debate (Fischer 2001). Supporters of hard-pegs have argued that this type of regime provides credibility and results in lower inflation, a more stable economic environment and faster economic growth.[1] Supporters of flexibility, on the other hand, have argued that under floating exchange rates the economy has a greater ability to adjust to external shocks.[2] According to this view, which at least goes back to Meade (1951), countries with a flexible exchange rate system will be able to buffer real shocks stemming from abroad. This, in turn, will allow countries with floating rates to avoid costly and protracted adjustment processes.[3]

In most models of open economies, real external shocks – including terms of trade and real interest rate shocks – will result in changes in the equilibrium real exchange rate (Obstfeld and Rogoff, 1995). If the nominal exchange rate is fixed, the adjustment in the equilibrium real exchange rate will have to take place through changes in domestic nominal prices and domestic wages. As Meade (1951, p. 201-02) argued early on, this adjustment will be difficult in countries with a fixed exchange rate and *inflexible* money wages. According to Meade (1951), in the presence of these rigidities the economy is likely to benefit from what he called a "*variable exchange rate*" regime, or from what we know today as a floating exchange rate system. He was careful to note, however, that flexible exchange rates are not a panacea, and that there are indeed circumstances when they may not help to accommodate external disturbances. This would be the case, for

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[1] Hard-peg regimes include currency boards, currency unions and dollarization. The growth effect is suppose to take place through two channels: (a) dollarization will mean lower interest rates, higher investment and, thus, faster growth. Dornbusch, for instance, (2001, p.240) has emphasized this channel, arguing that dollarization-induced lower interest rates are "conducive to investment and risk-taking, which translates into growth, and … a virtuous circle." And (b), by eliminating exchange rate volatility, hard-pegs will encourage international trade and this, in turn, will result in faster growth. Rose (2000), and Rose and Van Wincoop (2001), among others, have emphasized this trade channel within the context of currency unions. On analytical aspects of dollarization see Calvo (1999) and Eichengreen and Haussman (1999).

[2] In this paper we will use the terms "floating" and "flexible" exchange rate interchangeably.

[3] Friedman (1953) was an early proponent of this view. The idea that hard pegs magnify external shocks acquired greater prominence in the aftermath of the Argentine currency and debt crisis of 2001-2002.

instance, if due to indexation or other mechanisms *real* wages are inflexible.[4] This key point has also been recognized by modern scholars that have analyzed the merits of alternative exchange rate regimes (Dornbusch, 2001; Kenen, 2002).

Recently, a number of authors have argued that flexible exchange rate systems will not be effective in countries where the private and public sectors have large foreign currency-denominated liabilities (Eichengreen and Hausmann 1999). In this case, it has been argued, it is even possible that a flexible exchange rate regime will *amplify* the negative effects of terms of trade shocks. The reason for this is that in the presence of "balance sheet" effects, the currency depreciation generated by the external shock will generate (large) increases in the value of the debt expressed in domestic currency. This, in turn, may trigger bankruptcies, lead the public sector to insolvency, and result in a reduction in the rate of growth (Calvo 2000).

As the preceding discussion suggests, determining whether flexible exchange rate regimes are indeed able to insulate the economy from external shocks, and contribute to improving economic performance, is ultimately an empirical issue; it can only be elucidated by analyzing the historical evidence.[5] Surprisingly, there has been very little empirical work on the relationship between exchange rate regimes and the way in which terms of trade shocks affect growth and other measures of economic performance. In fact, papers that have investigated empirically the way in which terms of trade disturbances affect economic growth and growth volatility, have tended to ignore the role of the exchange rate regime in the transmission process. A literature search using *EconLit* indicates that 165 papers with the words "exchange rate regimes" and "growth" in the title or abstract were published between 1969 and 2002. During the same period, 98 papers with the words "terms of trade" and "growth" were published. However, only 3 articles that had all three terms were published during this 33-year span.[6]

The purpose of this paper is to bridge this gap in the literature, and to analyze empirically the effect of terms of trade shocks on economic performance *under*

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[4] In fact, Meade (1951, p. 203) explicitly said that "for the variable-exchange-rate mechanism to work effectively there must be sufficient divorce in movements in the cost of living and movements in money wage rates."

[5] Calvo (2000), for instance, has argued that if there are "dollarized liabilities" a flexible exchange rate regime may

alternative exchange rate regimes. We are particularly interested in investigating whether, as supporters of exchange rate flexibility have claimed, terms of trade disturbances have a smaller effect on growth in countries with a flexible exchange rate regime, than in countries with a more rigid exchange rate arrangement. We also analyze whether negative and positive terms of trade shocks have asymmetric effects on growth, and whether the magnitude of these asymmetries depends on the exchange rate regime. In order to investigate these issues we use a new data set that provides an improved classification of the exchange rate regime in each country at any particular moment in time. The advantage of this data set – which was constructed by Levy Yeyati and Sturzenegger (2002) – is that it does not rely on official country statements for classifying countries as having a pegged, intermediate or floating regime.[7] Instead, this new data set uses actual data on the behavior of nominal exchange rates and international reserves to classify countries under different regimes.

Our findings may be summarized as follows: First, we find evidence suggesting that terms of trade shocks get amplified in countries that have more rigid exchange rate regimes. Another way of saying this is that we find evidence indicating that, with other things given, countries with flexible exchange rates are able to accommodate better real external shocks. Second, we find evidence of an asymmetric response to terms of trade shocks. More precisely, the output response is larger for negative than for positive shocks, a fact consistent with the presence of asymmetries in price responses (with downward nominal inflexibility leading to larger quantity adjustments). Interestingly, while the output response in both directions is, again, larger the more rigid the exchange rate, this asymmetry is not present under flexible regimes.[8] In addition, we find evidence supporting the view that, after controlling for other factors, countries with more flexible exchange rate regimes grow faster than countries with fixed exchange rates, confirming previous findings in Levy Yeyati and Sturzenegger (2003).

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[6] Broda (2001) is a recent contribution that analyzes whether the exchange rate regime makes a difference in the way in which terms of trade shocks impact economic performance.

[7] It is well known that in many countries the authorities systematically state that they have a particular regime, when in reality they have a different one. See Edwards (1993) for a discussion on this issue.

[8] This would be in principle consistent with the presence of fear of floating, as reflected in a partial response of nominal exchange rates to positive shocks that result in larger real contractions. This hypothesis or, more generally, the hypothesis that exchange rates elasticity tends to be smaller in the event of negative shocks, is a fruitful topic for future research.

The rest of the paper is organized as follows: In section II we present our empirical framework, we discuss our data, and we present our basic results. In Section III we examine the robustness of the results to the use of the IMF de jure classification, and we extend the analysis to explore potential asymmetries in the output response to terms of trade shocks. Finally, in Section IV we present some concluding remarks.

II. Terms of Trade Shocks, Exchange Rate Regimes and Growth: An Empirical Analysis

Economists' concerns with the effects of terms of trade changes on economic growth go back, at least, to the writings of Prebisch (1950) and Singer (1950). These influential authors made two claims: first, they argued that developing countries' terms of trade had exhibited a secular deterioration through time. And second, they argued that this decline in relative exports' prices contributed to the developing countries' lack of industrialization, and resulted in low rates of growth and further impoverishment. As a result of Prebisch and Singer's empirical propositions, a number of authors developed theoretical models on the connection between terms of trade and economic growth. The majority of these models considered rather simple links, and argued that by negatively affecting real income, negative terms of trade shocks depressed aggregate demand and, thus, resulted in lower growth (Bloomfield 1984, Singer and Lutz 1994). More recent studies, however, have focused on a variety of transmission channels, including the effect of terms of trade on relative prices. Barro and Sala-I-Martin (1995), for example, have pointed out that whether growth in fact accelerates as a result of terms of trade improvements depends on the effects of relative price changes on productivity improvements.

Some authors have emphasized the effects of terms of trade shocks on capital accumulation and factor intensities. Basu and McLeod (1992), for example, constructed a stochastic model of growth where imported intermediate inputs are complementary to capital. In this setting, deterioration in the terms of trade makes imported inputs more expensive and has the potential of reducing capital's productivity. In addition, in this model, uncertainty regarding the terms of trade has a negative effect on investment and, ultimately, on growth. Mendoza (1997) developed a stochastic model of growth in which terms-of-trade uncertainty affects savings and growth. In this model terms of trade improvements have a positive effect on savings, capital accumulation and, thus, on the average rate of growth. The model also predicts that higher terms-of-trade variability could result in either faster or slower growth, depending on the degree of risk aversion.

In a comprehensive study Hadass and Williamson (2001) have reviewed most of the empirical literature on terms of trade and economic performance produced during the last five decades, including the works by Easterly et al (1993), Collier and Gunning (1999), Warner (1992), Barro and Sala-I-Martin (1995) and Barro (1997). They convincingly argue that, while there has been massive amount of work trying to explain the actual behavior of terms of trade, relatively few studies have focused on the effects of terms of trade shocks on growth. And none of the studies reviewed by them makes a distinction between countries with different exchange rate regimes. In a recent contribution, Broda (2001) provides one of the few empirical analyses on how terms of trade shocks affect real economic performance under alternative exchange rate regimes. He uses a VARs analysis to compute the way in which terms of trade shocks affect growth. He finds that the (negative) effect of a 10% deterioration in the terms of trade has a greater negative effect on growth under fixed than under flexible exchange rate regimes.

II.1 The Empirical Model

Our main interest is to investigate whether, as supporters of floating exchange rates have claimed, countries with floating exchange rate regimes are (partially) insulated from the effects of terms of trade shocks on growth. More specifically, we are interested in finding out if terms of trade disturbances affect differently countries with different exchange rate regimes. The point of departure of our empirical analysis is a two-equation formulation for the dynamics of real GDP per capita growth of country j in period t. Equation (1) is the long run GDP growth equation, while equation (2) captures the growth dynamics process.

$$(1) \qquad g^*_j = \alpha + \mathbf{x_j}\,\beta + \mathbf{r_j}\,\theta + \omega_j.$$

$$(2) \qquad \Delta g_{tj} = \lambda\,[\,g^*_j - g_{t-1\,j}\,] + \varphi\, v_{tj} + \gamma\, u_{tj} + \xi_{tj}\,.$$

The following notation has been used: g^*_j is the long run rate of real per capita GDP growth in country j. $\mathbf{x_j}$ is a vector of structural, institutional and policy variables that determine long run growth; $\mathbf{r_j}$ is a vector of regional dummies. α, β and θ are parameters, and ω_j is an error term assumed to be heteroskedastic. In equation (2), g_{tj} is the rate of growth of per capita GDP in country j in period t. The terms v_{tj} and u_{tj} are shocks, assumed to have zero mean, finite variance and to be uncorrelated among themselves. More specifically, v_{tj} is assumed to be an external *terms of trade shock*, while u_{tj} captures other shocks, including political shocks. ξ_{tj} is an error term, which is assumed to be heteroskedastic – see equation (3) below for details. λ, φ, and γ are parameters that determine the particular characteristics of the growth process.

From the perspective of the exchange rate regime discussion, an important question is whether the exchange rate system has a direct effect on the long-term rate of growth. We deal with this issue by investigating whether in equation (1) the intercept α is different for countries with different exchange rate regimes.[9] Equation (2) -- which has the form of an equilibrium correction model (ECM) --, states that the actual rate of growth in period t will deviate from the long run rate of growth due to the existence of three types of shocks: v_{tj}, u_{tj} and ξ_{tj}. Over time, however, the actual rate of growth will tend to converge towards it long run value, with the rate of convergence given by λ. Parameter φ, in equation (2), is expected to be positive, indicating that an improvement in the terms of trade will result in a (temporary) acceleration in the rate of growth, and that negative terms of trade shock are expected to have a negative effect on g_{tj}.

Our main interest is to determine whether parameter φ in equation (3) depends on the exchange rate regime of the country in question. If, as their supporters have argued, floating exchange rates allow countries to absorb foreign shocks better, we would expect φ to be smaller in countries with floating rates than in those countries with some version of a pegged rates exchange rate regime. We are also interested in determining whether positive and negative terms of trade shocks have asymmetric effects on growth – that we do in section III. Our task, then, is to estimate the system given by equations (1) and (2), and to analyze if the coefficients α and φ are different across exchange rate regimes. The estimation of this system is not trivial, and is subject to the complexities of estimating panels with lagged dependent variables and heteroskedastic errors.

We estimate the system (1) - (2) using a two-step procedure. In the first step we estimate the long run growth equation (2) using a cross-country data set. These data are averages for 1974-2000, and the estimation makes a correction for heteroskedasticity. These first stage estimates are then used to generate long run predicted rates of growth to replace g^*_j in the equilibrium correction model (2). In the second step, we estimate equation (2) using a feasible generalized least squares procedure (FGLS) suggested by Beck and Katz (1995) for unbalanced panels. In the estimation of equation (2) the error $\xi_{t\,j}$ is assumed to be heteroskedastic, with a different variance for each of the k panels.

$$(3) \qquad E[\xi\xi'] = \begin{pmatrix} \sigma^2_1 \mathbf{I} & 0 & \dots & 0 \\ 0 & \sigma^2_2 \mathbf{I} & \dots & 0 \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & \dots & \sigma^2_k \mathbf{I} \end{pmatrix}$$

The FGLS estimator has the same properties as the GLS estimator, and is asymptotically efficient. Notice that an alternative estimation strategy would be to re-parameterize equation (1) and (2), and to apply the Generalized-Method-of-Moments (GMM) for dynamic panel data models suggested by Arellano and Bond (1991). When we did this, the results obtained were similar to those obtained using our two-steps-FLS methodology.[10]

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[9] On debates on the effect of alternative exchange rate regimes on performance see, for example, Gosh et al (1995), Levy Yeyati and Sturzenegger (2002), Frankel (1999) and Kenen (2002).

[10] A potential limitation of the GMM strategy, however, is it does not lend itself to a straight forward interpretation of the equilibrium correction term. The results we obtained when using this method are available on request.

We use two alternative methods to investigate whether the terms of trade coefficient φ in equation (2) is different for different exchange rate regimes: The first one consists of including a variable that interacts the terms of trade shock with three alternative indicators for exchange rate regimes. Our second method consists of splitting the sample according to the exchange rate regime, and comparing the estimated coefficients for the terms of trade variable. If flexible regimes buffer the country better form external disturbances, we would expect the coefficient for the terms of trade variable to be significantly lower in countries with flexible exchange rate regimes than in countries with rigid regimes.

II.2 Data and Equation Specification

Our sample covers annual observations for 183 countries over the period 1974-2000. With the exception of the civil unrest, exchange rate regimes, and secondary school enrollment variables, the data were obtained from the IMF and the World Bank databases. Since data availability varies across countries and periods, all tests were run on consistent subsamples of observations corresponding to 96 and 100 countries. A list of countries, as well as the definitions and sources for the variables used, are reported in Appendix A.

As pointed out above, our main interest is to analyze the transmission of terms of trade shocks under alternative *exchange rate regimes*. There is generalized agreement, however, that the IMF's "official" exchange rate regime classification tends to be misleading. For this reason, we use a methodology proposed by Levy Yeyati and Sturzenegger (2002) to construct four indexes of exchange rate regimes. These indexes are constructed as time series, and are based on actual, as opposed to legal, exchange rate behavior– see Appendix B for details. The three indexes are defined as follows:

- A binary index that takes the value of one if in that particular year the country has a pegged exchange rate regime, and zero otherwise. We call this index *pegged*.
- A dummy variable that takes the value of one if in that particular year the country in question has a hard (as opposed to a conventional) peg – that is, if

it has a currency board, belongs to a currency union or it is dollarized. The index takes a value of zero otherwise. This variable is called *hard*.

- A dummy variable that takes the value of one if the exchange rate regime is an intermediate regime – crawling pegs, managed floats, and the like (see Levy Yeyati and Sturzenegger 2002, for details). We call this index *intermediate*. (Notice that from these definitions we are able to construct an index that takes the value of one if the regime is neither *pegged* nor *intermediate*. This index is called *flexible*.)
- And a three-way classification that combines some of the indexes described above, and distinguishes between pegged, intermediate and flexible exchange rate regimes. This index is called *regime* and takes a value of zero if in that particular year the country in question has a flexible rate. It takes a value of one if the country has an intermediate regime, and a value of two if the country has a pegged exchange rate in that particular year.

These indexes where constructed for each year in the sample (1974-2000). Table 1 presents a summary of the distribution of countries in our sample across the different exchange rate regimes that we have defined.

[TABLE 1 APPROXIMATELY HERE]

In estimating equation (1) for long run per capita growth, we follow the by now standard literature on growth, as summarized by Barro and Sala-I-Martin (1995), and use average data for 1974-2000. In terms of the equation specification, we follow Barro and Sala-I-Martin (1995), Sachs and Warner (1995) and Dollar (1992) among others, and assume that the rate of growth of GDP (g^*_j) depends on a number of structural, policy and social variables. More specifically, we include the following covariates: the log of initial GDP per capita (*gdpin*); the investment ratio (*invgdp*); the coverage of secondary education (*sec*, a proxy for human capital); an index of the degree of openness of the economy (*openness*); the ratio of government consumption relative to GDP (*gov*); and regional dummies for Latin American, Sub Saharan African and Transition economies (*latam*, *safrica*, and *trans*). In some specifications we also included the rate of growth of population. Finally, and in order to investigate whether the exchange rate regime affects long run growth, in some of the cross-section regressions we also incorporated two alternative indexes for the exchange rate regime. The first one, which we call *pegged_cross*, is a cross section version of the time series index *pegged*, defined above. It takes the value of one if the country in question has been classified as a fixed exchange rate regime for at least 50% of the time, and zero otherwise. The second index – called *regime_cross* – is a cross section version of the index *regime* described above, and is constructed as an average of that index. A lower value of this *regime_cross* index, then, represents a more flexible exchange rate regime. A full description of the data, including the data sources, is provided in Appendix A.

In the estimation of dynamics of growth equation (2), v_{tj} is the terms of trade shock (Δtt), and is defined as the percentage change of the relative price of exports to imports. Thus, a positive (negative) number represents an improvement (deterioration) in the terms of trade. In addition to the terms of trade shocks, we also included the terms of trade shock interacted with our different exchange rate regime indexes. An index of civil unrest was included as a proxy for other shocks (this can be interpreted as being an element in vector u_{tj} in equation (1)). In all equations we included time fixed effects, which capture systemic shocks to all countries, such as changes in global liquidity and shocks to world interest rates. We also included regional dummies, and in some of the equations we included lagged values of the terms of trade shocks. In Table 2 we present summary statistics for all variables used in our empirical analysis (See Appendix A for data sources).[11]

[TABLE 2 APPROXIMATELY HERE]

II.3 Main Results

The results from the first step estimation for the long run growth equation are reported in Table 3, where the t-statistics have been estimated using robust standard

[11] As usual, data availability differs across countries and variables. For consistency, the statistics reported in the table are based on the actual sample used in the empirical tests below.

errors computed using the Huber-White methodology. As may be seen, the results are quite satisfactory; all the coefficients have the expected sign and most of them are statistically significant. These results confirm previous findings with respect to the roles played by initial GDP, education, openness, and government consumption in explaining differentials in long run GDP per capita growth across countries. In terms of the main question raised in this paper, a particularly interesting finding in Table 3 is that the estimated coefficients for our two exchange rate regime indicators are significantly negative. This suggests that in the long run, and after controlling for traditional covariates, countries with (de facto) more rigid exchange rate regimes have tended to grow at a slower rate than countries with more flexible exchange rate systems. Moreover the absolute values of the point estimates are quite large, suggesting that, with other things given, countries with a fixed exchange rate regime have had a lower rate of growth of GDP per capita ranging between 0.66 and 0.85 percentage point per year, than countries with a flexible regime. These findings contrast with studies such as Gosh et al (1995) and IMF (1997) that have used the official IMF classification of regimes. According to these studies, while fixed exchange rate countries tend to have a lower rate of inflation than flexible rate ones, there is no statistical difference in terms of GDP per capita growth across both groups of countries. Our results, on the other hand, are consistent with recent findings by Levy Yeyati and Stuzenegger (2003).

[TABLE 3 APPROXIMATELY HERE]

We use the fitted values from the estimates for long run GDP per capita growth reported in equation (i) in Table 2 to construct a proxy for g^*_j in the second step estimation of equation (2). When alternative specifications for the long run growth equation were used, the results were very similar to those reported in the paper.[12]

Table 4.a contains the results from the estimation, using the FGLS procedure described above, of several versions of equation (2) on the dynamics of growth. All equations were estimated for the 1974 – 2000 period, and included yearly fixed effects; this allows us to capture the effects of shocks that are systemic to all countries in a

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[12] They are available from the authors on request.

particular year, such as changes in international interest rates. As may be seen the results are quite satisfactory. The estimated coefficient of [$g^{*}_{j} - g_{t-1\ j}$] is, as expected, positive, significant, and smaller than one. The point estimates are on the high side -- between 0.75 and 0.79. For instance, according to equation (i) in Table 4.a, after 4 years approximately 90% of a unitary shock to real GDP growth will be eliminated. Also, as expected, the estimated coefficients of the terms of trade shock are always positive and statistically significant, indicating that an improvement (deterioration) in the terms of trade results in an acceleration (de-acceleration) in the rate of growth of real per capita GDP. The results in Table 4.a also show that the coefficients of our political shocks variable – civil unrest – are negative in every specification. However, they are not significant at conventional levels.

Our main interest in this paper is the estimated coefficient of the interactive terms between our exchange rate regime indexes and the terms of trade shock. As may be seen from Table 4.a, the estimated coefficients of these interactive terms are always positive, and in most regressions they are significant at conventional levels. This indicates that the effects of terms of trade shocks on growth are larger under fixed exchange rate regimes that under floating regimes. Consider, as an example, the case of equation (i) in Table 4.a: the terms of trade coefficient has a point estimate of 0.043; the estimated interactive term, on the other hand, has a point estimate of 0.037. These results suggest, then, that in pegged exchange rates countries a 10% deterioration in the international terms of trade has been associated, on average, with a (contemporaneous) decline in GDP per capita growth of 0.80 of one percentage point. In flexible exchange rates countries, on the other hand, the same 10% decline in the international terms of trade has been associated on average with a (contemporaneous) reduction in GDP per capita growth of 0.43 of one percentage point. That is, according to this equation under flexible exchange rates the effects of terms of trade shocks on growth are approximately one half than under pegged regimes.

[TABLES 4.a THROUGH 4.c APPROXIMATELY HERE]

Table 4.b contains separate FGLS regression results for four groups of countries, each corresponding to a different exchange rate regime. The first group is comprised of countries that according to our indicator have a flexible exchange rate; the second sub-sample contains countries with an intermediate regime. The third sub-sample contains countries with a pegged exchange rate regime. And finally, the fourth sub-sample corresponds to countries that according to our classification have had a hard peg regime. As may be seen, the results indicate that the estimated coefficient of the terms of trade variables is always positive and significant. What is particularly interesting from the point of view of this paper's topic is that point estimates of these coefficients are different across the four sub-samples, and that they increase with the rigidity of the exchange rate regime. Indeed, the sum of the contemporaneous and lagged terms of trade coefficients is highest for the hard-peg regimes (0.168); the second highest value corresponds to the pegged regimes (0.129). The sum of these coefficients is 0.071 for the intermediate systems, and it is the lowest (0.057) for the group of countries that has had a flexible exchange rate system. Moreover, as the χ^2 tests reported in Table 4.c indicate, the coefficients for pegs are *significantly* larger (from a statistical point of view) than those for each of the more flexible regimes.[13]

In order to investigate further how of terms of trade shocks affect growth under alternative regimes, we divided our sample into industrial and emerging countries. This allows us to analyze whether the results reported above are driven by the level of development, rather than by their exchange rate regime. The results obtained – which are reported in Table 5 –, show that flexible exchange rate regimes have helped buffer terms of trade shocks for both industrial and emerging nations.

[TABLE 5 APPROXIMATELY HERE]

The results reported in Tables 4 and 5, then, provide support the hypothesis that countries with flexible regimes have been able to accommodate terms of trade shocks

[13] The χ^2 statistics in this table were computed interacting each of the regressors with the corresponding regime dummy. Thus, for example, to compute the statistics for the pegged – flexible comparison we restricted the sample to include pegs and flexible regimes, interacted all controls with the *pegged* and

better than countries with rigid exchange rates. In the next section we expand our analysis by investigating whether terms of trade shocks affect growth asymmetrically. More precisely, we examine whether the impact of negative shocks is stronger than that of positive shocks, as one should expect if nominal prices are rigid downward.

III. Asymmetric Effects and Robustness Analysis

In this section we deal with two extensions: First, we investigate whether positive and negative terms of trade shocks affect growth in an asymmetric way, and whether these asymmetric effects are different under alternative exchange rate regimes. And second, we analyze the robustness of our results to alternative classifications of exchange rate regimes, and to the use of alternative samples.

III.1 Asymmetric Effects of Terms of Trade Shocks under Alternative Regimes

According to a number of authors the most important advantage of flexibility is that it allows the economy to buffer *negative* terms of trade shocks through smooth changes (depreciations) in the real exchange rate. This contrasts with the case of pegged exchange rates, where real exchange rate depreciation requires a decline in *nominal prices*. If nominal prices are rigid downward, however, a negative terms of trade shock will result in unemployment, a decline in output and I the rate of growth – see Dornbusch (2001) and Kenen (2002) for details.In that sense, then, iIt is possible to argue that from a policy point of view what really matters is the way in which alternative exchange rate regimes accommodate *negative* terms of trade shocks.

In order to investigate this issue, we estimated a number of regressions that distinguished between positive and negative terms of trade shocks. As before we used a FGLS procedure for heteroskedastic panels. In this case, our system becomes:

(3) $$g^*_j = \alpha + \mathbf{x}_j \beta + \mathbf{r}_j \theta + \omega_j.$$

(4) $$\Delta g_{tj} = \lambda [g^*_j - g_{t-1\ j}] + \varphi\, vp_{tj} + \psi\, vn_{tj} + \gamma\, u_{tj} + \xi_{tj}.$$

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flexible dummies, and tested the null *Δtt* pegged+Δtt_1*neg*pegged – (Δtt*flexible + Δtt_1*flexible) = 0*. The last column (pegged vs. hard) compares conventional and hard pegs regimes.

Where vp $_{t j}$ refers to positive terms of trade shocks, vn $_{t j}$ refers to negative shocks; φ and ψ are coefficients to be estimated. If the effects of negative terms of trade disturbances on growth are indeed larger than those of positive shocks, we would expect ψ to be significantly larger than φ. In the estimation of equations (3) and (4) we made a distinction between four exchange rate regimes: hard-pegged; pegged; intermediate and flexible. If, as its supporters have argued, flexible regimes are able to accommodate better negative real shocks from abroad, the estimated ψs – that is, the coefficients of the *negative* terms of trade shocks -- would be *larger* in countries with more rigid exchange rate regimes than in countries with more flexible ones. As before, in the estimation of the equation on growth dynamics (equation (4)) we included time specific effects.

The results from the estimation of the second stage equation (4) are presented in Table 6 for two alternative samples: one that includes all countries and a sub-sample of emerging countries only. As may be seen, the results obtained indicate that there are indeed asymmetric effects of terms of trade shocks in six out of the seven regressions. In every equation, with the exception of (i), the sum of the coefficients for the negative shocks is higher than the sum of the coefficients for the positive shocks. Moreover, the differences in the terms of trade coefficients are statistically significant for the hard pegs, pegs, and intermediate regimes – see table 7 for formal tests.

[TABLE 6 APPROXIMATELY HERE]

[TABLE 7 APPROXIMATELY HERE]

Consider, for example, the comparison between pegged and flexible regimes for the whole sample. According to the FGLS estimates in Table 6, the sum of the coefficients of the negative terms of trade shocks is 0.158 for the pegged regime countries, but only 0.053 for those countries with a flexible exchange rate. From a statistical point of view, the sum of the (negative) terms of trade coefficients is significantly higher for the pegged regime countries – the χ^2 has a p-value of 0.017 (Table 7).[14] In fact, similar tests indicate that the sum of the negative terms of trade

[14] The χ^2 statistics in this table were computed interacting each of the regressors with the corresponding regime dummy. Thus, to compute the statistics for negative shocks for the pegged – flex comparison we

coefficients for countries with flexible (fixed) exchange rate arrangements are significantly lower (higher) than the sum of the coefficients for countries with non-flexible (non-pegged) rates. Thus, these results indicate that the reported asymmetric response to shocks in countries with more rigid exchange rate regimes is mainly driven by the larger effects of negative terms of trade shocks. This, combined with the fact that the sensitivity to both positive and negative shocks is higher the less flexible the regime, suggests that the lack of exchange rate flexibility increases the real impact of terms of trade shocks due to the lack of (downward) price flexibility.

To summarize, these results provide further support for the hypothesis that flexible exchange rates have played a role as shock absorbers, helping countries accommodate real terms of trade shocks. This ability to accommodate these shocks appears to have been particularly important in the presence of negative external shocks.

III.2 Alternative Classification of Exchange Rate Regimes

In this subsection we investigate whether the results reported above depend on the classification of exchange rate regimes that we have used. In order to do this we re-estimated our model using the standard and official exchange rate classification provided by the IMF. The results obtained in this case, not reported here due to space considerations, are somewhat weaker.[15] Although the coefficients have the expected signs, and in most cases have similar point estimates to those reported in Tables 4-6, they are estimated with a lower degree of precision.

To explore further this issue we conducted the following simple exercise: we revised the IMF-based classification, and tried to detect obvious misclassifications of regimes. We then re-estimated our equations using a restricted sample that include only uncontroversial *de jure* IMF-defined regimes. This entails the (relatively minor) loss of 89 observations.[16] The estimates, which are available from the authors on request, have a higher degree of precision than those obtained when the unadjusted IMF classification is used. As before, these results indicate that terms of trade shocks – and in particular

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included pegs and flexible regimes, interacted all the controls with the *pegged* and *flexible* dummies, and tested the null $\Delta tt*neg*pegged+\Delta tt*neg\_1*pegged - (\Delta tt*neg*flexible + \Delta tt*neg\_1*flexible) = 0$.

[15] These results are available on request.

negative terms of trade shocks – have a larger effect on growth under rigid exchange rate regimes than under more flexible regimes.

IV. Concluding Remarks

In this paper we examined two aspects of the economic implications of exchange rate regimes that, despite being recurrently used to argue in favor of exchange rate flexibility, have been the subject of little, if any, empirical work: (i) the role played by flexible exchange rates as absorbers of real shocks, and (ii) the link between this role and the presence of downward price rigidities. More precisely, we tested whether the sensitivity of real growth to terms of trade shocks declines as the degree of flexibility of the regime increases. In addition, we investigated whether this sensitivity is higher in the event of negative shocks, as it would be the case in the presence of asymmetric price rigidities.

Using a *de facto* classification of exchange rate regimes, we found that flexible exchange rate arrangements indeed help reduce the real impact of terms of trade shocks on GDP growth, both in emerging and industrial economies.[17] Moreover, we found real output growth to be more sensitive to negative than to positive shocks. In fact, most of the differential shock responses across regimes can be traced to the stronger real impact of negative shocks under a peg, be it of the conventional or the hard kind. The effects unveiled in this paper are, on the other hand, not only statistically significant but economically important: while a 10 percent deterioration of the terms of trade translates into a real contraction of around 0.4% for the average country, this effect nearly doubles under a peg. Thus, the choice of exchange rate regime indeed has important implications in terms of output volatility. Moreover, the fact that the asymmetry of output responses to real shocks increases with the rigidity of the regime suggests that pegs are associated with deeper and longer contractions.

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[16] While a similar correction can be done for floats and intermediates, it is certainly in the fix group where misclassifications are less debatable, as changes in the exchange rate are readily observable.

[17] Similar, albeit slightly weaker, results are obtained if a de jure regime classification is used.

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Table 1. Distribution of Exchange Rate Regimes

Pegged			Non-Pegged			
Conventional	Hard	Total	Intermediate	Flexible	Total	Total
1356	717	2073	600	662	1262	3335

Source: Levy Yeyati and Sturzenegger (2001).

Table 2. Summary Statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Δgdp	100	1.157	1.933	-5.689	5.850
gdpin	100	1.340	1.690	0.066	9.828
invgdp	100	0.217	0.054	0.097	0.440
sec	100	0.416	0.275	0.020	0.910
openness	100	0.355	0.204	0.083	1.168
gov	100	0.203	0.192	0.024	1.148
civil unrest	1733	3.494	1.745	1	7
Δtt	1733	4.226	16.185	-88.846	114.195

Table 3. Cross-Section First-Stage Growth Regressions

	(i)	(ii)	(iii)
gdpin	-0.550***	-0.467**	-0.494**
	(0.135)	(0.204)	(0.197)
invgdp	6.276	5.171	5.052
	(4.288)	(4.259)	(4.427)
sec	2.969***	2.591**	2.594**
	(0.908)	(1.138)	(1.105)
openness	0.479	1.351	1.531
	(0.970)	(1.048)	(1.098)
gov	-2.030	-2.520	-2.234
	(1.460)	(1.550)	(1.514)
latam	-0.971**	-0.828*	-0.858*
	(0.467)	(0.461)	(0.471)
safrica	-1.480***	-1.191**	-1.280**
	(0.547)	(0.566)	(0.554)
trans	-0.865**	-0.557	-0.621
	(0.412)	(0.615)	(0.593)
pegged_cross		-0.854***	
		(0.318)	
regime_cross			-0.656**
			(0.278)
constant	0.157	0.588	0.923
	(0.950)	(0.912)	(1.001)
Obs.	100	96	96
R^2	0.45	0.45	0.44

Note: ***, **, and * represent 99, 95 and 90% significance. Heteroskedasticity-consistent standard errors in parentheses.

Table 4.a. Growth Dynamics Regressions (FGLS)
Full Sample

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
$[g^*_j - g_{t-1\ j}]$	0.793***	0.751***	0.793***	0.803***	0.791***	0.748***
	(0.020)	(0.023)	(0.02)	(0.023)	(0.02)	(0.023)
Δtt	0.043***	0.051***	0.058***	0.060***	0.037***	0.045***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.011)	(0.011)
Δtt_1		0.026***		0.036***		0.021*
		(0.009)		(0.007)		(0.011)
*Δtt*pegged*	0.037***	0.037***				
	(0.011)	(0.011)				
*Δtt*pegged_1*		0.018*				
		(0.011)				
*Δtt*hard*			0.03	0.043**		
			(0.018)	(0.018)		
*Δtt*hard_1*				0.014		
				(0.018)		
*Δtt*regime*					0.019***	0.020***
					(0.007)	(0.007)
*Δtt*regime_1*						0.011*
						(0.007)
civil unrest	-0.029	-0.018	-0.028	-0.02	-0.034	-0.026
	(0.040)	(0.040)	(0.041)	(0.040)	(0.040)	(0.040)
constant	-0.182	-1.158**	-0.216	-1.165**	-0.142	-1.140**
	(0.488)	(0.459)	(0.495)	(0.472)	(0.490)	(0.459)
Obs.	1733	1650	1733	1723	1733	1650
Δtt + Δtt_1		0.077***		0.096***		0.066***
		[47.90]		[111.62]		[22.93]
Pegged [a]		0.055***				
		[15.23]				
Hard [b]				0.057*		
				[5.58]		
Regime [c]						0.031***
						[13.35]

Note: ***, **, and * represent 99, 95 and 90% significance. Heteroskedasticity-consistent standard errors in parentheses. $\chi 2$ in brackets. All regressions include year dummies.
[a] Refers to: *Δtt*pegged + Δtt*pegged_1.*
[b] Refers to: *Δtt*hard + Δtt*hard_1.*
[c] Refers to: *Δtt*regime+Δtt*regime_1.*

Table 4.b. Growth Dynamics Regressions (FGLS)
Split Sample by Regime

	(i) Flexible	(ii) Intermediate	(iii) Peg	(iv) Hard Peg
$[g^*_j - g_{t-1\ j}]$	0.882***	0.938***	0.767***	0.909***
	(0.035)	(0.035)	(0.030)	(0.066)
Δtt	0.037***	0.048***	0.083***	0.125***
	(0.009)	(0.010)	(0.008)	(0.020)
Δtt_1	0.020*	0.023**	0.046***	0.043**
	(0.009)	(0.010)	(0.008)	(0.020)
civil unrest	0.084	-0.116	-0.02	-0.108
	(0.060)	(0.082)	(0.052)	(0.251)
constant	-1.236**	2.109	0.001	1.494
	(0.603)	(1.567)	(0.386)	(2.126)
Obs.	462	416	845	225
Δtt + Δtt_1	0.057***	0.071***	0.129***	0.168***
	[17.76]	[25.06]	[134.28]	[39.68]

Note: ***, **, and * represent 99, 95 and 90% significance. Heteroskedasticity-consistent standard errors in italics. *χ2* in brackets. All regressions include year dummies.

Table 4.c. Differential Response by Regime: χ^2 Tests

	Flexible	Intermediate	Hard
Pegged	0.068*** [a] [9.17]	1.294*** [b] [6.77]	-0.064*[c] [3.49]
Obs.	1307	1261	845

Notes: ***, **, and * represent 99, 95 and 90% significance. *χ2* in brackets. All regressions include year dummies.

[a] Refers to: *Δtt*pegged + Δtt_1*pegged – (Δtt*flexible + Δtt_1*flexible).*

[b] Refers to: *Δtt*pegged + Δtt_1*pegged – (Δtt*intermediate + Δtt_1*intermediate).*

[c] Refers to: *Δtt*(pegged-hard) + Δtt_1*(pegged-hard) – (Δtt*hard + Δtt_1*hard).*

Table 5. Growth Dynamics Regressions (FGLS)
Emerging and Industrial Countries

	(i) Emerging	(ii) Industrial	(v) Emerging	(vi) Industrial
$[g^*_j - g_{t\text{-}1\ j}]$	0.789***	0.639***	0.787***	0.638***
	(0.027)	(0.045)	(0.027)	(0.045)
Δtt	0.049***	0.057***	0.036***	0.071***
	(0.010)	(0.019)	(0.013)	(0.020)
Δtt_1	0.025***	0.012	0.024*	-0.006
	(0.010)	(0.019)	(0.013)	(0.020)
Δtt*pegged	0.046***	-0.013		
	(0.012)	(0.027)		
Δtt*pegged_1	0.016	0.068**		
	(0.012)	(0.027)		
Δtt*regime			0.028***	-0.018
			(0.008)	(0.014)
Δtt*regime_1			0.008	0.049***
			(0.008)	(0.014)
civil unrest	-0.122*	-0.338**	-0.125*	-0.348**
	(0.064)	(0.144)	(0.064)	(0.142)
constant	-0.141	-2.171***	0.533	0.352
	(0.512)	(0.450)	(0.559)	(0.437)
Obs.	1281	369	1281	369
Δtt + Δtt_1	0.074***	0.069***	0.060***	0.065***
	[33.24]	[10.27]	[12.09]	[12.59]
Pegged [a]	0.062***	0.055**		
	[15.64]	[7.31]		
Regime [b]			0.036***	0.031***
			[13.62]	[13.09]

Note: ***, **, and * represent 99, 95 and 90% significance. Heteroskedasticity-consistent standard errors in parentheses. $\chi 2$ in brackets. All regressions include year dummies.
[a] Refers to: Δtt*pegged + Δtt*pegged_1.
[La b] Refers to: Δtt*regime+Δtt*regime_1.

Table 6. Asymmetry (FGLS)
Full Sample and Emerging Countries

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
	All				Emerging		
	Flexible	Intermediate	Peg	Hard	Flexible	Intermediate	Peg
$[g^*_j - g_{t-1\ j}]$	0.883***	0.916***	0.767***	0.907***	0.926***	0.974***	0.803***
	(0.035)	(0.037)	(0.030)	(0.067)	(0.039)	(0.043)	(0.033)
*Δtt*pos*	0.022	0.029**	0.066***	0.070*	0.032*	0.031*	0.062***
	(0.014)	(0.015)	(0.013)	(0.037)	(0.016)	(0.018)	(0.015)
*Δtt*pos_1*	0.041***	0.004	0.040***	0.046	0.027*	-0.006	0.029**
	(0.014)	(0.015)	(0.012)	(0.033)	(0.016)	(0.018)	(0.013)
Δtt_neg	0.060**	0.067***	0.105***	0.173***	0.065**	0.079***	0.119***
	(0.024)	(0.022)	(0.015)	(0.032)	(0.027)	(0.023)	(0.016)
*Δtt*neg_1*	-0.007	0.047**	0.053***	0.031	0.013	0.059***	0.055***
	(0.017)	(0.020)	(0.016)	(0.035)	(0.018)	(0.022)	(0.016)
civil unrest	0.095	-0.024	0.020	-0.061	0.084	-0.092	-0.124
	(0.065)	(0.087)	(0.059)	(0.249)	(0.119)	(0.128)	(0.084)
constant	-1.352**	2.103	0.202	1.777	-1.791	1.579	1.267
	(0.577)	(1.593)	(0.398)	(2.151)	(1.156)	(2.001)	(0.826)
Obs.	462	416	845	225	301	326	714
pos [b]	0.063***	0.033	0.106***	0.116**	0.059***	0.025	0.091***
	[12.00]	[2.49]	[40.69]	[5.82]	[7.99]	[0.92]	[25.30]
neg [c]	0.053*	0.114***	0.158***	0.204***	0.078**	0.138***	0.174***
	[3.45]	[16.98]	[58.13]	[19.80]	[5.99]	[20.42]	[64.79]
neg – pos [d]	-0.010	0.081**	0.052*	0.088	0.019	0.113***	0.083***
	[0.08]	[4.86]	[3.26]	[1.70]	[0.24]	[6.82]	[7.16]

Notes: ***, **, and * represent 99, 95 and 90% significance. Heteroskedasticity-consistent standard errors in parentheses. $\chi 2$ in brackets. All regressions include year dummies.
[a] There are no hard pegs among industrial countries.
[b] Refers to: *Δtt*pos + Δtt*pos_1*.
[c] Refers to: *Δtt*neg + Δtt*neg_1*.
[d] Refers to: *Δtt*pos+Δtt*pos_1 - Δtt*neg - Δtt*neg_1*.

Table 7. Asymmetry (FGLS)
Differential Response by Regime and Type of Shock: χ^2 Tests

	Pegged – Flex	Pegged – Nonpegged	Flex – Nonflex
Positive shock	0.032 [1.18]	0.060*** [5.81]	0.044 [2.02]
Negative shock	0.103*** [5.70]	0.080** [5.34]	0.086* [3.38]
Obs.	1307	1723	1723

Notes: ***, **, and * represent 99, 95 and 90% significance. $\chi 2$ in brackets. All regressions include year dummies.

Appendix A. Description of the Data

(a) Variables and Sources

Variable	Definitions and sources
g	Rate of growth of real per capita GDP (Source: World Economic Outlook [WEO])
Δtt	Change in terms of trade - exports as a capacity to import (constant LCU) (Source: World Development Indicators [WDI]; variable NY.EXP.CAPM.KN)
civil unrest	Index of civil liberties (measured on a 1 to 7 scale, with one corresponding to highest degree of freedom) (Source: Freedom in the World - Annual survey of freedom country ratings)
gdpin	Initial per capita GDP (average over 1970-1973) (Source: WEO)
gov	Growth of government consumption (Source: IMF's International Financial Statistics [IMF])
invgdp	Investment to GDP ratio (Source: IMF)
openness	Openness, (ratio of [export + import]/2 to GDP) (Source: IMF).
sec	Total gross enrollment ratio for secondary education (Source: Barro, 1991)
latam	Dummy variable for Latin American countries
safrica	Dummy variable for Sub-Saharan African countries
trans	Dummy variable for Transition economies

(b) List of Countries (183-country sample; industrial countries in bold)

- ***Australia***
- ***Austria***
- ***Belgium***
- ***Canada***
- ***Denmark***
- ***Finland***
- ***France***
- ***Germany***
- ***Greece***
- ***Iceland***
- ***Ireland***
- ***Italy***
- ***Japan***
- ***Netherlands***
- ***New Zealand***
- ***Norway***
- ***Portugal***
- ***San Marino***
- ***Spain***
- ***Sweden***
- ***Switzerland***
- ***United Kingdom***
- ***United States***
- *Afghanistan, I.S. Of*
- *Albania*
- *Algeria*
- *Angola*
- *Antigua And Barbuda*
- *Argentina*
- *Armenia*
- *Aruba*
- *Azerbaijan*
- *Bahamas, The*
- *Bahrain*
- *Bangladesh*
- *Barbados*
- *Belarus*
- *Belize*
- *Benin*
- *Bhutan*
- *Bolivia*
- *Bosnia And Herzegovina*
- *Botswana*
- *Brazil*
- *Brunei Darussalam*
- *Bulgaria*
- *Burkina Faso*
- *Burundi*
- *Cambodia*
- *Cameroon*
- *Cape Verde*
- *Central African Rep.*
- *Colombia*
- *Comoros*
- *Congo, Dem. Rep. Of*
- *Congo, Republic Of*
- *Costa Rica*
- *Cote D Ivoire*
- *Croatia*
- *Cyprus*
- *Czech Republic*
- *Chad*
- *Chile*
- *China,P.R.: Mainland*
- *China,P.R.:Hong Kong*
- *Djibouti*
- *Dominica*
- *Dominican Republic*
- *Ecuador*
- *Egypt*
- *El Salvador*
- *Equatorial Guinea*
- *Estonia*
- *Ethiopia*
- *Fiji*
- *Gabon*
- *Gambia, The*
- *Georgia*
- *Ghana*
- *Grenada*
- *Guatemala*
- *Guinea*
- *Guinea-Bissau*
- *Guyana*
- *Haiti*
- *Honduras*
- *Hungary*
- *India*
- *Indonesia*
- *Iran, I.R. Of*
- *Iraq*
- *Israel*
- *Jamaica*
- *Jordan*
- *Kazakhstan*
- *Kenya*
- *Kiribati*
- *Korea*
- *Kuwait*
- *Kyrgyz Republic*
- *Lao People's Dem.Rep*
- *Latvia*
- *Lebanon*
- *Lesotho*
- *Liberia*
- *Libya*
- *Lithuania*
- *Luxembourg*
- *Macedonia, Fyr*
- *Madagascar*
- *Malawi*
- *Malaysia*
- *Maldives*
- *Mali*
- *Malta*
- *Marshall Islands*
- *Mauritania*
- *Mauritius*
- *Mexico*
- *Micronesia, Fed.Sts.*
- *Moldova*
- *Mongolia*
- *Morocco*
- *Mozambique*
- *Myanmar*
- *Namibia*
- *Nepal*
- *Netherlands Antilles*
- *Nicaragua*
- *Niger*
- *Nigeria*
- *Oman*
- *Pakistan*
- *Palau*
- *Panama*
- *Papua New Guinea*
- *Paraguay*
- *Peru*
- *Philippines*
- *Poland*
- *Qatar*
- *Romania*
- *Russia*
- *Rwanda*
- *Samoa*
- *Sao Tome & Principe*
- *Saudi Arabia*
- *Senegal*
- *Seychelles*
- *Sierra Leone*
- *Singapore*
- *Slovak Republic*
- *Slovenia*
- *Solomon Islands*
- *Somalia*
- *South Africa*
- *Sri Lanka*
- *St. Kitts And Nevis*
- *St. Lucia*
- *St. Vincent & Grens.*
- *Sudan*
- *Suriname*
- *Swaziland*
- *Syrian Arab Republic*
- *Tajikistan*
- *Tanzania*
- *Thailand*
- *Togo*
- *Tonga*
- *Trinidad And Tobago*
- *Tunisia*
- *Turkey*
- *Turkmenistan*
- *Uganda*
- *Ukraine*
- *United Arab Emirates*
- *Uruguay*
- *Vanuatu*
- *Venezuela, Rep. Bol.*
- *Vietnam*
- *Yemen, Republic Of*
- *Zambia*
- *Zimbabwe*

Appendix B. De Facto Exchange Rate Regime Classification [18]

The de facto classification of exchange rate regimes used in this paper employ cluster analysis techniques to group countries according to the behavior of three variables related to exchange rate policy: (i) *Exchange rate volatility* (σe), measured as the average of the absolute monthly percentage changes in the nominal exchange rate relative to the relevant anchor currency (or basket of currencies, whenever the currency weights are disclosed) over the year; (ii) *Volatility of exchange rate changes* ($\sigma_{\Delta e}$), measured as the standard deviation of the monthly percentage changes in the exchange rate; and (iii) *Volatility of reserves* (σr), measured as the average of the absolute monthly change in dollar denominated international reserves relative to the dollar value of the monetary base in the previous month.

These variables are computed on an annual basis, so that each country-year observation represents a point in the (σe, $\sigma_{\Delta e}$, σr) space. In this space, floats are associated with little intervention in the exchange rate market (low volatility of reserves) together with high volatility of exchange rates. Observations with little or no exchange rate volatility and substantial reserves volatility correspond to the group of fixes. Finally, intermediate regimes are associated with moderate to high volatility across all variables, reflecting exchange rate movements in spite of active intervention. Observations are grouped by proximity using cluster analysis according to the characteristics previously identified.[19]

[18] Based on Levy Yeyati and Sturzenegger (2002).

[19] Those that do not display significant variability in either dimension are judged “inconclusives,” and left unclassified.