Uncertainty, Exchange Rate Regimes, and National Price Levels*

Christian Broda

Abstract

Large differences in national price levels exist across countries. In this paper, I develop a general equilibrium model predicting that these differences should be related to countries' exchange rate regimes. My empirical findings confirm that countries with fixed exchange rate regimes have higher national price levels than countries with flexible regimes. At the disaggregate level, the relationship between exchange rate regimes and national price levels is stronger for nontraded goods than for traded goods. I also find that measuring the misalignment in national price levels around times of regime shifts without considering a break in its equilibrium value results in the overestimation of the true misalignment.

JEL Classification: E52, F33, and F41

*The views expressed in this paper do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. I would like to thank Rudi Dornbusch, Jaume Ventura, Roberto Rigobon, Paolo Pesenti, Kei-Mu Yi, Cedric Tille, Lucas Llach, John Romalis and Roberto Benelli for their helpful comments and discussions. I also benefitted from the comments of seminar participants at MIT, NYU, and the Federal Reserve Bank of New York. Rachel Polimeni provided excellent research assistance. E-mail: Christian.Broda@ny.frb.org

I Introduction

The national price level of a country is defined as the ratio of the purchasing-power parity of the country's currency to its foreign-exchange rate.[1] As shown in Figure I, the national price levels of countries with similar levels of income are considerably different. For instance, the price level of Panama in 1990 was 60 percent that of the US while Colombia's price level was less than 30 percent that of the US. This difference cannot be explained by the conventional Balassa-Samuelson effect or the Kravis-Lipsey-Bhagwati hypothesis because Panama and Colombia had similar income levels in 1990.[2]

This paper provides an explanation for the observed large dispersion across price levels within income groups observed in the data. It shows that the equilibrium national price level of a country depends on its exchange rate regime. In particular, countries with fixed exchange rate regimes (grey-squared markers in Figure I) like Panama should have higher national price levels relative to countries with flexible regimes (black-triangular markers) like Colombia. The paper documents the strong relationship between price levels and exchange rate regimes during the post-Bretton Woods era for a sample of developed and developing countries.

One of the most important insights of the stochastic general equilibrium model pioneered by Obstfeld and Rogoff [2000a] and Corsetti and Pesenti [2001b] is that the price-setting behavior of agents is affected by the response of the monetary authority to real shocks. The response of the monetary authority, in turn, is constrained by the choice of exchange rate regime. As a result, this setup predicts that national price levels across countries should differ depending on the exchange rate regime adopted by each country. The intuition behind this result is the following: in countries with no exchange rate flexibility, the monetary authority is unable to accomodate productivity and world preference shocks to avoid employment variation. In a world with sticky wages (as in Obstfeld and Rogoff [2000a]), workers in countries with pegged regimes require a wage premium relative to workers under flexible regimes

[1] This terminology is taken from the empirical literature started by Balassa [1964] and Kravis and Lipsey [1983], and continued by Clague [1985], Heston and Summers [1984, 1991 and 1996] and Roger [2000] among others.

[2] Balassa [1964] and Samuelson [1964] argue that high-income countries are associated with a larger productivity difference between tradable and non-tradable goods than low-income countries. Kravis and Lipsey [1983] and Bhagwati [1984] suggest low-income countries have a higher labor intensity of non-tradable goods and relatively cheaper labor than rich countries. Both explanations imply a strong (positive) relation between national price levels and income levels.

to be compensated for the larger employment variations.[3] [4] Higher wages, in turn, drive domestic prices up. In a world with sticky prices (as in Corsetti and Pesenti [2001b] and Devereux and Engel [2000]), producers in pegs set higher prices than producers in floats for the same reason. Under both setups, equilibrium national price levels are predicted to be higher in countries with fixed regimes.

Despite the recent boom of theoretical work with this setup, there has been no attempt to test these predictions of the model in the data. The findings of this paper suggest that differences in the national price levels of countries with distinct exchange rate regimes are striking. For low and medium income countries, pegs have national price levels that are approximately 20 percent higher than floats. This cross-sectional difference is highly significant during most of the period between 1980 and 1996. For high-income countries, the relationship between exchange rate regimes and price levels is smaller and less significant. The model suggests that a weaker relationship for developed countries is consistent with a larger degree of local-currency pricing in developed countries relative to developing countries.[5] This pattern is robust to the following considerations: a) the inclusion of the controls that are commonly applied in the literature on the Balassa-Samuelson hypothesis, b) different price definitions and aggregation methods, and c) different exchange rate classifications. In particular, I explicitly abstain from using data for national price levels around times of regime shifts because short-run considerations are not the focus of the model presented.[6]

The strong exchange rate regime-price level relationship is also present at the disaggregate level. In accordance with the predictions of the model, price differences across regimes are larger for non-traded goods than for traded goods. For a selected sample of goods where the non-traded component is clearer, the effect of the exchange rate regime on the price level is highly significant for the selected non-traded goods, and insignificant for the selected traded goods. In particular, the regime-price

[3] There has been research related to temporary layoffs and compensating wage differentials in other fields. For instance, Abowd and Ashenfelter [1985] derive and test a model where the competitive wage includes a risk compensation proportional to the size of the employment variation in different industries.

[4] In the model presented in section 2, part of the price premium is independant of risk aversion. I thank Cedric Tille for this insight.

[5] Engel and Rogers [1996] and Parsley and Wei [1996] present evidence suggesting that indeed local currency pricing is more prevalent in developed countries.

[6] These considerations are the focus of the literature on inflation stabilizations and currency crisis. Throughout most of the empirical analysis I exclude country-year pairs that do not have constant exchange rate regimes during a 5-year interval.

relationship is more significant for those goods with a stronger Balassa-Samuelson effect. Finally, time-series evidence suggests that the countries that adopted more flexible regimes after Bretton Woods had larger falls in their average price level than those that adopted less flexible regimes.

A simple calibration of the model suggests that roughly 40 percent of the difference between regimes can be explained by the model.[7] Since the national price level of a country and its real exchange rate are closely related, this result has stark implications for the empirical literature on real exchange rate misalignment.[8] Real exchange rates are often characterized as overvalued or undervalued. This assessment depends on a notion of an equilibrium level of the real exchange rate. In the empirical literature, the equilibrium real exchange rate is usually measured as the trend of the real exchange rate series with no break between regimes. The findings of this paper suggest that measuring the misalignment in national price levels (or real exchange rates) in this way results in the overestimation of the true misalignment.

The results in this paper relate to the previous empirical literature on exchange rates in three ways. First, most of the empirical research on exchange rate regimes in recent decades has been guided by the predictions of the Mundell-Fleming-Dornbusch setup. Consequently, comparisons across regimes have focused on changes or volatilities of price and quantity variables, and not on the *levels* of these variables, as this paper does. Second, the results of this paper add to a growing body of evidence that suggests that the type of exchange rate regime may have a more important role in less developed countries than in developed countries. For developed countries, the results of this paper are in line with the main findings of Baxter and Stockman [1989] and Flood and Rose [1995], who find little evidence of systematic differences in the behavior of most macroeconomic aggregates which also holds for national price levels.[9] By contrast, for developing countries, this paper finds significant differences across regimes, as do Ghosh et al. [1997], Levy Yeyati and Sturzenegger [2001], and Broda [2001]. Finally, the analysis of this paper confirms some, but not all of the previous results of the literature on deviations from absolute purchasing power parity. In particular, the systematic tendency for poor countries to have relatively low national price levels, first suggested by Balassa

[7]This number varies from 10 percent to 65 percent depending on the degree of risk aversion to fluctuations in employment.

[8]See for example: Goldfajn and Valdes [2001], Berg and Patillo [1998], Williamson [1994] and the papers therein.

[9]As first noted in Mussa [1986], a notable exception is the volatility of the real exchange rate.

[1964], receives ample support from the data. Within income groups, however, the relationship between prices and income levels is weaker than that between prices and exchange rate regimes.

The paper is organized as follows. Section 2 develops a one-period general equilibrium model of an open economy faced with uncertainty and sticky prices. Section 3 discusses the data used and presents some descriptive statistics. Section 4 presents the empirical results of the paper. Section 5 presents a simple calibration of the model, and section 6 summarizes the main contributions of the paper.

II The model

A Preferences and Technology

The analysis assumes a continuum of consumer-workers, referred to as households, indexed by $j \in [0,1]$ in the Home country and $j^* \in [0,1]$ in the Foreign country. The utility function of Home agent j is:

$$U(j) = \ln C(j) + \ln \frac{M(j)}{P} - \frac{\kappa}{v} L(j)^v , \tag{1}$$

where utility is increasing in the consumption index $C(j)$ and real balances $\frac{M(j)}{P}$, and decreasing in labor effort $L(j)$. Foreign agents have symmetric preferences (Foreign variables appear starred). The specification assumed is restrictive in many ways but allows the model to be solved in closed form solutions. Under a similar specification, Corsetti and Pesenti [2001a] have shown that a multi-period model has no dynamics.[10]

The world economy has traded and non-traded goods. Each country is specialized in one type of traded good which will be denoted by H for the Home country and F for the Foreign country. Within a country, goods are produced in a number of brands indexed by $h \in [0,1]$ in the Home country for type H ($f \in [0,1]$ in the Foreign country for type F) and $n \in [0,1]$ for non-traded goods (type N). Households consume all brands of the three types of goods. $c(i,j)$ stands for consumption of brand i (type I) by agent j, where $i = h, f$ or n, and $I = H, F$ or N. Each brand is

[10] Other studies that use more general functional forms are also static. Obstfeld and Rogoff [2000a,b] explicitly consider a static model, and Engel and Devereux [1998] and Tille [2002] consider a complete-market setup which also implies that multi-period versions have no dynamics.

an imperfect substitute to all other brands, with constant elasticity of substitution $\theta > 1$. Consumption of Foreign households is similarly defined. For each agent j in the Home country, the consumption for type I is defined as:

$$C_I(j) = \left[\int_0^1 c(i,j)^{\frac{\theta-1}{\theta}}\, di\right]^{\frac{\theta}{\theta-1}} \tag{2}$$

The aggregate consumption indexes for the home and foreign agent are given by,

$$\begin{aligned} C(j) &= C_N(j)^{\eta}\left[C_H(j)^{\gamma} C_F(j)^{1-\gamma}\right]^{1-\eta} \\ C^*(j) &= C_N^*(j)^{\eta}\left[C_H^*(j)^{\gamma} C_F^*(j)^{1-\gamma}\right]^{1-\eta} \end{aligned}$$

where $\gamma \,\epsilon\, (0,1)$ and $\eta \,\epsilon\, (0,1)$ are identical across countries. The share of world income spent in the home traded good, that is γ, is assumed stochastic. $\gamma - shocks$ represent changes in world preferences and can be interpreted as terms-of-trade shocks. A rise in γ shifts world demand from the foreign traded good towards the home traded good. A similar type of shock has been used in Stockman and Tesar [1995], Devereux [2001] and Ventura [2002].

Similarly, $p(i)$ denotes the price of type I brand i in the Home country. The price index for each type of good is:

$$P_I = \left[\int_0^1 p(i)^{1-\theta}\, di\right]^{\frac{1}{1-\theta}}$$

The utility-based consumer price index, in turn, is defined as:

$$P = \frac{1}{\overline{\eta}} P_N^{\eta} P_T^{1-\eta}, \quad P^* = \frac{1}{\overline{\eta}} (P_N^*)^{\eta} (P_T^*)^{1-\eta} \tag{3}$$

where $\overline{\eta} = \eta^{\eta}(1-\eta)^{1-\eta}$ and the price index for tradable consumption is:

$$P_T = \frac{1}{\overline{\gamma}} P_H^{\gamma} P_F^{1-\gamma}, \quad P_T^* = \frac{1}{\overline{\gamma}} (P_H^*)^{\gamma} (P_F^*)^{1-\gamma} \tag{4}$$

where $\overline{\gamma} = \gamma^{\gamma}(1-\gamma)^{(1-\gamma)}$.

Home households face the following aggregate budget constraint:

$$\begin{aligned} & M(j) + P_H C_H(j) + P_F C_F(j) + P_N C_N(j) \\ = \; & M_0 + R(j) - T(j) \end{aligned} \tag{5}$$

where R is the revenue agent j receives from the sale of the goods he produces, M_0 is the initial money holdings, and $T(j)$ denotes lump-sum taxes. The government budget constraint in the Home country is

$$\int_0^1 (M(j) - M_0)\, dj + \int_0^1 T(j)\, dj = 0.$$

Each agent produces one brand of type H and one brand of type N. Sales revenues from brands h and n for agent j are given by,

$$R(j) = p(h) \int_0^1 C(h,j)\, dj + \varepsilon p^*(h) \int_0^1 C(h,j^*)\, dj^* + p(n) \int_0^1 C(n,j)\, dj. \tag{6}$$

where the consumers' optimal demands are given by,

$$C(h,j) = \left(\frac{p(h)}{P_H}\right)^{-\theta} C_H \tag{7}$$

$$C(n,j) = \left(\frac{p(n)}{P_N}\right)^{-\theta} C_N. \tag{8}$$

Technology is linear in household labor L in both sectors. Brand h is sold in both countries and brand n is only sold within each country. The resource contraints for brand h and n (produced by the same agent j) are:

$$\begin{aligned} AL(h,j) &= \int_0^1 C(h,j)\, dj + \int_0^1 C^*(h,j^*)\, dj^* \\ AL(n,j) &= \int_0^1 C(n,j)\, dj, \end{aligned} \tag{9}$$

where A is a stochastic labor productivity term and identical across sectors.[11] Total labor effort by each household j is given by, $L(j) = L(h,j) + L(n,j)$.

B Optimal Price Setting

It is assumed that agents set the price of their product before the start of the period without knowing the state of the world (i.e., (γ, A)). After the uncertainty is revealed, producers meet the demand they face at the preset prices.[12] The optimal

[11] Note that productivity shocks are modeled as country-specific shocks. See Tille (2002) and Canzoneri, Cumby and Diba (2001) for models that allow for sector-specific shocks.

[12] The same qualitative results are obtained in a setup were wages, instead of prices, are preset. See Obstfeld and Rogoff (2000a) or Benigno (2002) for examples.

pricing in the Home Country can be derived from the maximization of (1) in expected terms with respect to $p(h)$ and $p(n)$ subject to (5), (9), and the consumers' optimal demands. Rearranging the first order condition of this problem, we obtain the following expressions for the price of brands n and h:

$$p(n) = \frac{1}{\Phi} E_{-1}\left(A^{-1} M L^{v-1}\right) \tag{10}$$

$$p(h) = \frac{1}{\Phi} \frac{E_{-1}\left(\gamma A^{-1} M L^{v-1}\right)}{E_{-1}(\gamma)} \tag{11}$$

where E_{-1} stands for the expectation taken before the start of the period, and $\Phi = \frac{\theta-1}{\theta\kappa}$. That is, Home firms set optimal prices equal to a markup, $\frac{1}{\Phi}$, over the expected nominal marginal cost of types N and H, $E_{-1}\left(A^{-1}ML^{v-1}\right)$ and $E_{-1}(\gamma)^{-1} E_{-1}\left(\gamma A^{-v} M L^{v-1}\right)$, respectively. This marginal cost, in turn, depends on the productivity shock, world preference shock, equilibrium employment, and the monetary policy stance. Thus, equation (10) provides a direct relationship between the price level and uncertainty that was not captured by other types of models.

The Foreign country has an analogous expression for $p^*(f)$ and $p^*(n)$. It is also assumed that there are no deviations from the law of one price. That is,

$$p(f) = \varepsilon p^*(f), \qquad p^*(h) = \frac{1}{\varepsilon} p(h). \tag{12}$$

In the next section, the possibility of local currency pricing will be discussed.

C Equilibrium

The equilibrium allocation of the model can be expressed in closed form for all the endogenous variables. All variables are expressed as functions of real shocks (A, A^*), world preference shocks, γ, and Home and Foreign monetary stances (M, M^*). I focus here on the positive implications of the model with respect to the pricing behavior of agents under different exchange rate regimes.[13]

The balanced trade condition implies that the equilibrium exchange rate is given

[13] A similar positive approach has been taken by Baccheta and van Wincoop [2000]. They examine whether fixed exchange rate regimes induce more trade of goods and capital flows. For welfare comparisons across exchange rate regimes in models with nominal rigidities see Obstfeld and Rogoff [2000a], Corsetti and Pesenti [2001b], Tille [2002] among others.

by the following expression:

$$\varepsilon = \frac{1-\gamma}{\gamma}\frac{M}{M^*}. \tag{13}$$

A shift in preferences towards home goods requires an appreciation of the exchange rate to maintain the trade balance. An expansionary monetary policy in Home, in turn, depreciates the local currency relative to the foreign money.

Combining the resource constraint (9), the trade balance condition (13), and price setting conditions (10) and (11), we can obtain the equilibrium price for domestic goods (assuming symmetry):

$$P_H = \frac{1}{\Phi^{v^{-1}}}\left[\eta f(\gamma, A, M) + (1-\eta)\right]^{(v-1)v^{-1}}\left[\frac{E_{-1}(\gamma A^{-v}M^{v})}{E_{-1}(\gamma)}\right]^{v^{-1}} \tag{14}$$

$$P_N = \frac{1}{\Phi^{v^{-1}}}\left[\eta + \frac{(1-\eta)}{f(\gamma, A, M)}\right]^{(v-1)v^{-1}}\left[E_{-1}\left(A^{-v}M^{v}\right)\right]^{v^{-1}} \tag{15}$$

where the function f is given by,

$$f(\gamma, A, M) = \frac{E(\gamma A^{-v}M^{v})}{E(\gamma)\,E(A^{-v}M^{-v})}.$$

Note that the average ex-ante marginal cost depends on the comovement between shocks and monetary policy. This relationship underlies the main hypothesis to be tested in the next section. The following remark is key to understand the effects of monetary policy on the price setting behavior of agents.

Remark 1 *$E_{-1}\left(\gamma A^{-1}M\right)$ is increasing in $Cov\left(A_t^{-1}, M_t\right)$ and $Cov(\gamma, M_t)$. Therefore, $E_{-1}\left(\gamma A^{-1}M\right)$ falls the more pro-cyclical is the monetary policy response to $A-$shocks, and the less pro-cyclical is the monetary policy response to $\gamma-$shocks.*

Condition (14) and (15) are expressed without defining an explicit monetary behavior. I turn next to the relation between monetary policies and exchange rate regimes. It is apparent from equation (13) that, for a given M^*, a fixed exchange rate regime requires no monetary response to $A - shocks$ and a pro-cyclical monetary policy in response to $\gamma - shocks$ to prevent ε from moving. A flexible regime, however, can freely change its monetary policy regardless of the shocks. I characterize the optimal float as a benchmark case, and then define different levels of exchange rate flexibility in terms of monetary policies.

As is common in this literature the optimal float is able to replicate the constraint efficient equilibrium achieved under price flexibility. The optimal monetary policy can be obtained by comparing the equilibrium level of employment with and without price rigidity. Equation (16) shows the equilibrium level of employment in the presence of sticky prices,[14]

$$L = \Phi^{v^{-1}} A^{-1} M \left[\frac{\eta}{E_{-1}\left(A^{-v} M^{v}\right)} + \frac{(1-\eta) E_{-1}(\gamma)}{E_{-1}\left(\gamma A^{-v} M^{v}\right)} \right]^{v^{-1}} . \tag{16}$$

The main difference between the flexible-price solution of the model and the sticky-price solution is that under flexible prices all equilibrium conditions hold in any state of nature, not in expectation. It then becomes apparent from condition (16) that in the flexible-price case, the equilibrium employment level is constant at $\Phi^{v^{-1}}$. The optimal monetary policy (OF) under sticky prices can be defined as:[15]

$$M_{OF} = M_0 \frac{A}{E(A)}$$

That is, the optimal float does not respond to $\gamma - shocks$ and adopts a procyclical monetary policy when responding to $A - shocks$ that completely stabilizes employment. In other words, the equilibrium employment level is constant under an optimal float but fluctuates under any other less than fully-accomodating regime.

In the empirical section of the model, countries with different degrees of exchange rate flexibility are considered. Therefore, it is useful to derive the testable implications in terms of regimes with different degrees of flexibility. For this purpose I define an index $R \,\epsilon\, [0,1]$ that reflects the degree of exchange rate flexibility of the regime. A higher R implies a higher degree of exchange rate flexibility. A monetary policy consistent with a degree R of exchange rate flexibility is defined as:

$$M_R = M_0 \left(\frac{A}{E(A)} \right)^{R} \left(\frac{\gamma}{E(\gamma)} \right)^{1-R} . \tag{17}$$

In particular, note that $R = 0$ implies a fixed exchange rate regime, and $R = 1$ implies a fully accomodating (optimal) float.

[14] The equilbrium allocation is fully characterized in the appendix.

[15] As noted by Woodford [2000] and Corsetti and Pesenti [2002], the optimal monetary rules do not provide a nominal anchor to pin down nominal expectations. Since I am interested in the difference between two regimes, the nominal anchor problem turns out to be irrelevant.

D National Price Levels and Exchange Rate Regimes

This section compares the national price levels between Home countries with different degrees of exchange rate flexibility that face a common behavior by the Foreign country.[16] The main predictions of the paper result from combining condition (14) with the monetary policy consistent with exchange rate regime R, that is, (17). Before stating the main propositions, I discuss the distribution of the shocks and define national price levels.

Productivity shocks and world preference shocks are assumed to have the following distribution:[17]

$$\begin{pmatrix} \log A \\ \log \gamma \end{pmatrix} \sim N \begin{pmatrix} \mu_a & \sigma_a^2 & 0 \\ \mu_\gamma & 0 & \sigma_\gamma^2 \end{pmatrix}.$$

Definition 1 The aggregate and disaggregate national price levels (NPL) of a country are defined as the domestic price level expressed in foreign currency, namely:

$$NPL = \frac{P}{\varepsilon}; \quad NPL_N = \frac{P_N}{\varepsilon}; \quad NPL_T = \frac{P_T}{\varepsilon}$$

The following proposition states the main hypothesis to be tested in the next section.

Proposition 1 *The average National Price Level of a country decreases as its degree of exchange rate flexibility, R, increases. That is,*

$$\frac{dE \log NPL_R}{dR} < 0$$

Proof of Proposition 1. See the appendix for a technical proof. For a sketch

[16] This assumption stems from the fact that in the data any individual peg or float faces the same "rest of the world". For consistency, assume that $M^* = (1-\gamma)$. Thus, as stated above, an $R = 0$ is indeed a fixed exchange rate. If the foreign country were to respond to shocks A^*, (17) would have to be changed for $R = 0$ to imply a fixed exchange rate. The qualitative results that follow, however, would be unchanged.

[17] For simplicity, A and A^* are assumed uncorrelated (no global shocks). In the case with global shocks, the simultaneous increase of A and A^* can be accomodated even by a fixed exchange rate regime. Results are qualitatively unchanged without this restriction.

of the proof, note that from (3), (4), and the definition of NPL, we obtain:

$$\begin{aligned} E \log NPL_R &= \eta\left(E \log P_{NR} - E \log \varepsilon_R\right) + (1-\eta)\, E\gamma(\log P_{HR} - \log \varepsilon_R) \\ &\quad + (1-\eta)\left(1 - E\gamma \log P_F^*\right) \end{aligned}$$

It follows from Remark 1 that P_{HR} falls as R increases. It can be shown that P_{NR} also falls with R. Since the behavior of M^* is assumed common for different Rs of the Home country, P_F^* is independant of R. The effect of R on the nominal exchange rate depends on the relative variance of the shocks, but the magnitude of the effect is always dominated by the price effects. ■

The intuition behind this result is the following. First take the case of productivity shocks only. With a passive monetary policy (ie., low R as in pegs), employment fluctuates with productivity shocks, rising when productivity is low and falling when it is high. In other words, employment is high (low) when marginal costs are also high (low). When monetary policy is pro-cyclical (ie., high R as in floats), however, employment fluctuations are dampened. The smaller comovement between employment and productivity implies that the average ex-ante marginal cost is also smaller because labor effort is relatively higher (lower) when marginal costs are low (high). The smaller average ex-ante marginal cost, in turn, results in lower equilibrium preset prices in countries with a more accomodative monetary policy or, in other words, in countries with more flexible exchange rate regimes. Moreover, the incentive to increase preset prices (denominator of (10)) is higher the more consumers dislike employment variation (ie., the higher is v). Therefore, the higher is v, the larger is the difference in price levels across regimes.

The monetary policy response of different regimes to world preference shocks to the domestic good is different from the response to productivity shocks. The trade balance condition requires a fixed exchange rate regime to have a pro-cyclical monetary policy that induces employment variation in equilibrium. This undesired variation, in turn, generates a similar increase in the average marginal cost as in the case of productivity shocks. A flexible regime, however, can avoid the expansion in monetary policy when γ rises, by letting the exchange rate appreciate.

The next proposition provides two additional predictions of the model that will be tested in the next section using disaggregate data.

Proposition 2 *a) Both traded and non-traded national price levels fall as the degree* *of exchange rate flexibility raises. That is,*

$$\max\left(\frac{dE\log NPL_{TR}}{dR},\frac{dE\log NPL_{NR}}{dR}\right)\leq 0.$$

and b) for low values of $E\gamma$*,*[18] *the difference in national price levels between pegs and floats is larger for non-traded goods than for traded goods. In other words,*

$$\left|\frac{dE\log NPL_{NR}}{dR}\right|>\left|\frac{dE\log NPL_{TR}}{dR}\right|$$

Proof of Proposition 2. Part a) follows from remark 1. The intuition for part b) is the following: despite the fact that the price of home goods fall faster than th price of non-traded goods when R increases, the price of home goods is only a fraction γ of the traded goods price index. The rest is independent of R. Thus, for low values of $E\gamma$ the rate at which NPL falls is larger for N than for T. See the appendix for a technical proof. ■

The model presented in the previous sub-sections assumes producer currency prices (PCP). Betts and Devereux [2000] show that, when deviations of the law of one price are accounted for, the pricing of exported goods will differ. To illustrate this point, I adopt the simple pricing function used in Corsetti and Pesenti [2001b]. Equation (12) is replaced by,

$$p_t(f)=\varepsilon_t^{\omega}\widetilde{p}_t(f), \qquad p_t^*(h)=\frac{\widetilde{p}_t(h)}{\varepsilon_t^{\omega^*}},$$

where ω^* (ω) denotes the degree of pass-through in the Foreign country (Home country).[19] The prices with tildes stand for the predetermined component of prices that cannot be adjusted to variations of the exchange rate during t. If $\omega=1$ we are back to the PCP case examined in (12). If $\omega=0$, the Home producer fixes foreign prices in foreign currencies (also known as local currency pricing, LCP). For simplicity, assume that $v=1$ and γ is deterministic. As shown in the appendix, the equilibrium price for Home imports, P_F, becomes

$$P_F=\frac{1}{\Phi^*}\frac{1-\gamma}{\gamma}\left(\frac{M}{M^*}\right)^{\omega}E_{-1}\left((A^*)^{-1}(M^*)^{\omega}M^{1-\omega}\right). \tag{18}$$

[18] *The exact condition is presented in the appendix.*

[19] See Devereux and Engel [2001] for a model where the level of pass-through ω is endogenously determined.

Note that in the case of less than complete pass-through ($\omega < 1$), an accomodating foreign monetary policy will raise the domestic price of Foreign goods relative to the producer currency pricing case ($\omega = 1$). This is the basis for the next proposition.

Proposition 3 *For a given R, the lower is pass-through in domestic markets* (ω)*, the lower is* $\frac{d \log NPL_{TR}}{dR}$*,that is,*

$$\frac{d^2 E \log NPL_{TR}}{dR d\omega} > 0$$

Proof of Proposition 3. See appendix for proof. ■

As discussed in Corsetti and Pesenti [2001b], profits are a concave function of the nominal exchange rate, and increasing prices is a way to reduce the sensitivity of profits to exchange rate variability. This implies that more flexible regimes (higher R) will have higher price levels the lower is the pass-through coefficient ω. As discussed in Devereux and Engel [2000], there seems to be more widespread evidence of local currency pricing in developed countries than in small open economies. Therefore, this last proposition suggests that differences in price levels of traded goods between regimes may be smaller in developed countries relative to developing countries. We turn next to the empirical section.

III Data and Preliminary Diagnostics

The price data used in this paper comes from the Penn World Tables (PWT) Mark 5.6 and the World Development Indicators (WDI). Both databases use the survey on prices provided by the International Comparison Programme (ICP, United Nations). In this survey, prices of different goods and services (standardized with respect to quality) are collected for a selected number of countries (beginning with 60 in 1975 and increasing to 90 in 1990) at five-year intervals (the so-called benchmark years). Drawing on this sample of prices, both sources construct purchasing power parity (PPP) indexes for each country relative to the United States, defining a country's national price level as the PPP index of that country divided by it's foreign exchange rate. PWT calculates national price levels for country i as:

$$NPL_i^{PWT} = \frac{\sum_j w_j \frac{p_j^i}{p_j^{US}}}{e_{i\ us}}$$

where j are all goods available in the ICP survey, w_j are the weights used in the PWT index, and $e_{i\ us}$ is the exchange rate between the country i's currency and the US dollar. A similar equation is used in the WDI case. However, the PWT and WDI differ in the techniques they use to compute weights, and they rely on different methods to extrapolate the data for those countries and years not included in the benchmark surveys.[20] Data for more than 120 countries during the period between 1975 and 1998 are used in the regression analysis below (see Table A-I in the appendix).

Despite the explicit effort to make the two sets comparable, significant differences between the PWT and WDI data remain. As an illustration of these differences, Table A-II in the appendix shows the price levels for the two sources in 1990 (a benchmark year). In particular, differences are pronounced for low and medium income countries, with correlations between the price levels of the different sources being around 0.36 and 0.65 respectively. For high-income countries, however, differences are smaller. In addition, Mark 5.6 version of PWT provides data through 1992, while WDI data is available until 1998.

I use two different exchange rate classifications in the empirical analysis that follows. A de jure classification of exchange rate regimes is provided in the International Monetary Fund's Annual Report on Exchange Arrangements, and Exchange Restrictions and a de-facto classification is provided in Levy Yeyati and Sturzenegger [2000]. The IMF classification consists of ten categories (1 to 10), broadly grouped into pegs (1 to 4), arrangements with limited flexibility (5), and "more flexible arrangements," which include managed and pure floats (6 to 10). This classification captures the formal commitment to a regime, but it fails to capture whether the actual policies were consistent with this commitment. For example, de jure pegs can pursue policies inconsistent with their stated regime and require frequent changes in the nominal exchange rate, making the degree of commitment embedded in the peg in fact similar to a float. In the case of floats, fear of floating can induce a central bank to subordinate its monetary policy to eliminate fluctuations in the exchange rate, rendering a de jure float equivalent to a de-facto peg. These problems can potentially be solved if the classification are based on the observed behavior of the exchange rate. The available data for 1990 is summarized in Table A-I. In that year,

[20] For a complete description of the ICP survey see the Handbook of the International Comparison Programme [2000]. For detailed description of the method used by the World Bank see World Development Indicators [2000]. See Summers and Heston [1991] for the methodology used in the Penn World Tables.

roughly half the countries with de-facto fixed regimes were also classified as pegs by the IMF classification, and three out of four countries with de-facto flexible regimes had the same de jure classification.[21]

Figure I presents a summary of the PWT and IMF data in the year 1990 and a preview of what is to come in the next section. It shows price level (PWT) versus income relationships for 81 countries separated by level of per capita GDP. The exchange rate regime (IMF) is depicted by the shape and color of the data points. Countries are included only if their exchange rate regime remained constant from 1988 to 1992.[22]

On first consideration, the charts show that fixed regimes (grey points) have higher price levels than flexible regimes (black points). For instance, in the chart for low-income countries, the average price level in countries with fixed regimes is 50.9 percent of the U.S. level, while in less rigid regimes the level is 35.4 percent of that of the U.S. price level. The percentage difference is around 30 percent. In the chart for medium-income countries the difference across regimes is around 25 percent. For high-income countries, however, this difference is less evident. In short, Figure I provides preliminary evidence of a strong positive relationship between exchange rate rigidity and national price levels, which is investigated further in the next section.

IV Empirical Method and Results

The basic cross-country specification used is:

$$NPL_j = \alpha + \beta y_j + \gamma ER_j + \Lambda X_j + e_j, \tag{19}$$

where NPL_j is the national price level of country j relative to the U.S. ($NPL_{US} = 100$), y_j is the real per capita GDP of country j, and

$$X_j = \left\{ \overset{+}{GC}, \overset{+}{OPEN}, \overset{-}{OPEN} \times y, \overset{+/-}{\frac{p_X}{p_M}}, \overset{-}{CA\_y} \right\}$$

[21] For a detailed comparison of the IMF classification and a de-facto classification, see Levy Yeyati and Sturzenegger [2000].

[22] The reasons for this restriction will be explained in the next section.

is a matrix of control variables suggested by previous theoretical work on national price levels. A key control variable in the analysis is the income level, y_j. Since Balassa [1964], Samuelson [1964], and Kravis and Lipsey [1983] (hereafter, BS-KL), a country's income level has been recognized as an important determinant of the national price level. These studies find that price levels tend to increase with the level of income. This relationship also receives ample support in the databases used in this paper.[23]

Other researchers have suggested potential determinants of the national price level. Froot and Rogoff [1995] suggest the importance of "demand" factors such as the level of government spending (GC), that fall disproportionally on non-tradable goods. Kravis and Lipsey [1987] argue that a high propensity to trade should pull a country's prices towards the world average $(OPEN \times y)$ and should increase the prices of non-tradables for a given income level $(OPEN)$.[24] De Gregorio and Wolf [1994] suggest that the effect of a terms of trade increase (i.e., a rise in the ratio between the price of exported goods to imported goods, $\frac{p_X}{p_M}$) on the price level depends on the degree of substitutatibility between goods. Finally Clague [1986] conjectures that in countries where spending is temporarily higher than income, price levels should be higher. Therefore, the current account as a share of GDP (CA_y) is included in X.

Before presenting the results, a crucial assumption regarding the treatment of countries that often change regimes needs to be explained. The model in section 2 compares stylized countries with permanent exchange rate regimes and ignores short-run effects that may arise from sudden regime shifts. In the data, however, such stylized comparisons are more difficult to find. To avoid the incidence of short-run effects, the basic regressions are constrained to observations with

$$ER_{jt-a} = ... = ER_{jt-1} = ER_{jt} = ER_{jt+1} = ... = ER_{jt+a} \tag{20}$$

where a is set equal to two for most regressions. Thus, I prevent results from being driven by flexible regimes that have recently become floats (e.g., currency crisis events) or pegs that have recently adopted fixed regimes to stabilize inflation (e.g.,

[23] Both Balassa and Samuelson, and Kravis and Lipsey suggest that the relationship between prices and income levels should be stonger for non-tradable goods than for tradable goods. This insight will be employed below.

[24] They argue that trade tends to raise the prices of relatively abundant factors. If poor countries tend to have abundant labor, and if non-tradables tend to be labor intensive, openness should result in higher prices once you control for the income level.

exchange-rate based stabilizations).[25] Table A-I shows the country-year pairs that satisfy this restriction between 1975 and 1996. A series of robustness checks are performed to determine the importance of the omitted short-run considerations.

It is illustrative to note that the effect of relaxing restriction (20) on the coefficient of the exchange rate regime (γ) is ambiguous. In the case of exchange-rate based stabilizations, inflation inertia usually tends to increase the national price level relative to the initial post-stabilization level. The latter, however, depends on the nominal exchange rate at which the exchange rate is fixed. This implies that the short-run effect introduced by including these cases is positive when the nominal exchange rate is initally set at a low value, and negative when it is set at a high value.

In the case of currency crisis events, a temporary exchange rate overshooting would result in low national price levels being associated with the post-crisis regimes. In the case where the post-crisis regime is a float, this would imply lower prices for floats, just as predicted in the model in section 2. For the events selected by Flood and Rose (1995) as currency crisis, only forty out of ninety-one of the events were classified as having flexible regimes one year after the crisis. Therefore, inasmuch as Flood and Rose's classification includes the relevant events, relaxing restriction (20) has an ambiguous effect on the relationship between prices and exchange rate regimes. Indeed, this is what the next section shows.

A Main Results

Table I shows the main results of the paper. The first two columns show the cross-country regression originally performed by Balassa [1964], including the IMF exchange rate regime variable for the year 1990.[26] For both price databases, the exchange rate regime variable is negative (the more flexible the regime, the smaller the price) and highly significant. The coefficient reveals that in an average country

[25] Several of the country-year pairs that are defined as currency crashes in Flood and Rose [1995] and exchange-rate stabilizations in Calvo and Vegh [1998] are not associated with changes in the regime classification, and therefore are not excluded by restriction (20). In these cases, the country-year pairs were explicitly excluded from the regressions. These cases (39 out of 103) appear with an (x) in Table A1. Twenty-four of those episodes were classified as pegs before, during and after the currency crisis by the IMF (half of which are African countries in 1981). The rest were floats throughout the crisis.

[26] The robustness of the main results for other years is presented in Figure 2. A similar table for the year 1985 is available upon request. These years were chosen because they are benchmark years for the International Comparison Programme.

with a flexible regime, the price level is around 10 to 12 points lower (US = 100) than one with a fixed regime with the same level of income.[27] Furthemore, regressions (5) to (8) confirm this result using the de-facto classification.[28] In this case, the differences between regimes are larger but less significant. Note, as well, that the BS-KL effect (β) is highly significant in all the regressions.

The inclusion of the control matrix does not change the results qualitatively. In the case of the PWT data, the government consumption variable is positive and significant, and reduces the significance of both the income and the exchange rate regime variables. Nonetheless, both variables remain highly significant. In general, the coefficient for the rest of the control variables are not significant. For the WDI data, the inclusion of the controls sharply reduces the effect of the income variable but the effect of the exchange rate regime variable stays relatively constant.

Figure II shows how the coefficient γ has changed through time. Figures A and B show the estimated γ for the regressions (4) and (8) in Table I between 1980 and 1996. The strong positive relationship between exchange rate rigidity and national price levels is present during most of the 1980s and 1990s. The coefficients are particularly significant during the late 80s and early 90s. I will comment below on the effect that strengthening and relaxing restriction (20) has on γ.

Table II answers two important questions: 1) is the relationship between regime and national price level present in all income groups? and 2) restriction (20) notwithstanding, are the results driven by short-run considerations? Columns (1)-(4) show a common answer to the first question. The exchange rate variable is negative in all three income groups, but it is significant only among low and medium-income countries. For low-income countries, the price level in countries with flexible regimes is around 9 points lower than in those with fixed regimes. Since the average price level for low-income countries is 44 (relative to US = 100), the difference is approximately 20 percent. For medium-income countries the difference ranges from 20 to 30 percent, and is highly significant, even more so than in low-income countries. For high-income countries, the difference, though negative, is less robust across specifications and, in general, is not significant. Notably, within income groups, the price-regime relationship is stronger than the traditional price-income relationship.

Several potential explanations can account for the differences observed between

[27] The average fix and flexible regime are defined as having ER_IMF equal to 2.5 and 7, respectively.

[28] Note that FLEX is a 0-1 dummy. This explains the difference in the magnitude of the coefficients in Table 1.

rich and poor countries. First, the empirical evidence on LCP suggests that Proposition 3 can help explain part of the differences between income groups. Devereux and Engel [2000] suggest that LCP is more widespread in developed countries than in developing countries. In this case, the model in section 2 predicts that differences in national price levels across regimes should indeed be smaller in developed than in developing countries. Second, actual real GDP volatility differences across regimes are smaller in rich countries than in poor countries. Baxter and Stockman [1989] find insignificant differences in industrial production volatility in OECD countries across exchange rate regimes. By contrast, Ghosh et al. [1997] find that employment fluctuations in developing countries are significantly larger in countries with fixed regimes than in those with flexible regimes. Broda [2001] examines a large set of developing countries and finds larger real GDP fluctuations following terms-of-trade shocks in pegs than in floats. The pattern of this evidence is consistent with finding significant results for developing countries but not for developed countries. Third, developed countries may have better institutions to cope with employment variations which make the threat of being unemployed smaller than in developing countries. This explanation would imply that a weaker relationship exists between the national price level and the exchange rate regime in rich countries relative to poor ones.

Columns (5) to (8) of Table II address the question of the role of short-term considerations in creating the observed differences. To reduce the effect of short-run factors even further, restriction (20) is strengthened to include 5 years before and after 1990 (i.e., $a = 5$). In other words, regressions (5) and (6) include only those countries that maintained the same regime from 1985 to 1995. A total of 44 countries satisfy this restriction and have PWT data (21 fixed, 3 intermediate and 20 flexible, listed in Table A-I in the appendix). In this sample, the positive relationship between exchange rate rigidity and price levels is significant at the 1 percent level.

Furthermore, columns (7) and (8) exploit the panel nature of the data by looking at the country-year pairs for which the exchange rate regime is constant during a 17-year interval within the period 1975-98 (i.e., $a = 8$). In the case where the same country is selected more than once (e.g., Denmark 1988 and 1989), only the mean of the observations is included. Since the world average national price level has fluctuated during the period studied, deviations from the annual mean price level are considered. Roughly half the countries in the sample meet this restriction at least once within the period under study. Within this sample, average pegs have significantly higher price levels than the average float. Overall, these results suggest that the differences obtained in Table I are also present in longer term comparisons and that, if anything, shorter term dynamics reduce the economic significance of these differences.

Moreover, the appendix includes the time-series of the γ coefficient when the regressions (4) and (8) from Table I are estimated without restriction (20), that is, without excluding the possible short-run effects of sudden regime shifts (i.e., $a = 0$).[29] In this case, γ is usually smaller but slightly more significant than when excluding the short-run considerations.[30] This further suggests that the main results are not being driven by short-run considerations.

B Disaggregate Results

The model presented in Section 2 suggests that the relationship between exchange rate regimes and national price levels is stronger for non-traded goods than for traded goods (Proposition 2). This section tests this proposition in several ways. First, it examines the relationship between prices and regimes using traded and non-traded national price indexes. It then examines the hypothesis for a set of selected traded and non-traded goods, and finally checks it at the level of the major GDP categories.

The traded and non-traded indexes are computed following Roger [2001]. As discussed in Burstein, Neves and Rebelo [2000], these indexes have several shortcomings. In particular, there is usually a high share of non-traded components present in goods usually classified as traded. Indeed, Burstein et al. find that this share amounts to 60% of the final good's price in Argentina and 40% in the United States. Despite these shortcomings, the comparison between columns (1) and (2) of Table III reveals that the relationship between national prices and the exchange rate regimes is stronger for non-traded than for traded goods. This provides strong evidence in support of part a) of Proposition 2. We discuss below additional evidence in support of this result.

Column (2) also shows that the relationship between prices and regimes is significantly different at the 5 percent level for the sample of traded goods. Two interpretations of this finding are possible. First, the result can be interpreted as

[29] See Figures A1 in the appendix.

[30] The number of observations generally increases by at least 25 percent when restriction (20) is relaxed.

evidence in favor of part b) of Proposition 2. However, an alternative interpretation suggests that the imprecise definition of traded goods implies that this finding is simply a confirmation of part a) rather than support for part b). In order to check which of the two interpretations is more likely the case, I pick a group of 15 goods for which the non-tradable component is expected to be especially small and perform regression (19) for the selected group, and for each good separately. If for this group of traded goods, the strong price-regime relationship (i.e., γ significant) is not present anymore, the second explanation is the more plausible one. Furthermore, as noted in Footnote 20, for this group of goods, a weaker BS-KL effect (β) is expected.

Both grouped and individual regressions suggest that the regime-price level relationship for the selected traded goods is weak. Column (3) in Table III show that the coefficient of the exchange rate regimes variable is not significant for the group of traded goods as a whole. Figure III shows the regime versus price level relationship (γ) for each individual traded good in the bottom-left quadrant and the income versus price level relationship (β) in the top-right quadrant (both appear as unlabeled round data points). All of the selected traded goods have insignificant γ coefficients. Reassuringly, for this same group of goods, the strong positive relationship between income and prices found in BS-KL is not present. These findings suggests that the significant results for the overall traded sample are more the result of an imprecise definition of traded goods than evidence in favor of part b) of Proposition 2.

Figure III also shows results for a selected group of non-traded goods (superimposed on the coefficients for traded goods (unlabeled)). Both β and γ coefficients have the correct sign and are highly significant. The differences between the selected group of tradable and non-tradable goods are striking. The unlabeled round data points (traded goods) are all concentrated near the (0,0) point, while the labeled squares (non-traded) are spread away from (0,0). This provides additional evidence supporting part b) of Proposition 2.

Dividing the price level into traded and non-traded goods uncovers different roles for the control variables. As expected, the government consumption variable, GC, is positive and significant only for non-tradable goods. Furthermore, Kravis and Lipsey [1987] suggest that prices of tradables should tend toward greater uniformity the larger the trade share and that, controlling for income, the price of non-tradable goods should be lower for more open countries. At the disaggregate level, the hypothesis that prices are pulled towards uniformity finds support, while the hypothesis that prices are lower among more open countries, does not. Openness tends to reduce the price of traded goods for rich countries and increase the price in poor countries ($OPEN\_y$). The price of non-tradable goods increases with openness, but the rise is not statistically significant. Surprisingly, this effect is significant for traded goods ($OPEN$). Finally, the terms of trade effect and the current account are not significant.

Figure IV decomposes the results in Table III according to the major categories of GDP. Two points are important to note. First, the figure shows that the large price differentials across regimes are mostly driven by six out of the twelve major categories. Government (GNT), medical care (MC) and food, beverages and tobacco (FBT) are among those with significant γs, while net exports (NX), home furnishing (HF) and rent, fuel and power (RFP) are not. Second, as mentioned above, the BS-KL effect is expected to be weaker the more tradable is the good. Therefore, the ranking between the signifcance of the βs and the γs can serve as an alternative test of part b) of Proposition 2. The figure shows that the ranking of significance of the β coefficient is similar to that of the γ coefficient, though not highly significant. The correlation between both rankings is around 0.68. This finding suggests that the price level-regime relationship is stronger the larger the non-tradable component found in these categories.

C Time Series Evidence

Most of the results presented above exploit the cross-country dimension of the databases. I now turn to the time series results, and compare national price levels within each country during and after the Bretton Woods era. In particular, I compute the difference between the average price level between 1960-1973 and 1974-1992 (dp) for each country.[31] In addition, I group the 116 countries for which pre-1973 PWT data is available in terms of their post Bretton Woods average exchange rate regime (av_ER) and perform the following regressions:[32]

$$dp_i = a_2 y_i + a_1 dy_i + a_3 av\_ER_i + \varepsilon_i$$

Table IV shows that among developing countries, those that adopted more flexible regimes after 1973 had the largest declines in their price levels, controlling for the change and level of their income. For instance, the average pre-Bretton Woods developing country had a price level of 60 percent of US level. If that country

[31] Bayoumi and Eichengreen [1994] and Baxter and Stockman [1989] also take a similar approach.
[32] The income variable y is measured relative to US (US=100).

adopted a fixed regime after 1973, it's average price level for the subsequent period, would be 58.9 percent of that in the US. If it adopted a flexible regime, its price level would be 52.6. As in the cross-section results, for the developed countries, the sign of the exchange rate variable is negative, but not significant.

V Misalignment or Mismeasurement?

In this section I calibrate the simple model presented in section 2 to assess whether the model can account for the magnitude of the empirical differences between national price levels with alternative regimes.

Table V shows the difference between the $\log NPL$ for a country with $R = 0.75, 0.5, 0.25$ and 0 relative to a country with $R = 1$. The last column shows the difference between a completely pegged regime and a fully accomodating float for different values of aversion to employment variability, v. For the case where $v = 1$, the difference in equilibrium $NPLs$ across regimes is 2 percent. This difference raises monotonically as v increases and reaches almost 15 percent when $v = 5$. As expected, the higher is R, the smaller the difference in $NPLs$ between regimes. This table suggests that for different values of v, the simple model can account for between 10 percent to 65 percent of the observed differences in NPLs between regimes in developing countries.

As discussed above, the empirical section of this paper explicitly abstains from considering national price levels around times of regime shifts. However, these short run considerations are the focus of a vast empirical literature that studies the behavior of the real exchange rate.[33] Given the close relationship between national price levels and real exchange rates, the findings of this paper can be related to this literature. Table IV can be interpreted as reflecting the difference in the equilbrium NPL that should be expected when comparing two countries with different exchange rate regimes. In the aforementioned empirical literature, however, the equilibrium real exchange rate is usually measured as the low frequency component of the real exchange rate series with no break between regimes. Hence, the findings of this paper suggest that a large proportion of what is usually dubbed as overvaluation or undervaluation can be accounted for by the mismeasurement of the equilibrium national price level (or real exchange rate).

[33] For instance, this literature includes papers like Goldfajn and Valdes [2001] and Berg and Patillo [1998] among others that attempt to predict currency crisis.

Figure VI presents a graphical illustration of the potential mismeasurement of the misalignment. The figure shows an example of an episode of a change in exchange rate regime. The actual NPL under a float is smaller than under a peg (as section 4 suggests), as is the case with the equilibrium NPL (as section 2 suggests). For simplicity, assume that the average NPL for the whole period is constant. This is the proxy for the equilibrium exchange rate estimated without a break for regime shifts used in the empirical literature. It then becomes apparent that the measured misalignment (full arrow) is larger than the true misalignment (dashed arrow).

VI Final Remarks

This paper has attempted to explain the large differences in national price levels observed across countries. The strategy chosen was to develop a general equilibrium model that predicts that national price levels should differ across countries depending on their exchange rate regime. The empirical findings of the paper suggest that there is a strong relationship between national price levels and exchange rate regimes. These findings explicitly exclude any short-run effects that may arise when the regime shift is produced. As predicted by the model, countries with fixed exchange rate regimes have higher national price levels than countries with flexible regimes.

The relationship between exchange rate rigidity and price levels is found to be strong for developing countries during most of the post-Bretton Woods era. This relationship, while still present, is not significant for developed countries. The discrepancy between developed and developing countries is consistent with the observation by Devereux and Engel [2000] that local currency pricing is more prevalent in OECD countries, but other potential explanations also exist. At the disaggregate level, the overall evidence presented suggests that the regime-price level relationship is highly significant for non-traded goods, is significant but less so for broadly defined traded goods, and insignificant for selected traded goods.

The final section applies the theoretical and empirical findings of the paper to a classical problem faced by international economists, determining how far the national price levels (or, more generally, the real exchange rate) diverge from their equilibrium values. The paper suggests that calculating national price level misalignments around the time of a regime shift without incorporating the change in the equilibrium rate implies overestimating the true misalignment.

VII Appendix

Consumers maximize (1) subject to (5) and (6) with respect to $C_H(j)$, $C_F(j)$, $C_N(j)$, and $M_t(j)$ which imply the following equilibrium conditions:

$$
\begin{aligned}
(21)\quad PC(j) &= \frac{1}{\eta} P_N C_N(j) = \frac{1}{\gamma(1-\eta)} P_H C_H(j) = \frac{1}{(1-\gamma)(1-\eta)} P_F C_F \\
PC &= P_N C_N(j) + P_H C_H(j) + P_F C_F(j) \\
\frac{M_t(j)}{P_t} &= C_t(j) \\
(22)\quad \lambda_t &= \frac{1}{P_t C_t}
\end{aligned}
$$

The optimal pricing in the Home Country can be derived from the maximization of expected utility with respect to $p(h)$ and $p(n)$ subject to (6), (9), (7) and (8). The FOC that emerges is (already assuming symmetry),

$$
(23)\qquad E_{-1}\left[\frac{\theta\kappa L^{v-1}A^{-1}C_I}{P_I^2}\right] = E_{-1}\left[\frac{\lambda(\theta-1)C_I}{P_I}\right],\ \text{where } I = H \text{ and } N
$$

Using (21) and (22), and rearranging we obtain equation (10) from the main text. The complete solution of the model can then be obtained by using the trade balance condition and the resource constraint, equations (13) and (9), respectively. The solution is presented in $(24-31)$. Similar expressions hold for the Foreign country.

$$
\begin{aligned}
(24)\quad \varepsilon &= \frac{1-\gamma}{\gamma}\frac{M}{M^*} \\
(25)\quad P_N &= \frac{P_H}{f(\gamma, A, M)} \quad \text{where} \quad f(\gamma, A, M) = \frac{E(\gamma A^{-v}M^v)}{E\gamma E(A^{-v}M^{-v})} \\
(26)\quad P_H &= \frac{1}{\Phi^{v^{-1}}}\left[\eta f(\gamma, A, M) + (1-\eta)\right]^{(v-1)v^{-1}}\left[\frac{E_{-1}(\gamma A^{-v}M^v)}{E_{-1}(\gamma)}\right]^{v^{-1}} \\
(27)\quad P_F &= \varepsilon_t P_F^* \\
(28)\quad M &= PC \\
(29)\quad L &= \Phi^{v^{-1}}A^{-1}M\left[\frac{\eta}{E_{-1}(A^{-v}M^v)} + \frac{(1-\eta)E_{-1}(\gamma)}{E_{-1}(\gamma A^{-v}M^v)}\right]^{v^{-1}}
\end{aligned}
$$

(30)

$$
C = \frac{\tau\Phi^{v^{-1}}E(\gamma)^{(\eta+(1-\eta)\gamma)\nu^{-1}}\,E(1-\gamma)^{(1-\eta)(1-\gamma)\nu^{-1}}\,M^{\eta+(1-\eta)\gamma}(M^*)^{(1-\eta)(1-\gamma)}}{c_1[E_{-1}(\gamma A^{-v}M^v)]^{(\eta+(1-\eta)\gamma)\nu^{-1}}[E_{-1}((1-\gamma)(A^*)^{-v}(M^*)^v)]^{((1-\eta)(1-\gamma))\nu^{-1}}}
$$

(31)

$$
c_1 = (1-\eta+\eta f(\gamma, A, M))^{(\eta+(1-\eta)\gamma)(v-1)\nu^{-1}}\,(1-\eta+\eta f(1-\gamma, A^*, M^*))^{(1-\eta)(1-\gamma)(v-1)\nu^{-1}}
$$

where $\tau = \eta^{\eta}((1-\eta)\gamma)^{(1-\eta)}$. When the assumption of full exchange rate pass-through is relaxed, the FOC for setting $\widetilde{p}_t(h)$ optimally is given by (after assuming symmetry and non-stochastic γ),

$$E_{t-1}\left[\frac{\theta A^{-1}C_H^*}{\varepsilon P_H^*}\right] = E_{-1}\left[\lambda(\theta-1)C_H^*\right] \tag{32}$$

Using the analogous expression of (21) and (22) for the Foreign country, we obtain (18) in the main text.

Proof of Proposition 1. Note that if $\log X$ is normally distributed, $\log E(X^a) = aE(\log X) + \frac{a^2}{2}Var(\log X)$. Replacing (17) in (14) and (15) we can obtain the difference in domestic prices across regimes as a function of the variance of the exogenous shocks. Using (13) (together with the assumption that M^* is common across Rs) we obtain $NPLs$ for different Rs. It is easy to show that:

$$\begin{aligned}
\frac{dE\log\varepsilon}{dR} &= \frac{1}{2}\left(\sigma_\gamma^2 - \sigma_A^2\right) \\
\frac{dE\log f(\gamma, A, M)}{dR} &= -v\sigma_\gamma^2 \quad \text{and} \quad f(\gamma, A, M) \geqslant 1 \\
\frac{dE\log P_H}{dR} &= -\frac{\eta f(\gamma, A, M)}{\eta f(\gamma, A, M) + (1-\eta)}(v-1)\sigma_\gamma^2 - \frac{1+2(1-R)v}{2}\left(\sigma_\gamma^2 + \sigma_A^2\right)
\end{aligned}$$

which, after some algebra, implies that:

$$\frac{d\log NPL_T}{dR} \leq 0. \tag{33}$$

Using the following expression:

$$P_N = P_H\frac{E(\gamma)E(A^{-v}M^{-v})}{E(\gamma A^{-v}M^v)}$$

it can be shown that,

$$\frac{dE\log NPL_N}{dR} \simeq -v(1-R)\left(\sigma_\gamma^2 + \sigma_A^2\right) \leq 0 \tag{34}$$

where it is assumed that $1-\eta \simeq 0$. As expected, the higher the variance of the shocks and the higher is v, the larger is the difference in NPL across regimes. This difference also increases as v increases. Using the fact that P_F^* is independant of R, together with (33) and (34) we get Proposition 1. ■

Proof of Proposition 2. See Proof of proposition 1 for part a). The condition that determines the sign of part b) is given by:

$$\frac{dE\log NPL_N}{dR} - \frac{dE\log NPL_T}{dR} = -(1-E\gamma)\left(\frac{\eta f(\gamma,A,M)(v-1)}{\eta f(\gamma,A,M)+(1-\eta)}+1\right)\sigma_\gamma^2 - (1-E\gamma)\,v\,(1-R)\left(\sigma_\gamma^2+\sigma_A^2\right)+v\sigma_\gamma^2.$$

It is easy to show that there exists $E\gamma < 1$ such that this difference is negative. For any $E\gamma$ larger than this critical value, the difference is negative. ■

Proof of Proposition 3. In this case, an accomodating foreign monetary policy implies that

$$M^* = M_0^*\left(\frac{A^*}{E(A^*)}\right)^{R^*}.$$

Applying the same logic as in Remark 1 to equation (18), it is easy to show that P_F^* is increasing in ω. As P_{NR} and P_{HR} remain unchanged, this is sufficient to prove the proposition. ■

References

[1] Abowd, J. and O. Ashenfelter, "Anticipated Unemployment, Temporary Layoffs, and Compensating Wage Differentials," The Collected Essays of Orley Ashenfelter, K. Hallock, ed., Vol. I (1997), 167-96.

[2] Balassa, B., "The Purchasing Power Parity Doctrine: A Reappraisal," Journal of Political Economy, Vol. LXXII (December 1964), 584-596.

[3] Baxter, M. and A. Stockman, "Business cycles and the exchange rate regime," Journal of Monetary Economics, Vol. XXIII (1989), 377-400.

[4] Bayoumi, T. and B. Eichengreen, "Macroeconomic Adjustment under Bretton Woods and the Post Bretton Woods Float: An Impulse Response Analysis," The Economic Journal, Vol.CIV, Issue 425 (July1994).

[5] Benigno, P., "A Simple Approach to International Monetary Policy," Journal of International Economics, Vol. LVII (2002), 177-196.

[6] Betts, C. and M. Devereux, "Exchange Rate Dynamics in a Model of Pricing to Market," Journal of Internatinal Economics, Vol. L, No. 1 (February 2000), 215-244.

[7] Bhagwati, Jagdish, "Why Services are Cheaper in Poor Countries," Economic Journal, Vol. XCIV (1984), 279-86.

[8] Broda, C., "Coping with Terms-of-Trade Shocks: Pegs Versus Floats," American Economic Review, Vol. XCI, No. 2 (May 2001), 376-380.

[9] Burstein, A., Neves, J. and Rebelo, S., "Distribution Costs and Real Exchange Rate Dynamics During Exchange-Rate-Based Stabilizations," NBER Working Paper No. 7862, August 2000.

[10] Calvo, G. and C.Vegh, "Inflation Stabilization and BOP Crisis in Developing Countries," Handbook of Macroeconomics, J. Taylor and M. Woodford, eds., Vol. Ic, Amsterdam: North-Holland Publishing, 1999, 1531-1614.

[11] Clague, C., "Determinants of the National Price Level: Some Empirical Results," Review of Economics and Statistics, Vol. LXIII, No. 2, 320-323.

[12] Corsetti, G. and P. Pesenti, "Welfare and Macroeconomic Interdependence," Quarterly Journal of Economics, Vol. CXVI, No. 2 (May 2001a), 421-445.

——— and ———, "International Dimensions of Optimal Monetary Policy," NBER Working Paper No. 8230, April 2001b.

[13] De Gregorio, J. and H.C. Wolf, "Terms of Trade, Productivity, and the Real Exchange Rate," NBER Working Paper No. 4807, July 1994.

[14] Devereux, M. and C. Engel, "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange Rate Flexibility," NBER Working Paper No. 7665, April 2000.

——— and ———, "Endogenous Currency of Price Setting in a Dynamic Open Economy Model," NBER Working Paper No. 8559, October 2001.

[15] Friedman, M., "The Case for Flexible Exchange Rates," Essays in Positive Economics, University of Chicago, Chicago, IL, 1953.

[16] Flood, R. and A. Rose, "Fixing Exchange Rates: A Virtual Quest for Fundamentals," The Journal of Monetary Economics, Vol. XXXVI (1995), 3-37.

[17] Froot, K.A. and K. Rogoff, "Perspectives on PPP and Long-Run Real Exchange Rates," Handbook of International Economics, Vol. III, Grossman, G.M., Rogoff, K., eds., Amsterdam: New Holland Publishing, 1995.

[18] Ghosh, A., Gulde, Ostry and Wolf, "Does the Nominal Exchange Rate Regime Matter?" NBER Working Paper No. 5874, (January 1997).

[19] Goldfajn, I. and R. Valdez, "The Aftermath of Appreciations," Quarterly Journal of Economics, Vol. CXIV No. 1 (February 1999), 229-262.

[20] Heston and Summers, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," Quaterly Journal of Economics, Vol. CVI, No. 2 (May 1991), 327-368.

[21] International Monetary Fund Publication: Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), 2001.

[22] Kravis, Irving B. and Robert E. Lipsey, "Toward an Explanation of National Price Levels," Princeton Studies in International Finance, No. 52: Princeton University Press, November1983, 21.

[23] ——— and ———, "The Assessment of National Price Levels," Real Financial Linkages Among Open Economies, Arndt, Sven W. and Richardson, David J., eds., Cambridge: MIT Press, 1987.

[24] Levy Yeyati, E. and F. Sturzennegger, "Classifying Exchange Rate Regimes: Deeds vs. Word," 2000, available at http:// www.utdt.edu/~ely/papers.html.

[25] ——— and ———, "Exchange Rate Regimes and Economic Performance," IMF Staff Papers, No. 47 (2001), Special Issue.

[26] Mundell, Robert. International Economics, Collection of articles, New York: Macmillan, 1968.

[27] Mussa, M., "Nominal Exchange Rate Regimes and the Behavior of the Real Exchange Rate," Real Business Cycles, Real Exchange Rates and Actual Policies, Karl Brunner and A. Meltzer, eds., Amsterdam: North Holland Publishing, 1986, 117-213.

[28] Poole, William, "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model," Quarterly Journal of Economics, (Vol. LIV May 1970), 197-216.

[29] Obstfeld, M. and K. Rogoff, Foundations of International Economics, Cambridge: MIT Press, 1996.

——— and ———, "New Directions for Stochastic Open Economy Models," Journal of International Economies, Vol. L (February 2000a), 117-153.

——— and ———, "Do We Really Need a New International Monetary Compact?" NBER Working Paper No. 7864, August 2000b.

[30] Rogers, J., "Price Level Convergence, Relative Prices and Inflation in Europe," mimeo Federal Reserve Board, 2001.

[31] Samuelson, P., "Theoretical Notes on Trade Problems," Review of Economics and Statistics, Vol. XLVI (1964), 145-164.

[32] Stockman, A. and L. Tesar, "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," American Economic Review, Vol. LXXXV (March 1995), 168-185.

[33] Tille, C., "The Role of Consumption Substitutability in the International Trasmission of Shocks," Journal of International Economics, Vol. LIII, No. 2 (April 2001), 421-424.

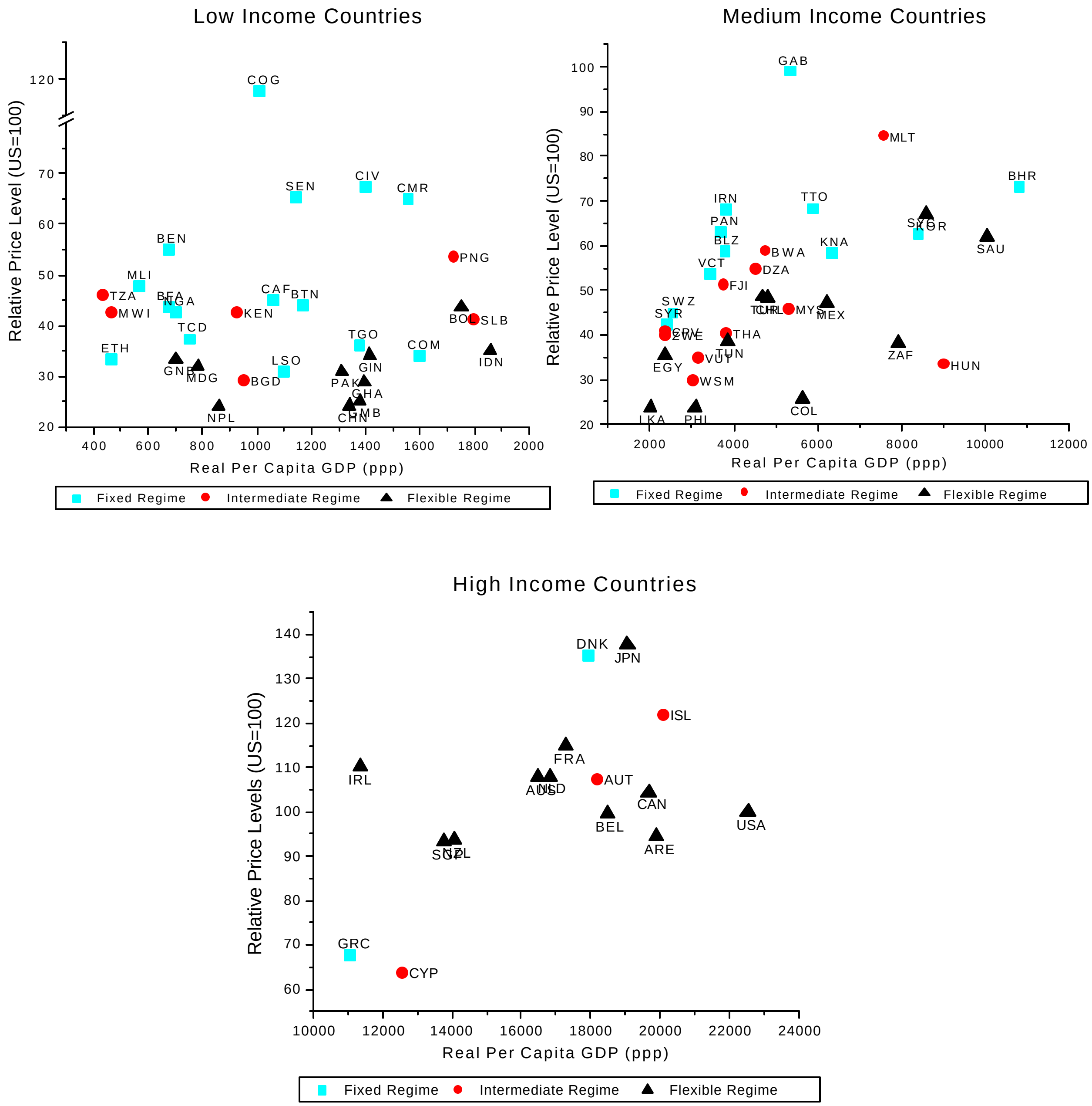
———, "How Valuable is Exchange Rate Flexibility? Optimal Monetary Policy under Sectoral Shocks," mimeo Federal Reserve Bank of New York, 2002.

[34] Penn World Tables, Mark 5.6 available at http://pwt.econ.upenn.edu/.

[35] Ventura, Jaume and Aart Kraay, "Trade Integration and Risk Sharing", European Economic Review, (June 2002).

FEDERAL RESERVE BANK OF NEW YORK.

Figure I
National Price Levels and Exchange Rate Regimes (1990)
By Income Level



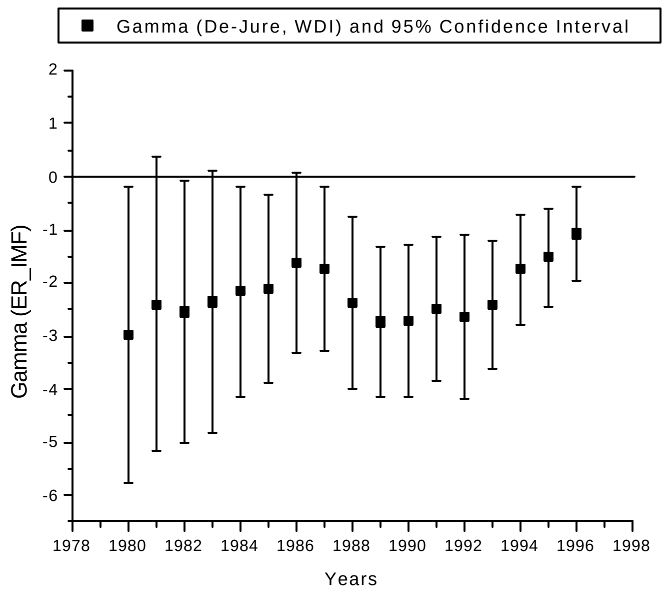
Notes: Acronyms for countries can be found in Table A-III in the appendix. A country is classified as having a Fixed Exchange Rate Regime if ER_IMF < 5, an Intermediate Regime if ER_IMF = 5 and a Flexible Regime if ER_IMF > 5. The countries included were constrained to having ER_IMF (1988) = ER_IMF (1989) = ER_IMF (1990) = ER_IMF (1991) = ER_IMF (1992) to avoid potential problems raised in the main text. A total of 32 low income countries (RPCGDP(ppp) < 2000), 33 medium income countries (2000<RPCGDP(ppp)<11000) and 16 high income countries (RPCGDP(ppp)>11000) were included.

TABLE I
Cross-Country National Price Level Regressions (*)

	Dependant Variable: National Price Level (US=100)							
Year	1990	1990	1990	1990	1990	1990	1990	1990
Classification	de-jure	de-jure	de-jure	de-jure	de-facto	de-facto	de-facto	de-facto
Price Data	PWT	WDI	PWT	WDI	PWT	WDI	PWT	WDI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ER_IMF	-2.47	-2.23	-1.74	-2.72				
	-(3.0)	-(3.7)	-(1.9)	-(3.7)				
FLEX					-20.11	-9.30	-18.23	11.95
					-(2.4)	-(1.8)	-(2.0)	-(1.7)
INTERM					-19.31	-9.14	-19.12	12.09
					(2.1)	-(1.5)	-(1.9)	-(1.6)
Y/1000 (**)	4.73	4.18	3.31	4.76	5.41	4.95	3.31	4.33
	(11.1)	(13.7)	(3.4)	(6.5)	(11.6)	(14.5)	(2.7)	-(4.9)
GC			1.35	-0.25			0.72	-0.47
			(2.3)	-(0.5)			(1.4)	-(0.1)
OPEN			-0.14	0.03			-0.28	-0.04
			-(1.2)	(0.3)			-(1.6)	-(0.4)
OPEN*Y			0.00	0.00			0.00	0.00
			(1.2)	-(0.6)			(1.6)	(1.0)
BCA_Y			-9.55	-13.09			12.07	-2.37
			-(0.5)	-(0.9)			(0.2)	-(0.1)
TOT			0.00	0.00			0.00	0.00
			(0.3)	-(0.2)			(0.2)	-(0.2)
_cons	50.15	45.19	37.85	48.99	41.34	31.10	48.16	35.96
	(9.7)	(12.3)	(3.3)	(5.5)	(5.1)	(6.2)	(4.1)	(3.4)
R-squared	0.65	0.71	0.67	0.72	0.79	0.84	0.82	0.86
Countries	69	80	65	71	42	44	40	39

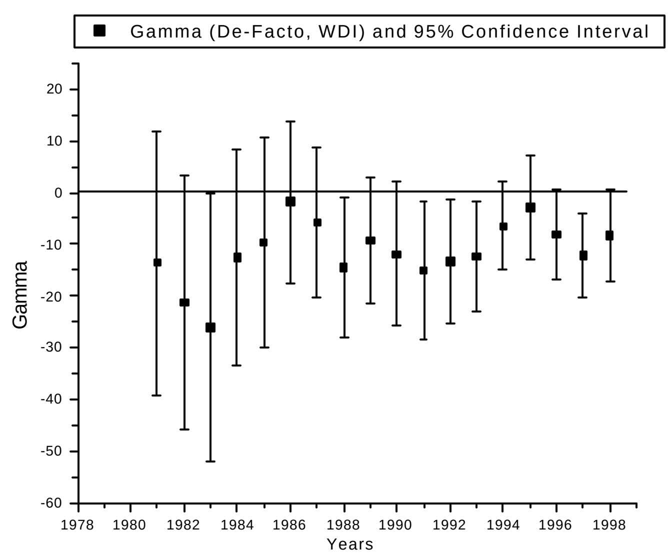
Notes: T-statistics in parenthesis. Acronyms can be found in Table A-III in the appendix. ER_IMF varies from 1 (fully pegged) to 10 (fully float). FLEX and INTERM are dummies that take the value of 1 when the country is classified as having a de-facto flexible and intermediate as defined in Levy Yeyati and Sturzennegger (2000). (*) Selection criteria: Regressions (1)-(4) estimated for countries that satisfied the following restriction: ER_IMF(-2) = ER_IMF(-1) = ER_IMF (0) = ER_IMF (-1) = ER_IMF (+2) (that is, restriction (20) with a = 2). Regressions (5)-(8) are estimated with a = 1. (**) The per capita real gdp (Y) of the corresponding data source is used in each regression.

Figure IIA



Note: Gamma is the coefficient for ER_IMF in Column 4 of Table I. ER_IMF varies from 1 (de-jure fully pegged) to 10 (de-jure fully float). The same restrictions as in Table 1 apply.

Figure IIB



Note: Gamma is the coefficient for FLEX in Column 8 of Table I. FLEX is a dummy that takes the value of 1 if a country is classified as having a de-facto flexible regime. The same restrictions as in Table I apply.

TABLE II

Income Levels and Permanent Exchange Rate Regimes

	Dependant Variable: National Price Level (US=100)							
Year	1990	1990	1990	1990	1990	1990	1975-1998	1975-1998
Classification	de-jure	de-facto	de-jure	de-facto	de-jure	de-jure	de-jure	de-jure
Price Data	PWT	PWT	WDI	WDI	PWT	WDI	PWT	WDI
Value of a (*)	2	1	2	1	5	5	8	8
	(1)	(2)	(3)	(4)	(5)	(6)	(7) (**)	(8) (**)
ER_IMF					-2.69	-2.84	-2.22	-2.96
					-(2.4)	-(2.8)	-(2.7)	-(3.0)
ER_LI	-2.02	-18.73	-2.30	-12.45				
	-(1.6)	-(2.0)	-(3.4)	-(1.9)				
ER_MI	-2.10	-16.19	-3.46	-14.51				
	-(2.3)	-(2.5)	-(4.8)	-(2.3)				
ER_HI	-0.13	-0.32	-1.35	-5.95				
	-(0.1)	(0.0)	-(0.9)	-(0.5)				
Y/1000	2.36	2.93	4.47	4.48	3.43	4.99	5.11	4.17
	(1.8)	(2.4)	(3.7)	(3.3)	(3.1)	(5.3)	(10.3)	(7.7)
GC	1.36	0.50	0.14	0.02	1.09	-0.70		
	(2.2)	(1.1)	(0.3)	(0.1)	(1.5)	-(1.1)		
OPEN	-0.15	-0.15	0.03	0.04	-0.17	0.05		
	-(1.4)	-(1.2)	(0.3)	(0.4)	-(1.1)	(0.4)		
OPEN_Y	0.00	0.00	0.00	0.00	0.00	0.00		
	(1.5)	(1.6)	-(0.4)	-(0.1)	(1.2)	-(0.5)		
CA_Y	-9.93	7.01	-13.08	-1.11	-12.93	-11.57		
	-(0.8)	(0.4)	-(0.9)	-(0.1)	-(0.7)	-(0.7)		
TOT	0.00	0.00	0.00	0.00	0.00	0.00		
	(0.6)	(0.1)	-(3.2)	-(2.5)	(0.2)	-(0.1)		
_cons	41.99	45.39	44.57	33.43	47.58	55.52	-11.18	-4.57
	(3.3)	(4.4)	(5.8)	(3.8)	(3.2)	(4.5)	-(2.7)	-(0.9)
R-squared	0.68	0.78	0.78	0.77	0.70	0.69	0.65	0.55
Countries	65	40	80	42	44	48	60	52

Notes: Same Notes as in Table I apply. (*) See Restriction (20) in text. For example, a = 5 implies: ER_IMF(-5) = . = ER_IMF(-1) = = ER_IMF (0) = ER_IMF (-1) = . = ER_IMF (+5). (**) Regressions (7)-(8) are estimated with a panel-between estimator. An average of 5 observations per country are used. The dependant variable used is the difference between the country's price level for a given year and that year's mean price level.

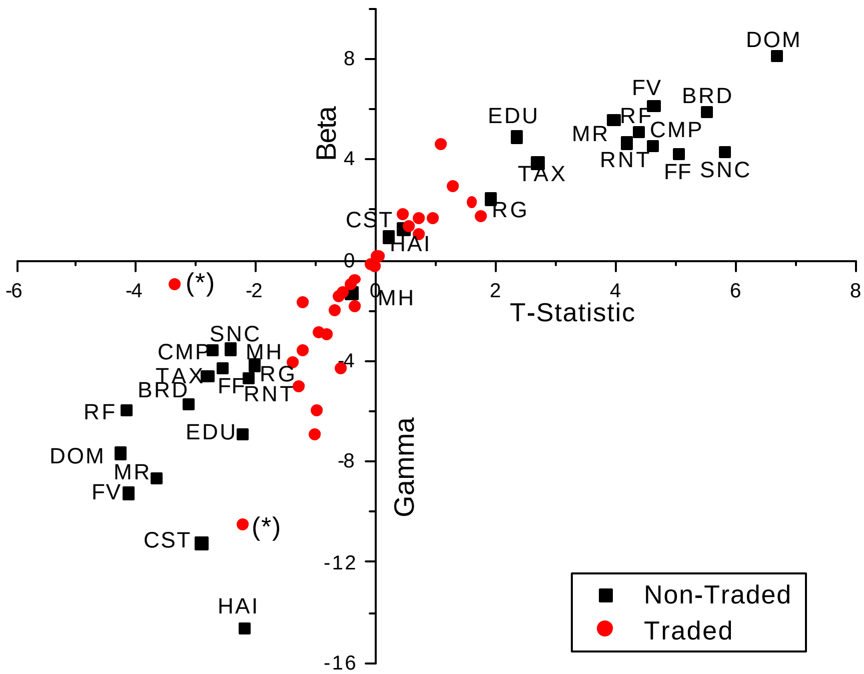
TABLE III
Tradable and Non-Tradable Goods

	Dependant Variable: Relative Price Level (US=100)			
Year	1980-1985-1990	1980-1985-1990	1980-1985	1980-1985
Goods Included	All Tradable	All Non-Tradable	Selected Tradable	Selected Non-Tradable
	(1)	(2)	(3)	(4)
ER_IMF	-2.39	-1.91	-0.97	-3.34
	-(1.8)	-(3.3)	-(.5)	-(4.5)
Y/1000	-0.15	3.07	-5.38	3.74
	-(0.1)	(4.1)	-(2.3)	(3.9)
GC	1.63	1.13	0.64	3.66
	(1.8)	(2.9)	(1.3)	(3.1)
OPEN	-0.48	-0.08	-0.55	-0.14
	-(2.0)	-(.7)	-(1.7)	-(1.0)
OPEN*Y	0.04	0.01	0.03	0.01
	(1.7)	(1.2)	(1.1)	(.9)
BCA_Y	37.54	10.67	133.56	5.77
	(2.2)	(1.4)	(5.8)	(.6)
TOT	0.00	0.00	0.00	0.00
	-(.3)	-(.9)	(.1)	-(.9)
_cons	121.02	46.28	125.96	66.14
	(6.9)	(6.0)	(5.3)	(6.7)
R-squared	0.35	0.71	0.43	0.61
Obs.	82	82	82	82

Notes: Same notes as in Table I apply. Time dummies included in all the regressions.

Figure III

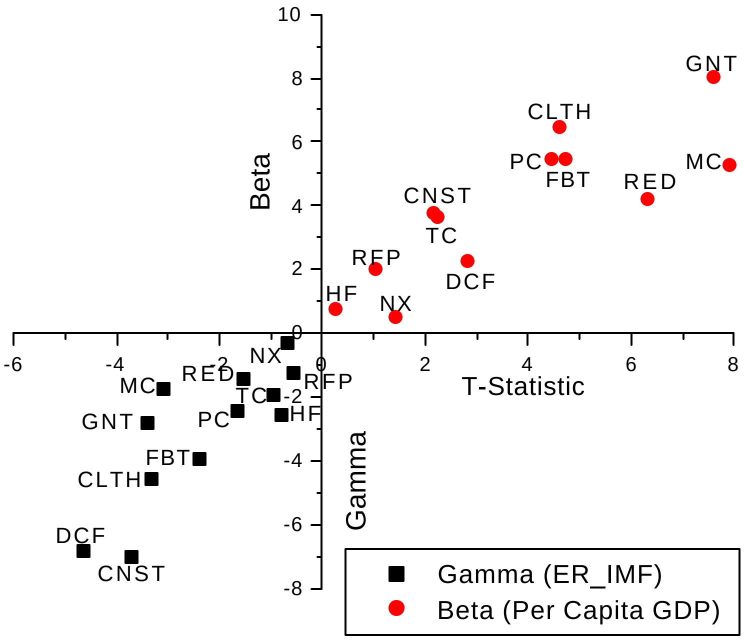
National Price Level (US=100) of Selected T & NT Goods
Gamma and Beta



Note: Coefficients from regression: P_X = alpha + Beta * Y + Gamma * ER_IMF + e subject to ER(-2) = ER(-1) = ER(0) = ER(+1) = ER(+2), where P_X is the Natinoal Price level (relative to US=100) for a selected group of Non-Traded and Traded goods. Non-Traded goods include: TAX Local taxis, HAI Svc. of hair/barb, CMP Compensation, RNT Gross rents, FF Fresh Fruit, FV Fresh Vegetables, RG Repair Glass MH Maint homes, CNS Construction, DOM Domestic services, RG Repairs glass/tab, RF Repairs Footwear, SNC Svc of nurses , EDU Education Services, MR Maint & Repair sv, BRD Bread. Traded goods (unlabeled) include: Rice (RCE), Pasta (PST), Coffee (COF), Jam (JAM), Chocolate (CHO), Refrigerator (RFR), Wash and Cooking Appliances (WSC), AC, Radio (RAD), Recreation Durables (RCE), Ships (SHP), Equipment (EQP), Office Equipment (OFE) and Net Exports (NX). A (*) next to the good's name stand for beta coefficients outside the upper right quadrant (notably, SHP and RFR).

Figure IV

National Price Levels (US=100) for Major Categories of Price Index
Gamma and Beta



Note: Coefficients from regression: P_X = alpha + Beta * Y + Gamma * ER_IMF + e subject to ER(-2) = ER(-1) = ER(0) = ER(+1) = ER(+2) and where P_X is the National Price level (relative to US=100) for category X of the CPI index. X includes: FBT (Food, Beverages and Tobacco), CLTH (Clothing and Footwear), MC (Medical Care), RED (Recreation and Education), TC (Transport and Communication), RFP (Rent, Fuel and Power), HF (Home Furnishing), GNT (Government Compensations), DCF (Domestic Capital Formation), PC (Personal Care) and NX (net exports).

TABLE IV
During and After Bretton Woods

		Dependant variable: dp		
Sample	nobs	a1	a2	a3
Developed	26	0.01	0.42	-1.58
		(0.03)	(3.10)	-(1.23)
Developing	90	-0.54	0.17	-1.41
		(1.75)	(0.64)	-(2.59)

Notes: dp stands for the change in the national price level between the Bretton Woods average (1960-1973) and the post-Bretton Woods average (1974-1992). T-statistics appear in parethesis.

Table V
Percent Difference relative to NPL (R = 1)

	Values for R			
Values for v	0.75	0.5	0.25	0
1	0.005	0.010	0.015	0.020
2	0.018	0.027	0.037	0.048
3	0.029	0.044	0.060	0.077
4	0.041	0.062	0.083	0.105
5	0.054	0.079	0.104	0.129

Notes: This calibration exercise assumes the utility function in (1), eta=0.5, mu(gamma) = log(0.5), mu(A) = 0, variance(A) = 0,01 and variance(gamma) = 0.01.

Figure V: How Large is the Misalignment?

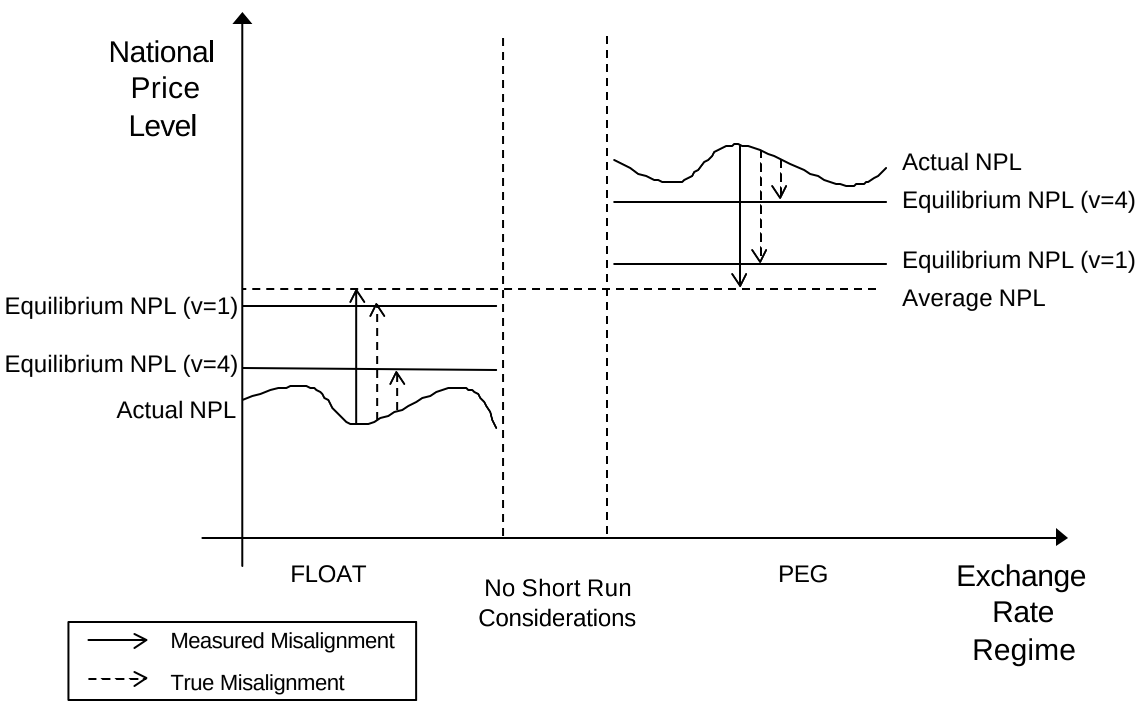


Table A-I. Countries and Years used in Sections 3 and 4 (*) (***)

Country Name	Code	Year	Country Name	Code	Year	Country Name	Code	Year
Angola	AGO	(1991)	United Kingdom	GBR	(1977-87, 1994-96)	Netherlands	NLD (**)	(1977-96)
Albania	ALB	(1994-96)	Georgia	GEO	(1996)	Norway	NOR	(1980-89)
United Arab Emirates	ARE	(1980-96)	Ghana	GHA	(1980-82, 1988-96)	Nepal	NPL	(1977-80, 1985-90)
Argentina	ARG	(1984-86, 1993-96); (1985-86x)	Guinea	GIN	(1990, 1991, 1996)	New Zealand	NZL (**)	(1981-82, 1987-96)
Armenia	ARM	(1995-96)	Gambia, The	GMB	(1977-83, 1988-96)	Pakistan	PAK (**)	(1977-79, 1984-96)
Australia	AUS (**)	(1978-80,1985-96)	Guinea-Bissau	GNB (**)	(1980, 1985-94); (1991x)	Panama	PAN (**)	(1977-96)
Austria	AUT	(1977-91, 1996)	Greece	GRC (**)	(1978-96)	Peru	PER	(1987,1992-96)
Burundi	BDI	(1977-80, 1985-89, 1994-96)	Guatemala	GTM	(1977-86, 1991-96); (1986x)	Philippines	PHL (**)	(1977-79, 1986-96)
Belgium	BEL (**)	(1977-96)	Guyana	GUY	(1977-78, 1993-96)	Papua New Guinea	PNG	(1980-91, 1996)
Benin	BEN (**)	(1977-96); (1981x)	Honduras	HND	(1977-87, 1996)	Poland	POL	(1988, 1993-96)
Burkina Faso	BFA (**)	(1986-96)	Croatia	HRV	(1996)	Portugal	PRT	(1979-87, 1994-96)
Bangladesh	BGD (**)	(1981-96)	Haiti	HTI	(1977-88, 1993-96)	Paraguay	PRY	(1977-86, 1991-95); (1984x)
Bahrain	BHR	(1982-96)	Hungary	HUN	(1984-92)	Romania	ROM	(1994-95)
Belarus	BLR	(1995-96)	Indonesia	IDN (**)	(1980, 1985-94)	Saudi Arabia	SAU	(1977-96)
Belize	BLZ (**)	(1984-96)	Ireland	IRL (**)	(1981-96)	Sudan	SDN	(1977-82, 1989); (1982x)
Bolivia	BOL (**)	(1985-96)	Iran, Islamic Rep.	IRN	(1982-90)	Senegal	SEN (**)	(1977-96)
Brazil	BRA	(1977-87, 1996); (1983x-85x-87x)	Iceland	ISL	(1977-85, 1990-96)	Singapore	SGP	(1977-84, 1989-96)
Bhutan	BTN	(1983-96); (1991x)	Israel	ISR	(1979-80, 1993-96)	Solomon Islands	SLB	(1981-95)
Botswana	BWA	(1982-96); (1985x)	Italy	ITA	(1981-89)	Sierra Leone	SLE	(1992-96)
Central African Republic	CAF (**)	(1977-96); (1981x)	Jamaica	JAM	(1992-96)	Sao Tome and Principe	STP	(1996)
Canada	CAN (**)	(1977-96)	Jordan	JOR	(1978-86, 1991-95)	Slovenia	SVN	(1995-96)
Switzerland	CHE	(1994-96)	Japan	JPN (**)	(1977-96)	Sweden	SWE	(1979-89, 1994-96)
Chile	CHL (**)	(1984-94)	Kenya	KEN	(1977-84, 1989-90, 1995)	Swaziland	SWZ	(1977-96); (1984x)
China	CHN	(1982, 1988-96)	Cambodia	KHM	(1995-96)	Seychelles	SYC (**)	(1981-93)
Cote d'Ivoire	CIV (**)	(1977-96); (1981x)	Kiribati	KIR	(1988-96)	Syrian Arab Republic	SYR (**)	(1977-96); (1988x)
Cameroon	CMR (**)	(1977-96); (1981x)	St. Kitts and Nevis	KNA (**)	(1986-96)	Chad	TCD (**)	(1977-96); (1981x)
Congo, Rep.	COG (**)	(1977-96); (1981x)	Korea, Rep.	KOR (**)	(1977, 1982-94)	Togo	TGO (**)	(1977-96); (1981x)
Colombia	COL	(1977-91, 1996)	Lao PDR	LAO	(1991-92); (1980x, 1985x)	Thailand	THA (**)	(1986-94)
Comoros	COM (**)	(1984-96)	Lebanon	LBN	(1991-96); (1984x-1990x)	Tonga	TON	(1987-88, 1993-96)
Cape Verde	CPV (**)	(1988-95)	Sri Lanka	LKA (**)	(1979-96)	Trinidad and Tobago	TTO	(1978-90, 1995-96); (1986x)
Costa Rica	CRI	(1977, 1984-89)	Lesotho	LSO (**)	(1977-96); (1984x)	Tunisia	TUN	(1977-83, 1988-96)
Cyprus	CYP (**)	(1977-96)	Lithuania	LTU	(1996)	Turkey	TUR (**)	(1977-96); (1978x, 1984x, 1988x)
Czech Republic	CZE	(1992-94)	Moldova	MDA	(1995-96)	Tanzania	TZA	(1990, 1995, 1996)
Germany	DEU (**)	(1993-96)	Madagascar	MDG	(1977-79, 1988-91, 1996)	Uganda	UGA	(1994-96)
Denmark	DNK (**)	(1980-96)	Maldives	MDV	(1993-96)	Uruguay	URY	(1984-89, 1994-96)
Dominican Republic	DOM	(1977-82, 1996)	Mexico	MEX	(1978-91, 1996); (1982x,1986x)	United States	USA (**)	(1977-96)
Algeria	DZA	(1977-91, 1996); (1991x)	Macedonia, FYR	MKD	(1996)	St. Vincent and the Gre.	VCT	(1981-96)
Ecuador	ECU	(1977-80, 1985, 1991); (1990x)	Mali	MLI (**)	(1977-96); (1981x)	Venezuela, RB	VEN	(1977-80, 1985-86)
Egypt, Arab Rep.	EGY	(1977-84, 1989-96)	Malta	MLT	(1977-96)	Vietnam	VNM	(1993-96)
Spain	ESP	(1978-85, 1991-96)	Mozambique	MOZ	(1994-96)	Vanuatu	VUT	(1985, 1990-96)
Estonia	EST	(1994-96)	Mauritania	MRT	(1977-84, 1989)	Samoa	WSM	(1984-85, 1990-96)
Ethiopia	ETH	(1983-90, 1995)	Malawi	MWI	(1977-81, 1986-91)	Yemen, Rep.	YEM	(1992-93)
Finland	FIN	(1977-89)	Malaysia	MYS	(1977-90, 1995)	South Africa	ZAF (**)	(1981-96)
Fiji	FJI (**)	(1977-96)	Namibia	NAM	(1994-96); (1992x)	Zambia	ZMB	(1978-80, 1994-96); (1983x,
France	FRA (**)	(1981-96)	Nigeria	NGA (**)	(1977-96); (1986x)	Zimbabwe	ZWE	(1982-91, 1996)
Gabon	GAB (**)	(1977-96); (1981x)	Nicaragua	NIC	(1977-87); (1985x)			

Notes: (*) Country/Years pairs were included if all 3 of the following conditions were met: 1) Country/Year had price data (either for the WDI or PWT database), 2) Country/Year had an IMF exchange rate regime classification and 3) the Country had a constant exchange rate regime for Year(-2) to Year(+2). See section 4 for a detailed explanation of condition 3. (**) Countries included in Table 2, Column (5).
(***) An "x" stands for country-year pairs excluded despite restriction 3) being met. This is because these country-year pairs appear in Frankel and Rose (1996) classification of currency crisis or in Calvo and Vegh (1998) list of exchange-rate based stabilizations.

Table A-II. Descriptive Statistics of Price and Exchange Rate Classification Data for 1990

	Price Data							Exchange Rate Classification			
	Nobs.	Mean	St. Dev.	Min	Max	rho		Nobs.	Fixed (*)	Intermediate (*)	Flexible (*)
PWT							ER_IMF				
All Countries	104	62.9	36.5	10.2	158.8		All Countries	121	36	30	55
Low Income	35	43.9	23	10.2	123.4		Low Income	27	18	9	17
Medium Income	44	50.3	20.1	19.4	122.9		Medium Income	29	16	13	24
High Income	23	114.3	26.4	56.1	158.8		High Income	10	2	8	14
WDI							LY_S				
All Countries	121	56	30.1	17.9	146.5		All Countries	71	24 (13)	21 (3)	26 (18)
Low Income	44	41.8	17.1	17.9	116.6	0.36	Low Income	16	9 (5)	5 (0)	2 (0)
Medium Income	53	46.5	16.1	23.6	99.1	0.65	Medium Income	36	12 (7)	11 (2)	13 (11)
High Income	24	104.2	27.1	29.1	146.5	0.92	High Income	19	3 (1)	5 (1)	11 (7)

Notes: See Table A-III for acronyms. Only countries with an IMF exchange rate classification are included. Rho stands for the correlation coefficient between PWT and WDI. (*) The number of de facto regimes that have the same de-jure classification appear in brackets next to the LY_S classification.

Table A-III. Definitions and Sources

Variable	Definitions and Sources
Price Data	
PWT (*)	Price level (GDP) from Penn World Tables Mark 5.6. [104, 66, 1975-1992]
Dissagregate Price Data (*)	Price Level for the Major Categories of GDP and for 123 individual goods data. (Source: Benchmark Data from the International Comparison Programme (ICP), United Nations). [51, 30, 1980-1985-1990]
WDI (*)	Price Level variable from World Development Indicators (WDI, World Bank). [121, 71, 1975-1998]
Exchange Rate	
ER_IMF	IMF based exchange rate Regime Classification. (Source: IMF's Annual Report on Exchange Rate Rate Arrangements and Exchange Restrictions.)
FLEX (LY_S)	Dummy variable that takes the value of 1 when the country is classified as having a de-facto flexible regime as defined in Levy Yeyati and Sturzenegger (2000).
INTERM (LY_S)	Dummy variable that takes the value of 1 when the country is classified as having a de-facto intermediate regime as defined in Levy Yeyati and Sturzenegger (2000).
Rest of Data	
Y	Real Per capita GDP. When PWT5.6 price data used, CGDP variable used for cross country comparisons and RGDPCH (Chain)variable used for panel comparisons. (Source: PWT5.6). For WDI price data, RGDP_PC (ppp) used. (Source WDI).
OPEN	Openness (ratio of (Export+Imports)/2 to GDP. (Source: PWT5.6 or alternatively IMF)
BCA_Y	Current Account Balance as a ratio of GDP. (Source: IMF)
TOT	Terms of Trade (Ratio between the Price of Imports in dollars and the Price of Exports in dollars). (Source: WDI)
GC	Government Consumption as a ratio of GDP. (Source: IMF)
PI_CPI	Consumer Price Inflation. (Source: IMF)
POP	Population. (Source: IMF)
Tradable and Non- Tradable	Classification used to distinguish between Tradable and Non-tradable goods. (Source: Rogers (2001))

Notes (*): [# of countries with price data and IMF classification, # of countries with price data and de-facto classification, Time frame for which the data is used].