Nominal exchange rate flexibility and real exchange rate adjustment: Evidence from dual exchange rates in developing countries

Yin-Wong Cheung
Department of Economics, University of California, Santa Cruz, CA 95064, USA
AND
Kon S. Lai
Department of Economics, California State University, Los Angeles, CA 90032, USA

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Abstract: This study investigates whether exchange rate flexibility aids real exchange rate adjustment. Instead of relying on inter-period comparisons of exchange rate regimes, as previous studies of industrial countries have done, this study examines intra-period data on dual exchange rates from developing countries. Specifically, it analyzes whether the flexible parallel market rate implies a faster speed of real exchange rate adjustment than the much less flexible official rate does. We find that greater nominal exchange rate flexibility does not tend to produce faster real exchange rate adjustment. The study also uncovers substantial variation in adjustment speeds across developing countries. We further examine whether the observed cross-country variation in adjustment speeds can be linked to inter-country differences in structural economic characteristics, including trade openness, productivity growth, government spending, and money growth.

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1. Introduction

Recent international events such as the Asian financial crisis and the advent of the Euro zone have rekindled an old but important debate over exchange rate flexibility. The role of flexible exchange rates in economic adjustment has long been a hotly contested issue. Nurkse (1944) concludes from interwar experience that speculative exchange rate movements can magnify and prolong disequilibria rather than accelerate economic adjustment. Such sentiment gave rise to the postwar system of pegged exchange rates under the Bretton Woods (BW) agreement. In contrast, Friedman (1953) contends that it is easier for the economy to adjust to shocks by securing needed changes in the real exchange rate through exchange rate than through price adjustment. Instead of fearing the instability flexible rates might bring, Friedman suggested that speculative movements would actually quicken exchange rate adjustment and hasten its equilibrating process. As the BW arrangement grew increasingly strained with currency crises in the late 1960s, many economists began advocating greater exchange rate flexibility.

The post-BW period, however, has been marked by a dramatic rise in the volatility of nominal and real exchange rates (Mussa, 1986; Stockman, 1983), despite no significant changes in macroeconomic volatility across regimes (Baxter and Stockman 1989; Flood and Rose 1995).[1] In addition, real exchange rates appear to have grown more persistent since the move to the current float (Mussa, 1986). Adding to the empirical regularities, many studies finds it much harder to detect stationarity in real exchange rates under flexible than under fixed rate regimes and that the observed speed of real exchange rate adjustment is excessively slow under the current float (Rogoff, 1996). The implication that exchange rate flexibility can actually slow down rather than speed up real exchange rate adjustment raises questions about the stabilizing function of flexible exchange rates. The sluggish adjustment of real exchange rates – which signifies sustained currency under- or overvaluation – can foster and perpetuate economic imbalance.

The issue then arises as to whether flexible exchange rates promote real exchange rate adjustment. Cross-period comparison results are far from self-evident. On one end, the inter-period difference in persistence can be treated as evidence that real shocks are more significant in the post-BW than in the BW period. Under this interpretation, the change in real exchange rate persistence is a result more of the historical period than of the nominal exchange rate arrangement. For example, Grilli and Kaminsky (1991) examine data spanning many exchange rate regimes and report that what is crucial to the real exchange rate behavior is the specific historical period rather than the exchange rate arrangement.

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[1] The 'disconnect' puzzle about exchange rate volatility has spurred a growing literature on the relationship (or lack thereof) between exchange rate flexibility and macroeconomic behavior (e.g., Dedola and Leduc, 2001; Devereux and Engel, 2002; Duarte, 2003; Monacelli, 2004). It is shown that the presence of pricing-to-market along with sticky prices can hamper the expenditure-switching effect of exchange rate changes on consumer goods, thus generating the exchange rate disconnect from the macroeconomy.

At the other end, the rise in real exchange rate persistence under floating rates can be viewed as evidence that exchange rate flexibility undermines rather than promotes real exchange rate adjustment. According to this view, speculative forces may send the nominal exchange rate temporarily off its equilibrating path. Consequently, exchange rate fluctuations not only introduce an extraneous source of variability but also decelerate the process of real exchange rate adjustment.[2] Following this interpretation, the slow adjustment speed is a result more of the exchange rate arrangement than of the historical period.

These opposing interpretations of the empirical evidence underline a basic problem with cross-period comparison analysis. Different historical periods can differ not only in the exchange rate arrangement but also in international events (such as oil crises) and domestic economic conditions. Unless the statistical analysis can fully control for all relevant inter-period differences in both global and domestic economic conditions, it is difficult to determine the true extent to which the change in exchange rate flexibility is responsible for the observed change in real exchange rate persistence across historical periods. Ideally, if controlled experiments could be done, we would like to observe what would happen to the speed of real exchange rate adjustment had the exchange rate been flexible (fixed) during the fixed (flexible) rate period.

This study provides indirect evidence from dual exchange rate systems on the issue in whether exchange rate flexibility aids real exchange rate adjustment. Not only during the BW period but also afterwards, parallel markets for foreign exchange – especially for the U.S. dollar – were common among developing countries. Unlike the official rate, which is fixed and occasionally reset by the monetary authority, the parallel rate is determined by market demand and supply. With limited access to the official exchange market, the parallel market serves to meet unsatisfied demand for foreign currency. Many developing countries use the dual exchange rate system as a tool to stabilize the real economy and to insulate real economic activity from the volatility of financial markets (Pozo and Wheeler, 1999). As noted by Reinhart and Rogoff (2004), parallel exchange rates represent a form of "back-door" floating.

The spread between the parallel and the official exchange rate – referred to as the parallel market premium – often works as an indicator of exchange rate misalignments and has been used as a guide to realigning the official rate. According to Reinhart and Rogoff (2004), the parallel exchange rate is "a far better barometer of monetary policy than is the official exchange rate" and that the parallel market premium often correctly predicts realignments in the official rate and anticipates future official rate changes. Earlier studies of the parallel market premium (Dornbsuch et al., 1983; Kamin, 1993; Monteil and Ostry, 1994; Pozo and Wheeler, 1999) also suggest an important role for the expectations of future

[2] Recent studies by Engel and Morley (2001) and Cheung et al. (2004) find that the glacial speed of real exchange rate adjustment may come largely from slow nominal exchange rate adjustment rather than from slow price adjustment. The finding raises question about the facilitating role typically expected from nominal exchange rate adjustment.

official rate changes in driving the premium. Ghei and Kamin (1999) recognize that the parallel exchange rate is a good, though not entirely perfect, proxy for the free-market currency value.

To examine whether greater exchange rate flexibility leads to quicker real exchange rate adjustment, this study analyzes data on dual exchange rates for 24 developing countries. For each of these countries, a parallel market for foreign exchange exists alongside the official one during both BW and post-BW periods. With official and parallel rates being available for the same historical period, this special data set permits intra-period analysis. We can evaluate he relative adjustment speed of the real official and the real parallel rate for each country within a given time period. This minimizes the need to control for any inter-period differences in economic conditions. Two questions of interest are: Do the official and the parallel market rate revert toward one another over time? Does the flexible parallel market rate imply a faster speed of real exchange rate adjustment than the less flexible official rate?

In addition to analyzing the difference in adjustment speed between real official and parallel rates on a country-by-country basis, this study also reveals that the speed of adjustment for either rate can vary considerably across countries, even within the same historical period. A cross-section analysis will be conducted to determine how much the cross-country variation in real exchange rate adjustment speeds is attributable to inter-country differences in structural economic characteristics such as trade openness, productivity growth, government spending, and money growth.

2. Empirical Methodology

The adjustment dynamics of economic processes will be evaluated based on fractional time series models. Fractional processes can exhibit a wide variety of adjustment dynamics, not captured by standard time series models (Diebold et al., 1991; Cheung and Lai, 1993). Indeed, these processes provide a better approximation to the Wold decomposition of time series dynamics than conventional processes (Granger and Joyeux, 1980; Hosking, 1981). Fractional processes are in general represented by

$$B(L)(1-L)^d y_t = D(L)v_t \qquad (1)$$

where y_t is the time series under consideration, L is the standard lag operator, $B(L) = 1 - \beta_1 L - \ldots - \beta_p L^p$, $D(L) = 1 - \delta_1 L - \ldots - \delta_q L^q$, all roots of $B(L)$ and $D(L)$ are stable, v_t is the random error term, and the fractional differencing part is

$$(1-L)^d = \sum_{m=0}^{\infty} \frac{\Gamma(m-d)L^m}{\Gamma(m+1)\Gamma(-d)} \qquad (2)$$

with $\Gamma(\cdot)$ being the gamma function. This model describes a broad class of time series processes known as autoregressive fractionally integrated moving-average (or ARFIMA(p, d, q)) processes. It extends the standard ARMA(p, q) and ARIMA (p, 1, q) models by permitting non-integer values of d. Such extended flexibility in modeling dynamics can be important for a proper evaluation of economic adjustment. The long-run reversion property of y_t is determined by the fractional integration parameter, d. Cheung and Lai (1993) show that mean reversion occurs so long as $d < 1$.

In our statistical analysis, a frequency-domain maximum likelihood procedure is used to estimate the ARFIMA(p, d, q) model. Following Fox and Taqqu (1986), we utilize the property that maximizing the likelihood function is asymptotically equivalent to:

$$\text{Minimizing } \sum_{k=1}^{T-1} \frac{I_y(2\pi k/T)}{f_y(2\pi k/T;\, \xi)} \text{ with respect to } \xi = (d, \beta_1, \ldots, \beta_p, \delta_1, \ldots, \delta_q) \tag{3}$$

where

$$f_y(\lambda_k, \xi) = |1 - \exp(i\lambda_k)|^{-2d}\, |B^{-1}(\exp(-i\lambda_k))D(\exp(-i\lambda_k))|^2 \tag{4}$$

$$I_y(\lambda_k) = \frac{1}{2\pi T}\left|\sum_{t=1}^{T} y_t \exp(i\lambda_k t)\right|^2 = \frac{1}{2\pi T}\left[\left(\sum_{t=1}^{T} y_t \cos(\lambda_k t)\right)^2 + \left(\sum_{t=1}^{T} y_t \sin(\lambda_k t)\right)^2\right] \tag{5}$$

with $\lambda_k = 2\pi k/T$ and i being the imaginary part of the complex number. Specifically, $I_y(\lambda_k)$ gives the periodogram of y_t at the kth Fourier frequency, and $f_y(\lambda_k, \xi)$ is proportional to the spectral density of y_t at frequency λ_k. The resulting estimator for d is consistent and has an asymptotic normal distribution (Tanaka, 1999). Cheung and Diebold (1994) show that this maximum likelihood procedure for estimating fractional processes has good finite-sample properties.

3. The behavior of the parallel market premium

Before analyzing the relative adjustment speed of the real official and the real parallel exchange rate, we examine the behavior of the parallel market premium. Let e_{Ot} and e_{Pt} be, respectively, the official and the parallel market rate in logarithms. The parallel market premium is given by $e_{Pt} - e_{Ot}$. Although infrequently done, a monetary authority may adjust the official rate to reduce currency misalignments. If the parallel market premium is a good gauge of the degree of misalignment and a useful guide for setting the official rate, the official and parallel exchange rates should not drift too far apart. It follows that a long-run stationary relationship likely exists between these two rates. Theoretical models – including portfolio balance models (Dornbusch et al, 1983; Phylaktis, 1991) and monetary models (Kouretas and Zarangas 1998; Phylaktis, 1996) – also suggest the parallel market premium be stationary with the official and parallel exchange rates moving in the same proportion over the long run (see also Appendix A).

This study examines time series data from 24 developing countries for which exchange rate and price data are available for both BW and post-BW periods. Data on both monthly consumer prices and official exchange rates were taken from the IMF's International Financial Statistics database. As studied by Reinhart and Rogoff (2004), parallel market rates are from various issues of *Pick's Currency Yearbook* and *Pick's World Currency Report* (later became the *World Currency Yearbook*). All exchange rates are expressed in units of foreign currency per U.S. dollar. Dictated by data availability, the sample data cover the period January 1957 through December 1998.[3] The countries under study include Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, India, Israel, Korea, Malaysia, Mexico, Morocco, Pakistan, Paraguay, Philippines, South Africa, Sri Lanka, Thailand, Uruguay, and Venezuela. Even during the post-BW period, these countries chose to have official pegs or crawls (with fixed or limited flexibility in rates) against the U.S. dollar most of the time.

Unlike previous cross-regime studies, which explore the different flexibility of official rates between the BW and the post-BW period, this study builds on the premise that official rates are less flexible than parallel rates within the same period. The dual-rate analysis does not require any assumption of official rates being absolutely fixed over time.[4] Table 1 shows the average size (measured as the mean absolute change) of official and parallel rate movements over the two time periods. The data are consistent with the conventional wisdom that market-determined parallel rates move more freely than official rates.

Table 2 reports some descriptive statistics showing the average size and standard deviation of the parallel market premium during the BW and post-BW periods. As shown, the parallel market premium can vary greatly both in size and in variability across countries, even within the same period. Moreover, the data reveal no systematic pattern of change in the average premium size across the two time periods. The average parallel market premium rises in 9 countries but falls in 15 countries when moving from the BW to the post-BW period. There is also no systematic pattern of cross-period change in variability, with increases for 10 countries and decreases for 14 countries from the BW to the post-BW period.

Table 3 summarizes the unit-root test results from fractional integration analysis by country. The unit-root null hypothesis of $d = 1$ is tested against the mean-reverting alternative of $d < 1$. For the BW period, the unit-root hypothesis can be rejected for all but one of the 24 countries at the 5% significance level. The post-BW data also widely reject the unit-root hypothesis. In all but two cases can the unit-root hypothesis be rejected at the 5% significance level. In general, the statistical results strongly support that the differential between the official and the parallel market rate is stationary.

It should be noted that although the official and parallel exchange rates display a long-run stationary relationship, their short-run differential can still be large and persistent. From an algebraic viewpoint, the

[3] The *World Currency Yearbook* had stopped being published after 1998. In addition, due to limited data availability of parallel market rates, a slightly shorter sample period that begins later than 1957 is used in the cases of Dominican Republic, El Salvador, Morocco, and Venezuela. For several countries (Brazil, Costa Rica, Korea, and Thailand), moreover, consumer price data are not available for the sample period. In these cases, we use either wholesale or producer price data.

[4] To be sure, most nominal exchange rates are neither completely fixed nor completely flexible over time. This is true for both the BW period and the post-BW period. This is also true for both developing and industrial countries.

parallel market premium represents the difference between the real parallel exchange rate (RER_{Pt}) and the real official exchange rate (RER_{Ot}) during the same time period:

$$e_{Pt} - e_{Ot} = RER_{Pt} - RER_{Ot} \quad (6)$$

where $RER_{Pt} = e_{Pt} + p_{Ft} - p_{Dt}$ and $RER_{Ot} = e_{Ot} + p_{Ft} - p_{Dt}$, with p_{Ft} being the U.S. price level and p_{Dt} being the domestic price level (in logarithms). The short-run differential between e_{Pt} and e_{Ot} shows the possible difference in the dynamic behavior between the real official and the real parallel exchange rate.

4. Adjustment speeds of real official and parallel exchange rates

The adjustment behavior of real official and parallel exchange rates is examined next. We first check the stationarity of individual real exchange rate series. If purchasing power parity (PPP) holds in the long run, then the real official and the real parallel exchange rate should exhibit mean reversion. In analyzing the adjustment behavior of real exchange rates in industrial countries, previous studies generally report greater difficulty in finding mean reversion in flexible than in fixed rate data. In terms of historical periods, it seems much harder to detect mean reversion during the post-BW period as opposed to other historical periods. Do similar results apply to the behavior of real exchange rates in developing countries? Compared to those for industrial countries, empirical findings for developing countries are relatively limited and less extensive. Our results from dual exchange rates may offer an alternative perspective on the dynamics of real exchange rate adjustment.

Table 4 contains the results from tests for mean reversion in real exchange rates. For the BW period, the unit-root hypothesis can be rejected at the 5% significance level in 18 out of 24 cases for real official rates and in 19 out of 24 cases for real parallel rates. For the post-BW period, the unit-root hypothesis can be rejected in 18 out of 24 cases for real official rates and in 17 out of 24 cases for real parallel rates. Hence, the real official and the real parallel exchange rate show little difference in terms of the number of unit-root rejection cases. In the large majority of cases, both real official and parallel rates exhibit mean reversion. This applies to the BW and the post-BW period alike.

4.1. Intra-period comparison of adjustment speeds by country

We next evaluate how fast the real official and the real parallel exchange rate adjust to shocks. To analyze whether the flexible parallel market rate produces quicker real exchange rate adjustment than the pegged official rate, their adjustment speeds – measured in terms of half-lives of shocks to real exchange rates – are computed using impulse response analysis. Based on the ARFIMA model, as described in (1), the half-life can be estimated from a moving average representation of the time series process:

$$(1 - L)y_t = A(L)v_t \quad (7)$$

where $A(L) = 1 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L^3 + \ldots$ derived from

$$A(L) = (1 - L)^{1-d}\Phi(L) \quad (8)$$

with $\Phi(L) = B^{-1}(L)D(L)$. The moving average coefficients $\{\alpha_1, \alpha_2, \alpha_3, \ldots\}$ are often referred to as impulse responses, and they track and measure how much the real exchange rate adjusts in subsequent periods after a unit shock. The calculated half-life indicates how long it takes for the impact of a unit shock to the real exchange rate to dissipate by half.

The question at issue is whether nominal exchange rate flexibility facilitates real exchange rate adjustment. The conventional argument is that, in a world of sticky prices, the speed at which the real exchange rate adjusts should depend a lot on exchange rate flexibility. Under pegged exchange rates, real exchange rates are expected to adjust at a relatively slow pace limited by price stickiness. Exchange rate realignments may sometimes help accelerate adjustment but they occur infrequently. With flexible exchange rates, on the other hand, real exchange rates can adjust quickly through immediate changes in nominal exchange rates. Despite the intuitive appeal of this argument, it is not straightforward to verify empirically the relevance of exchange rate flexibility. The usual approach is to analyze the difference in real exchange rate behavior between fixed-rate and flexible-rate regimes over different historical periods. Apart from facing the possible issue in exchange rate regime classifications (Reinhart and Rogoff, 2004), the cross-regime/cross-period comparison presents another problem, namely that different historical periods can have different global and domestic conditions that can alter real exchange rate behavior.

In our analysis of dual exchange rates, the adjustment speed of the real official exchange rate is compared to that of the real parallel exchange rate over the same time period. If nominal exchange rate flexibility promotes real exchange rate adjustment, the flexible parallel market rate should yield a faster speed of real exchange rate adjustment than does the inflexible official rate. To the extent that the speeds of real official and parallel rates are compared over the same period for the same country, the intra-period country-by-country comparison averts the need to control for the influences of economic fundamentals.

Table 5 presents the half-life estimates for both real official and parallel exchange rates of individual countries. Evidently, the empirical results show no systematic pattern for the country group as a whole. While the estimated half-life of the real parallel rate can differ significantly from that of the real official rate in a given country, there is no identifiable general pattern in the half-life difference between the two real rates. Interestingly, real parallel rates appear as likely to yield a shorter half-life as real official rates. In about half of the cases, real parallel rates may actually adjust more slowly rather than more quickly in comparison to real official rates. Qualitatively similar findings are obtained, regardless of whether the BW or the post-BW period is considered. Overall, there is no consistent evidence to support that greater nominal exchange rate flexibility tends to generate faster real exchange rate adjustment. Nor does it tend to produce slower real exchange rate adjustment.

The foregoing analysis has been based on point estimates of half-lives. As discussed later, some recent studies (Cheung and Lai, 2000; Murray and Papell, 2002) investigate the potential uncertainty in estimating half-lives of real exchange rates. The allowance for uncertain half-life measurements would further reinforce our conclusion that there is little evidence of any systematic relationship between nominal exchange rate flexibility and the speed of real exchange rate adjustment.

4.2. Interesting departures from consensus estimates

Previous studies of real exchange rate dynamics typically report slow adjustment speeds with half-lives estimated to be 3 to 5 years. Describing the "consensus" on half-life estimates as remarkable and puzzling, Rogoff (1996) points out the difficulty in reconciling the slow adjustment speed of real exchange rates with their immense short-term volatility. The significance of short-term exchange rate volatility is often attributed to monetary shocks. Although standard exchange rate models with sticky prices may account for the huge short-term volatility, the consensus half-life estimates are, as Rogoff (1996) notes, still too slow to be explained by nominal rigidities. On the other hand, the slow adjustment speed may reflect the influence of real shocks. If real shocks are predominant, they can exert significant long-lasting effects on the real exchange rate. Nevertheless, existing models based on real shocks cannot account for short-term exchange rate volatility.

The consensus on half-life estimates identified by Rogoff (1996) comes mainly from real exchange rate studies of industrial countries. Departing from the consensus range, the half-life estimates obtained from the study here are much more dispersed. As shown in figure 1, the half-life estimates for both real official and parallel exchange rates show substantial variation among the developing countries under study. In a large majority of cases, these half-life estimates fall far outside Rogoff's (1996) consensus range of 3-5 years. Indeed, the half-life estimates are as likely to be higher as to be lower than the previous consensus estimates. This applies to the BW and the post-BW period alike. For the BW period, the estimated half-lives of the real official and parallel rates are shorter than 2 years in 9 to 13 cases and longer than 6 years in 10 to 13 cases. For the post-BW period, the estimated half-lives of the real official and parallel rates are less than 2 years in 7 to 11 cases and more than 6 years in 9 to 10 cases.

All in all, the half-life consensus reported among previous studies on real exchange rates in industrial countries fails to prevail among developing countries, which display considerably greater heterogeneity. For a number of developing countries, the results may seem consistent with relatively fast adjustment speeds as suggested by sticky-price models. For other developing countries, the data may yield sluggish rates of real exchange rate adjustment that are so slow that there is little long-run reversion. Similar findings are obtained from both BW and post-BW data, and the empirical evidence is robust with respect to whether the real official or the real parallel exchange rate is considered.

4.3. Increased uncertainty in adjustment speed measurements

In analyzing the speed of real exchange rate adjustment during the post-BW period, Cheung and Lai (2000) evaluate the sample half-life measure and its estimation accuracy. To quantify the inevitable imprecision with which the adjustment speed is estimated, confidence intervals for half-life estimates are computed for several major industrial countries. These confidence intervals are found to be wide, indicating a high level of uncertainty in measuring the half-life of real exchange rate adjustment. The lower-bound estimates generally come in with half-lives less than 2 years, but the upper-bound estimates contain half-lives that last 7 to 9 years. Murray and Papell (2002) examine the post-BW data from 20 industrial countries and find even greater uncertainty associated with half-life measurements. While the lower-end estimates can reach as low as just one year, the higher-end estimates are often infinitely large.

In this study we provide alternative evidence from the experience of developing countries with dual exchange rates over both the BW and post-BW periods. To explore whether the previous results on uncertain half-lives may similarly be observed in the data for developing countries, the 95% confidence interval for each individual half-life measurement is computed by Monte Carlo simulation. Using the estimated ARFIMA process for the respective data series as the data generating process, the half-life confidence interval is constructed based on 10,000 simulation replications in each case.

Table 6 gives the lower and upper bounds (denoted respectively by $LB_{95\%}$ and $UB_{95\%}$) of the half-life confidence interval. According to the lower-bound estimates, most half-lives can be as short as within a year for both real official and parallel rates. The upper-bound estimates of half-lives, in contrast, show no general pattern. Unlike those estimates previously reported for industrial countries (Cheung and Lai, 2000; Murray and Papell, 2002), these upper-bound half-life estimates vary widely among developing countries, ranging from less than a year to infinitely many years.

A closer examination of our results suggests a possible difference in pattern between the BW and the post-BW period. Figure 2 summarizes the results on half-life uncertainty by looking at the relative width of half-life confidence intervals among developing countries during each historical period. The interval width, which is the difference between $UB_{95\%}$ and $LB_{95\%}$, shows the level of uncertainty in estimating the half-life. A wider (narrower) confidence interval indicates greater (lesser) uncertainty. Compared to those for the BW period, the half-life confidence intervals for the post-BW period are more likely to be wider than to be narrower. This observed pattern holds for both real official and parallel exchange rates. For the post-BW data, in only one out of the 24 cases can the width of the half-life confidence interval be shorter than 3 years. For the BW data, in contrast, the width of the confidence interval can be less than 3 years in at least 10 cases.

The foregoing results raise interesting questions about the source of the increased uncertainty in measuring real exchange rate adjustment speeds. In our study, the post-BW sample period yields a larger number of observations than the BW sample period does. Although the width of the confidence interval depends partly on the sample size, the difference in sample size cannot account for the observed difference in the interval width between the two historical periods. For a given confidence level, the width of the confidence interval decreases, not increases, as the sample size grows. All else being equal, we should actually expect to see lower measurement uncertainty for the post-BW data than for the BW data. The empirical evidence shows just the opposite. Accordingly, the increased uncertainty may reflect the difference in variability of shocks rather than the difference in sample size. This suggests that some not yet identified factors can be responsible for the greater uncertainty in measuring real exchange rate adjustment speeds during the post-BW period than during the BW period. This poses an interesting issue for future research.

5. Cross-country variation in adjustment speeds and structural determinants

With the estimated half-life of the real exchange rate varying greatly from country to country, it is instructive to investigate how much the observed cross-country variation is ascribable to inter-country differences in structural economic characteristics. We will examine several key country characteristics that have been identified in the literature as possible factors influencing real exchange rate dynamics. The first structural characteristic is the country's openness to trade. A basic element of the PPP adjustment process is that goods market arbitrage affects trade flows and induces real exchange rate adjustment. To ascertain whether openness to trade facilitates real exchange rate adjustment, the degree of trade openness is measured by the ratio of total trade (imports plus exports) to the country's GDP.

The second structural characteristic under examination is the country's productivity growth. This supply-side factor is the focus of the Balassa-Samuelson hypothesis, which posits that productivity growth can induce sustained changes in real exchange rates due to its differential impact on the prices of traded and non-traded goods (Balassa, 1964; Samuelson, 1964). Empirical evidence for the Balassa-Samuelson hypothesis has been provided by, e.g., Canzoneri et al. (1999) and Chinn and Johnston (1999) based on OECD data.

Money growth is another country characteristic to be explored. A country's money growth rate is an indicator for the general stance of monetary policy: A lower (higher) rate of money growth means a tighter (easier) monetary policy. Unlike productivity changes, which are a source of real shocks, money supply changes represent monetary shocks. If nominal exchange rate and price changes are dominated by monetary rather than real shocks, real exchange rates are expected to adjust relatively fast. It is thus interesting to see if there is any significant negative relationship between half-lives of real exchange rates and money growth rates across countries.

The fourth country characteristic under consideration is government spending, a demand-side factor included in some structural models of real exchange rates (e.g., Frenkel and Razin, 1996; Froot and Rogoff, 1991, Obstfeld and Rogoff, 1996). Unlike private spending, government spending tends to fall more heavily on non-traded goods. Consequently, government spending can affect the relative demand for – and thus the relative price of – traded and non-traded goods. Balvers and Bergstrand (2002) also highlight the complementarity of private and government consumption as an important channel through which government spending can influence the equilibrium real exchange rate. In addition to short-run effects, Alesina and Perotti (1995) show that government spending, if financed by distortionary taxes, can have long-run real effects. De Gregorio et al. (1994) examine panel data from OECD countries and report empirical evidence in support of a positive relationship between government spending and the relative price of traded and non-traded goods. Chinn and Johnston (1999) also find significant evidence from OECD data that government spending affects real exchange rates.

Table 7 shows the differences among the 24 developing countries in terms of structural economic characteristics. The trade openness variable represents the average ratio of total trade to GDP over the relevant sample period. For the productivity growth variable, the average annual rate of growth in real per capita GDP over the sample period is used as a broad proxy. The money growth variable measures the average annual rate of quasi money (M2) growth (adjusted for real GDP growth) over the sample period. The G/GDP growth variable gives the average annual rate of growth in government spending as a share of GDP over the sample period. In general, the cross-country data display huge variability in structural economic characteristics among the developing countries under study.

An inspection of the cross-country variation in either adjustment speeds or structural characteristics suggests that the usual distributional assumption on normality is not tenable for these data. This calls for the use of nonparametric methods in our statistical analysis. We first employ Spearman's rank correlation analysis to gauge the strength (and direction) of the relationship between the half-life of the real exchange rate and each structural economic variable. The rank correlation method makes no assumptions about the data distribution, and it does not require the underlying relationship between the variables to be linear.[5] The rank-based method also works well when the data are not given in precise sample values.

[5] The Pearson product-moment correlation coefficient, which is the standard correlation statistic, measures how well a linear equation describes the relation between two variables. The Spearman rank correlation coefficient, in contrast, measures how well an arbitrary monotonic function can describe the relationship between two variables. The monotonic function can be nonlinear.

To implement the Spearman analysis, all the observations are ranked from the smallest to the largest for each data series. In case when a tie in rank occurs, the observations involved are assigned the average value of the ranks they would receive as if they were in successive order. Considering a pair of variables, say (x_1, x_2), the rank correlation statistic (denoted by ρ) is given by

$$\rho = 1 - \frac{6\sum_{j=1}^{N}[R(x_{1j}) - R(x_{2j})]}{N(N^2 - 1)} \tag{9}$$

where N is the number of observations for each variable, $R(x_{1j})$ is the rank order of the jth observation of variable x_1, and $R(x_{2j})$ is the rank order of the jth observation of variable x_2. The null hypothesis of $\rho = 0$ (i.e., of no correlation between the two variables) can be tested against the alternative hypothesis of $\rho \neq 0$. Based on the rank correlation estimates (not reported but available upon request), little correlation could be found in all but one case. In the exception case, a significantly negative correlation was found between the money growth rate and the half-life of the real official exchange rate. In all the other cases, the correlation estimates were either statistically insignificant or having ambiguous signs or both.

A more formal analysis of the cross-country data is performed using the multiple rank regression method. Similar to rank correlation analysis, rank regression analysis is based on the rank-ordered data instead of the original data. The regression equation includes the various structural economic factors as explanatory variables:

$$HL_j = \zeta_0 + \zeta_1 OPEN_j + \zeta_2 PROD_j + \zeta_3 GOVT_j + \zeta_4 MONEY_j \qquad j = 1, 2, \ldots, N \tag{10}$$

where HL is the half-life of the real exchange rate of the corresponding country, $OPEN$ is the trade openness of the respective economy, $PROD$ is the country's average productivity growth rate, $GOVT$ is the average increase in government spending as a share of the country's GDP, and $MONEY$ is the average money growth rate (adjusted for real GDP growth) in the respective country.

Table 8 contains the results from rank regression analysis, and they are largely consistent with those from rank correlation analysis. The coefficients on the variables of trade openness, productivity growth, and government spending are all found to be statistically insignificant. Some of these coefficients may even have ambiguous signs. For the money growth variable, the coefficient is statistically significant in the case involving the real official exchange rate. The negative coefficient in this case suggests that countries with higher money growth rates tend to have faster speeds of real exchange rate adjustment.[6] However, this finding does not apply to the real parallel exchange rate, which yields a money growth coefficient of an incorrect sign, though it is statistically insignificant. In addition to the separate

[6] The negative relationship found between the adjustment speed and the rate of money growth is consistent with previously reported findings that PPP holds particularly well for economies with high inflation rates (e.g., McNown and Wallace, 1989).

regressions conducted for the BW and the post-BW period, regressions were also run using pooled data from both BW and post-BW periods together, with a time-period dummy being included as well. Qualitatively similar results were obtained from the pooled data that only the money growth coefficient was found to be statistically significant. Overall, the results indicate that most of the observed cross-country variation in adjustment speeds is still unaccounted for.

6. Conclusion

A longstanding issue in exchange rate economics concerns whether exchange rate flexibility aids real exchange rate adjustment. The latter represents an important channel through which an open economy adjusts to disturbances. Some economists consider nominal exchange rate flexibility to be important for facilitating real exchange rate adjustment, while others hold the opposing view that free exchange rate movements may actually disrupt and prolong the real exchange rate adjustment process.

Instead of relying on inter-period comparisons of different exchange rate regimes, as previous studies of industrial countries have done, this study examines the intra-period data on dual exchange rates from developing countries. Specifically, it analyzes whether the flexible parallel market rate implies a faster speed of real exchange rate adjustment than the much less flexible official rate does. The use of the intra-period data on dual exchange rates averts the usual need to control for inter-period differences in economic fundamentals. Based on the information from dual exchange rates, there is no significant evidence that greater nominal exchange rate flexibility tends to produce faster real exchange rate adjustment. Nor is there evidence that it tends to yield slower adjustment. Similar results are obtained from both BW and post-BW data. In general, no systematic relationship can be found between nominal exchange rate flexibility and the speed of real exchange rate adjustment.

Our study also uncovers substantial variation in real exchange rate adjustment speeds across developing countries. These adjustment speed estimates, which are computed in terms of half-lives, are generally found to differ from Rogoff's (1996) range of consensus estimates identified for industrial countries. Further analysis has been conducted to examine if the observed variation in adjustment speeds can be linked to inter-country differences in structural economic characteristics, including trade openness, productivity growth, government spending, and money growth. Although some of the cross-country variation may be linked to inter-country differences in money growth, most of the observed variation in adjustment speeds remains unexplained. This is certainly an area that warrants additional research in the future.[7]

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[7] Opening up an interesting line of research, a new study by Benigno (2004) illustrates how a country's choice of monetary policy rules may influence real exchange rate persistence.

Appendix A

The parallel market premium and PPP deviations

The parallel market premium can be linked to and reflect part of the deviation from PPP. To illustrate, we consider a simple variant of the parallel exchange rate models discussed by Diamandis (2003) and Kouretas and Zarangas (1998), under which both financial and goods arbitrages take place in the parallel foreign exchange market. All the model variables are in logarithms. Financial arbitrageurs exploit any divergence between the official and the parallel market rate, and their net supply of foreign exchange in the parallel market is described by

$$S_{Pt} = \theta_0 + \theta_1(e_{Pt} - e_{Ot}), \qquad \theta_1 > 0 \tag{A.1}$$

where e_{Pt} is the parallel market rate and e_{Ot} is the official rate (all expressed as domestic currency per US dollar). This indicates that as the parallel market premium increases, so does the profit incentive to meet demand for foreign exchange in the parallel market. Goods arbitrages, on the other hand, are carried out based on the differential between the foreign price (p_{Ft}) and the domestic price (p_{Dt}). Since demand for foreign exchange rises as foreign goods become cheaper relative to domestic goods, the net demand for foreign exchange from goods arbitrageurs in the parallel market is specified as

$$D_{Pt} = \zeta_0 + \zeta_1(p_{Dt} - e_{Pt} - p_{Ft}), \qquad \zeta_1 > 0 \tag{A.2}$$

where $p_{Dt} - e_{Pt}$ gives the domestic price in foreign currency units (i.e., in U.S. dollars). At market equilibrium (i.e., when $S_{Pt} = D_{Pt}$), equations (A.1) and (A.2) combine to yield the following condition:

$$e_{Pt} - e_{Ot} = \varphi_0 + \varphi_1(\bar{e}_t - e_{Ot}) \tag{A.3}$$

where $\varphi_0 = (\zeta_0 - \theta_0)/(\theta_1 + \zeta_1)$, $\varphi_1 = \zeta_1/(\theta_1 + \zeta_1)$, and $\bar{e}_t = p_{Dt} - p_{Ft}$ is the PPP-implied equilibrium rate. To the extent that PPP prevails in the long run, the parallel market premium, $e_{Pt} - e_{Ot}$, is stationary, implying the existence of a long-run equilibrium relation between e_{Pt} and e_{Ot}.

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Table 1. The mean absolute size of nominal exchange rate movements

Country	Bretton Woods		Post-Bretton Woods	
	Official rate	Parallel rate	Official rate	Parallel rate
Argentina	2.38	4.02	8.24	9.40
Bolivia	0.59	1.59	4.20	5.47
Brazil	3.09	4.61	9.12	9.78
Chile	2.42	5.42	2.56	3.57
Colombia	1.25	2.44	1.61	2.27
Costa Rica	0.09	1.55	1.52	2.83
Dominican Republic	0.00	3.19	1.47	2.38
Ecuador	0.27	1.97	1.96	3.00
Egypt	0.11	3.83	0.77	2.74
El Salvador	0.00	1.25	0.49	3.94
India	0.45	2.85	1.31	2.84
Israel	0.44	1.83	3.50	4.98
Korea	1.13	3.08	1.06	2.59
Malaysia	0.16	0.62	1.26	1.73
Mexico	0.00	0.03	2.71	3.46
Morocco	0.16	1.98	1.82	2.58
Pakistan	0.56	3.07	0.58	2.35
Paraguay	0.39	1.38	1.19	2.67
Philippines	0.70	2.41	1.28	2.79
South Africa	0.19	1.51	2.10	5.31
Sri Lanka	0.22	3.62	1.54	2.33
Thailand	0.04	0.99	0.83	2.46
Uruguay	3.14	4.52	3.39	3.91
Venezuela	0.24	0.33	1.89	3.34

All the numbers reported in this table are expressed in percentage terms.

Table 2. The average size and variability of the parallel market premium

Country	Bretton Woods		Post-Bretton Woods	
	Mean	St. Dev.	Mean	St. Dev.
Argentina	11.60	23.60	26.34	35.25
Bolivia	12.83	15.91	23.50	47.61
Brazil	10.26	14.34	21.06	21.26
Chile	40.17	49.46	15.24	14.72
Colombia	21.22	18.37	7.68	6.80
Costa Rica	20.68	11.46	13.60	12.71
Dominican Republic	24.38	9.07	23.90	23.23
Ecuador	15.82	7.80	19.88	21.81
Egypt	74.99	23.84	42.39	39.10
El Salvador	16.60	6.64	41.09	33.35
India	38.05	15.88	12.49	7.20
Israel	16.92	9.37	9.10	12.53
Korea	34.94	32.38	4.40	6.52
Malaysia	1.95	1.91	0.63	2.04
Mexico	-0.08	0.04	8.37	13.85
Morocco	12.05	6.87	4.39	4.30
Pakistan	54.60	18.31	12.98	10.66
Paraguay	14.06	13.53	31.58	34.18
Philippines	22.36	25.88	6.36	6.49
South Africa	6.87	4.51	9.16	9.58
Sri Lanka	67.59	28.46	20.34	20.13
Thailand	1.26	2.10	0.13	3.39
Uruguay	35.56	48.68	8.77	10.52
Venezuela	10.41	15.55	24.69	38.72

The parallel market premium is measured in percentage terms.

Table 3. Testing for mean reversion in the parallel market premium

Country	Bretton Woods		Post-Bretton Woods	
	$d-1$	t-stat	$d-1$	t-stat
Argentina	0.00	(0.01)	-0.20	(-2.83)*
Bolivia	-0.06	(-3.54)*	-0.38	(-4.21)*
Brazil	-0.64	(-5.16)*	-0.32	(-2.94)*
Chile	-0.06	(-1.98)*	-0.41	(-3.59)*
Colombia	-0.35	(-10.58)*	-1.09	(-12.58)*
Costa Rica	-0.79	(-6.39)*	-0.23	(-3.00)*
Dominican Republic	-0.27	(-3.48)*	-0.99	(-6.92)*
Ecuador	-0.30	(-4.85)*	-0.20	(-2.38)*
Egypt	-1.16	(-5.34)*	0.09	(1.00)
El Salvador	-0.04	(-2.20)*	-0.12	(-1.99)*
India	-1.06	(-7.91)*	-1.08	(-8.80)*
Israel	-1.01	(-5.20)*	-0.09	(-1.15)
Korea	-0.84	(-42.63)*	-1.33	(-26.61)*
Malaysia	-0.38	(-6.63)*	-1.35	(-3.43)*
Mexico	-0.25	(-8.54)*	-0.64	(-8.62)*
Morocco	-0.32	(-4.12)*	-1.44	(-13.10)*
Pakistan	-1.41	(-5.97)*	-0.18	(-3.56)*
Paraguay	-0.89	(-4.44)*	-0.44	(-4.12)*
Philippines	-0.27	(-3.35)*	-1.10	(-12.42)*
South Africa	-0.94	(-6.62)*	-0.41	(-8.74)*
Sri Lanka	-0.08	(-2.32)*	-0.46	(-7.77)*
Thailand	-1.26	(-7.84)*	-1.36	(-21.38)*
Uruguay	-0.98	(-7.08)*	-0.33	(-3.82)*
Venezuela	-1.44	(-7.71)*	-0.77	(-3.78)*

The unit-root null hypothesis of $d-1=0$ is tested against the mean-reverting fractional alternative of $d-1<0$. The numbers in parentheses are the t-statistics for the corresponding estimates. Statistical significance is indicated by an asterisk (*) for the 5% level.

Table 4. Testing for mean reversion in real official and parallel exchange rates

Country	Bretton Woods				Post-Bretton Woods			
	Real official rate		Real parallel rate		Real official rate		Real parallel rate	
	$d-1$	*t*-stat	$d-1$	*t*-stat	$d-1$	*t*-stat	$d-1$	*t*-stat
Argentina	-0.18	(-6.10)*	-0.14	(-2.05)*	-0.25	(-3.08)*	-0.14	(-2.83)*
Bolivia	-0.75	(-6.88)*	-0.06	(-1.92)	-0.50	(-8.63)*	-0.07	(-0.68)
Brazil	-1.21	(-8.56)*	-0.10	(-2.07)*	-0.74	(-6.22)*	-0.16	(-2.90)*
Chile	-0.95	(-4.73)*	0.05	(0.86)	0.06	(1.18)	-0.13	(-1.48)
Colombia	-0.19	(-3.31)*	-0.83	(-6.64)*	0.12	(1.71)	0.05	(0.99)
Costa Rica	-0.04	(-0.49)	-0.85	(-8.59)*	-1.02	(-5.09)*	-0.14	(-0.80)
Dominican Republic	-1.09	(-6.65)*	-1.02	(-7.48)*	-0.14	(-3.95)*	-0.93	(-12.62)*
Ecuador	-0.10	(-2.07)*	-0.03	(-0.73)	-0.11	(-1.39)	-0.24	(-3.65)*
Egypt	-0.82	(-5.74)*	-1.04	(-8.76)*	0.06	(0.84)	-0.20	(-3.04)*
El Salvador	-0.07	(-0.88)	-0.82	(-5.64)*	-0.92	(-15.97)*	-0.87	(-4.64)*
India	-0.94	(-3.53)*	-1.14	(-5.63)*	-0.74	(-3.27)*	-0.73	(-3.94)*
Israel	-0.10	(-1.64)	-0.70	(-4.24)*	-0.07	(-2.85)*	-0.26	(-17.18)*
Korea	-1.05	(-4.41)*	-0.92	(-9.24)*	-0.95	(-7.95)*	-1.02	(-4.88)*
Malaysia	-0.78	(-4.51)*	-0.11	(-2.78)*	-1.42	(-4.42)*	-0.92	(-6.75)*
Mexico	-0.03	(-0.81)	-0.03	(-24.32)*	-0.85	(-8.05)*	-0.10	(-2.22)*
Morocco	0.04	(-0.58)	-0.34	(-4.28)*	0.07	(1.39)	-0.03	(-0.26)
Pakistan	-0.03	(-3.94)*	-0.33	(-3.93)*	0.09	(1.64)	-1.17	(-7.56)*
Paraguay	0.02	(0.57)	-0.03	(-2.28)*	-0.04	(-4.59)*	-0.02	(-17.43)*
Philippines	-0.68	(-5.10)*	0.03	(0.58)	-0.80	(-4.07)*	-0.87	(-4.16)*
South Africa	-0.19	(-4.12)*	-1.29	(-5.78)*	-0.26	(-3.64)*	-0.19	(-4.08)*
Sri Lanka	-0.03	(-5.43)*	-0.06	(-1.92)	-0.14	(-2.40)*	-0.03	(-0.22)
Thailand	-1.03	(-11.99)*	-1.10	(-8.08)*	-0.96	(-12.34)*	-1.05	(-29.30)*
Uruguay	-1.09	(-4.96)*	-0.84	(-4.57)*	-0.75	(-7.20)*	0.04	(0.52)
Venezuela	-0.06	(-2.00)*	-0.26	(-2.97)*	-0.15	(-2.89)*	-0.15	(-2.54)*

The unit-root null hypothesis of $d-1=0$ is tested against the mean-reverting fractional alternative of $d-1<0$. The numbers in parentheses are the *t*-statistics for the corresponding estimates. Statistical significance is indicated by an asterisk (*) for the 5% level.

Table 5. Estimates of adjustment speeds for real official and parallel rates

Country	Bretton Woods		Post-Bretton Woods	
	Real official rate	Real parallel rate	Real official rate	Real parallel rate
	Half-life	Half-life	Half-life	Half-life
Argentina	13.97	9.86	1.29	5.31
Bolivia	5.16	100+	0.15	0.11
Brazil	0.61	35.30	2.08	4.88
Chile	0.73	∞	∞	100+
Colombia	6.25	1.12	∞	∞
Costa Rica	100+	1.95	0.57	80.51
Dominican Republic	0.69	0.44	7.02	2.84
Ecuador	58.83	100+	34.52	13.61
Egypt	2.56	0.48	∞	1.04
El Salvador	34.33	1.91	0.64	1.37
India	1.16	0.57	2.27	1.48
Israel	34.61	1.73	46.33	0.50
Korea	1.06	1.76	1.52	0.91
Malaysia	2.07	23.56	1.22	1.45
Mexico	100+	100+	2.65	59.28
Morocco	∞	0.73	∞	100+
Pakistan	100+	0.71	∞	0.32
Paraguay	100+	100+	100+	100+
Philippines	1.58	∞	1.89	1.11
South Africa	1.60	0.39	5.70	1.80
Sri Lanka	100+	100+	4.27	100+
Thailand	0.73	0.64	1.49	0.70
Uruguay	0.46	1.07	4.60	∞
Venezuela	100+	2.09	4.61	100+

All half-life estimates are expressed in years. For half-life estimates that are longer than 100 years, they are indicated by "100+" in the table. In cases in which the real exchange rate process yields an estimated integration order greater than one (i.e., $d > 1$), it is indicated by "∞" and considered as having an infinite half-life.

Table 6. Sampling uncertainty in half-life estimates

Country	Bretton Woods				Post-Bretton Woods			
	Real official rate		Real parallel rate		Real official rate		Real parallel rate	
	$LB_{95\%}$	$UB_{95\%}$	$LB_{95\%}$	$UB_{95\%}$	$LB_{95\%}$	$UB_{95\%}$	$LB_{95\%}$	$UB_{95\%}$
Argentina	[0.39,	∞]	[0.71,	100+]	[0.31,	17.94]	[0.31,	100+]
Bolivia	[0.63,	5.60]	[0.99,	∞]	[0.10,	0.25]	[0.08,	∞]
Brazil	[0.30,	0.71]	[0.51,	100+]	[0.79,	17.07]	[0.45,	100+]
Chile	[0.32,	0.81]	[33.32,	∞]	[100+,	∞]	[0.89,	∞]
Colombia	[0.37,	100+]	[0.65,	2.10]	[3.78,	∞]	[100+,	∞]
Costa Rica	[1.75,	100+]	[1.19,	2.38]	[0.23,	4.03]	[1.07,	100+]
Dominican Republic	[0.24,	0.85]	[0.24,	0.53]	[0.55,	100+]	[0.94,	12.30]
Ecuador	[0.55,	100+]	[1.71,	∞]	[0.36,	∞]	[0.99,	100+]
Egypt	[0.80,	3.18]	[0.23,	0.64]	[0.63,	∞]	[0.23,	12.98]
El Salvador	[0.17,	∞]	[0.62,	2.15]	[0.39,	3.46]	[0.40,	100+]
India	[0.42,	1.24]	[0.33,	0.58]	[0.99,	9.93]	[0.61,	4.07]
Israel	[0.50,	∞]	[0.46,	2.40]	[1.41,	100+]	[0.18,	1.78]
Korea	[0.44,	1.09]	[0.63,	2.14]	[0.59,	6.37]	[0.49,	3.62]
Malaysia	[0.66,	2.54]	[0.47,	100+]	[1.07,	8.45]	[0.67,	12.18]
Mexico	[1.47,	∞]	[1.47,	∞]	[1.02,	53.96]	[0.95,	100+]
Morocco	[100+,	∞]	[0.22,	3.67]	[100+,	∞]	[0.63,	∞]
Pakistan	[1.46,	∞]	[0.24,	6.88]	[100+,	∞]	[0.18,	12.09]
Paraguay	[7.21,	∞]	[1.64,	∞]	[2.87,	∞]	[6.93,	∞]
Philippines	[0.77,	3.04]	[11.13,	∞]	[0.57,	12.58]	[0.46,	3.95]
South Africa	[0.23,	86.31]	[0.27,	0.42]	[0.78,	100+]	[0.31,	23.29]
Sri Lanka	[1.72,	∞]	[0.87,	∞]	[0.23,	100+]	[1.20,	∞]
Thailand	[0.41,	0.98]	[0.48,	1.06]	[0.69,	6.70]	[0.35,	32.61]
Uruguay	[0.24,	0.50]	[0.41,	1.26]	[1.23,	21.48]	[2.81,	∞]
Venezuela	[0.88,	∞]	[0.35,	41.25]	[0.48,	100+]	[1.91,	∞]

All half-life estimates are expressed in years. For half-life estimates that are longer than 100 years, they are indicated by "100+" in the table. [$LB_{95\%}$, $UB_{95\%}$] indicates the lower and upper bounds of the 95% confidence interval for the corresponding half-life estimate.

Table 7. Cross-country differences in structural economic characteristics

Country	Bretton Woods				Post-Bretton Woods			
	Trade openness	Productivity growth	Money growth	G/GDP growth	Trade openness	Productivity growth	Money growth	G/GDP growth
Argentina	22.05	14.93	18.22	-10.59	17.32	0.16	183.55	-1.21
Bolivia	43.58	3.25	22.45	1.70	47.70	0.13	94.72	1.35
Brazil	13.57	6.03	43.28	-1.33	17.65	1.52	266.31	3.01
Chile	74.31	13.86	42.38	3.22	52.73	2.95	46.45	-1.30
Colombia	27.37	3.94	19.56	3.47	31.22	1.69	34.29	3.57
Costa Rica	54.74	3.16	7.93	2.90	73.87	1.24	25.53	-0.41
Dominican Republic	39.62	2.72	14.66	-2.81	64.02	1.97	17.29	-0.88
Ecuador	35.54	2.95	10.50	-0.97	52.53	0.92	10.23	-0.09
Egypt	37.84	N.A.	N.A.	3.27	53.13	2.75	14.75	-3.45
El Salvador	51.78	2.32	7.66	0.06	57.62	0.41	10.95	-0.45
India	10.60	1.46	9.80	1.99	16.60	2.72	14.84	1.54
Israel	65.06	4.61	0.71	4.56	91.06	2.10	61.91	-1.36
Korea	26.68	4.51	42.07	-0.69	68.59	5.76	15.04	0.59
Malaysia	87.13	7.01	11.50	1.96	130.66	3.97	9.95	-1.87
Mexico	20.59	3.32	9.46	4.43	34.16	1.21	38.72	0.54
Morocco	42.52	1.22	9.72	0.13	50.04	1.52	14.67	1.70
Pakistan	20.62	1.12	14.37	2.45	33.81	2.37	12.71	0.57
Paraguay	30.80	1.89	24.79	0.17	54.74	1.53	22.47	1.70
Philippines	30.23	1.78	10.91	1.51	59.56	0.62	19.25	1.66
South Africa	52.29	2.19	6.55	2.15	50.56	-0.40	11.81	1.74
Sri Lanka	54.02	3.96	7.14	-0.45	70.60	3.76	17.70	-0.70
Thailand	37.48	4.24	15.02	1.43	63.38	4.85	12.44	0.70
Uruguay	26.35	-0.24	35.45	1.51	39.70	2.18	63.65	-0.74
Venezuela	48.52	2.05	7.75	0.25	53.25	-0.37	26.22	-1.70

All the above numbers are given in percent per year, and they represent average values over the corresponding sample period.

Table 8. Multiple rank regression analysis of the cross-country differences in adjustment speeds

	Bretton Woods		Post-Bretton Woods	
	Real official rate	Real parallel rate	Real official rate	Real parallel rate
Trade Openness	-0.077	0.148	-0.347	-0.089
	(0.218)	(0.261)	(0.257)	(0.263)
Productivity Growth	-0.007	0.255	0.237	-0.038
	(0.203)	(0.243)	(0.229)	(0.235)
Government Spending	0.011	-0.032	-0.075	0.038
	(0.188)	(0.225)	(0.241)	(0.247)
Money Growth	-0.666	0.187	-0.125	0.217
	(0.216)*	(0.259)	(0.231)	(0.237)
R^2	0.411	0.144	0.118	0.079

The dependent variable is the adjustment speed measured in terms of the half-life of the real exchange rate. Standard errors of the coefficient estimates are given in parentheses. Statistical significance is indicated by an asterisk (*) for the 5% level.

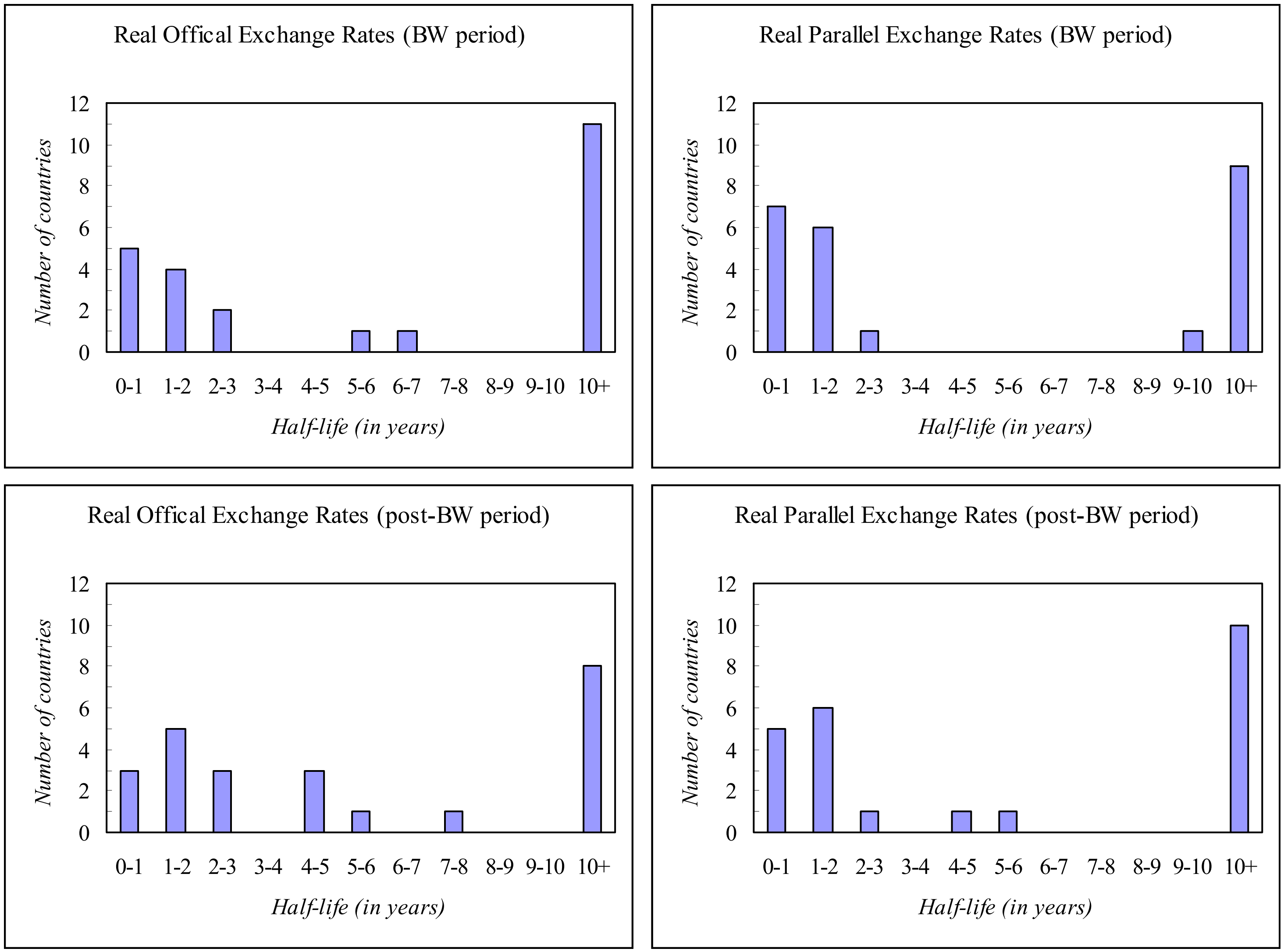

Fig. 1. Cross-country differences in half-life estimates

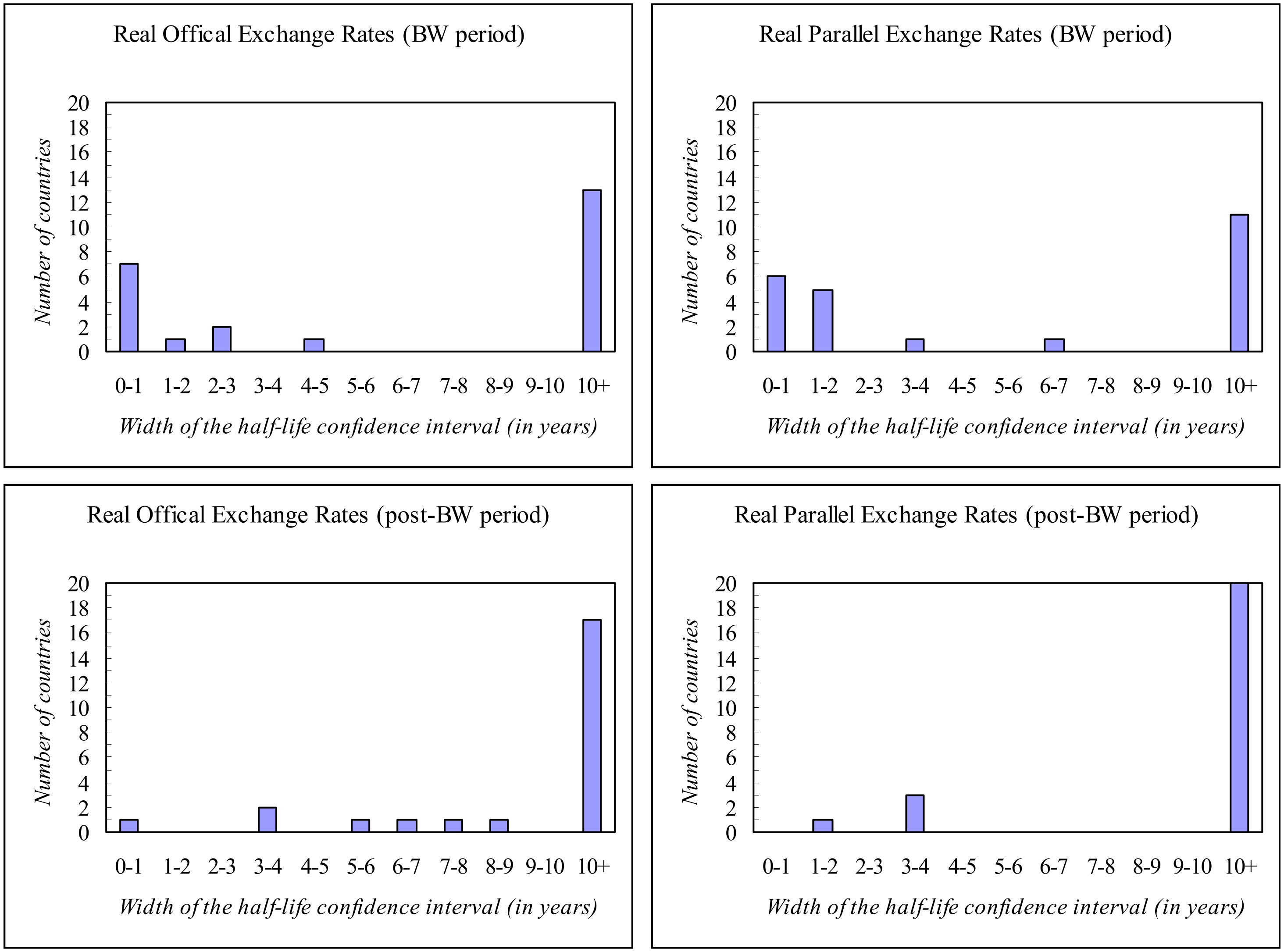

Fig. 2. Cross-country variation in the uncertainty in half-life estimation