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Essays in International Macroeconomics

by

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A thesis submitted for the degree of

Doctor of Philosophy

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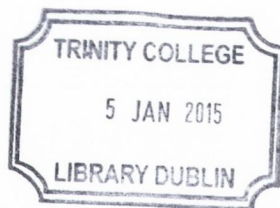
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2014

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Thesis 10460

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Short Non-Technical Summary

This thesis comprises three essays on topics in international macroeconomics. In particular, the research conducted in this thesis focuses on the dynamics of real exchange rates and external imbalances, and is predominantly of the empirical variety.

The first of the three essays examines the persistence of real exchange rates across the globe post Bretton Woods. The analysis is performed on a country-by-country basis using univariate time series techniques given the high degree of heterogeneity in the dynamics of real exchange rates across countries. Significantly, our study considers empirical models of the real exchange rate that allow for deterministic structural breaks and non-linearities in the adjustment process, where the latter can be justified from both traded goods and financial asset market perspectives. The estimates of real exchange rate inertia that we obtain are consistent with the notion of nominal rigidities presiding over the short run, with rates of mean-reversion typically being higher for multilateral exchange rates. Moreover, industrial countries are found to have the highest rates of persistence, while, from a geographical standpoint, Latin America and Africa tend to be characterised by the fastest rates of real exchange rate convergence.

The second essay investigates the connection between the real exchange rate persistence estimates derived in the first paper and a collection of country-specific macroeconomic and geographic factors in order to ascertain the potential reasons for the variation in parity-reversion rates across nations. For this purpose we adopt a cross-sectional parametric approach. The results indicate that higher inflation, nominal exchange rate volatility and trade openness are associated with faster real exchange rate mean-reversion. Conversely, for bilateral exchange rates, it is found that countries located further away from the reference country are characterised by greater real exchange rate inertia. Some modest evidence of a positive relation between productivity growth and persistence is also attained. The degree of international financial openness only matters at the country group level, with differences across groups perhaps obscuring results in full samples. Further elaborating, developing economies exhibit a positive comovement between the two variables, while more advanced economies display signs of a negative link. In the case of the former cohort of nations, there is a

suggestion that the relation may be driven by the debt and reserve components. Additional scrutiny along qualitative lines reveals that foreign exchange reserves are positively correlated with real exchange rate inertia in the non-industrialised world.

The final essay contributes to the literature on external imbalances by analysing the bivariate relation between large current account imbalances and the real exchange rate over different degrees of nominal exchange rate variability. The study is conducted using a panel framework for a large group of advanced and non-advanced economies over the post Bretton Woods period yet again. Employing linear and non-linear estimation procedures our findings unequivocally suggest that nominal exchange rate flexibility or volatility plays an influential role in the aforementioned relation. Specifically, at lower nominal exchange rate rigidity levels, an inverse correlation between large imbalances and the real exchange rate can be observed. This is in contrast to the often non-existent or positive comovement that materialises under regimes that entail lower nominal exchange rate variation. From our results we infer that greater nominal exchange rate adjustment can induce a stabilising current account-real exchange rate relation, in the sense that it helps to establish a negative link between the two variables. The results are ultimately interpreted as offering evidence of more effective and immediate expenditure-switching-based adjustment at higher nominal exchange rate flexibility levels. Controlling for the real exchange rate, we also find that current account persistence decreases with nominal exchange rate flexibility or volatility. This is consistent with the notion that there can also be greater scope for interest rate-based output-shifting effects under more flexible exchange rate arrangements. Put differently, there may be added potential for the expenditure-shifting channel to act as another outlet for current account adjustment in such an environment. The second part of the paper executes further checks along the cross-section. The most salient findings in this latter section are a) the striking positive relation between current account persistence and real exchange rate persistence based on country-specific estimates and b) the inverse correlation between persistence in either the current account or real exchange rate and nominal exchange rate volatility.

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Chapter 1

General Introduction

1.1 Brief Overview

This thesis is a collection of three essays that explore topics in the field of international macroeconomics. In particular, the research focuses on issues pertaining to the dynamics of real exchange rates and external imbalances and seeks to empirically address any questions. Although the three chapters that follow have been written as separate pieces of work, they are all interlinked to varying degrees both through the subjects examined and the data set estimates that carry over from the first of these chapters. Notably, the persistence of variables is a reoccurring theme throughout all three research projects.

In chapter 2 we contribute to the literature on the persistence of real exchange rate parity deviations. Indeed, this is a topic that has often featured at the heart of exchange rate policy debates since the rate at which the real exchange rate converges can determine the extent to which the macroeconomic system is self-equilibrating. Our study is novel in that it is a global analysis which endeavours to more accurately capture the dynamics of real exchange rates by accounting for deterministic structural breaks and adjustment non-linearities in univariate country-by-country time series specifications. Non-linear speeds of convergence can be rationalised from both traded goods and financial asset market perspectives. The univariate time series approach is preferred due to the high degree of heterogeneity in dynamics across countries, which may obscure results in a panel setting, and since we seek to provide an initial descriptive survey of country-specific aggregate rates of adjustment. As we discuss, studies of this particular variety have been relatively scarce.

Regarding the findings, our empirical models yield real exchange rate inertia levels consistent with the notion of nominal rigidities presiding over the short run, with rates of mean-reversion typically higher for multilateral exchange rates. More specifically, the median half-life of real exchange rate parity deviations over the entire sample is found to be considerably less than 2 years in the case of bilateral exchange rates, and less than 1 year in the case of effective exchange rates. Furthermore,

industrial countries are reported to have the slowest rates of adjustment, while, from a geographical standpoint, Latin America and Africa tend to be characterised by the fastest rates of real exchange rate convergence.

In chapter 3 we aim to investigate the link between the real exchange rate persistence estimates of chapter 2 and a set of macroeconomic and geographic factors in order to discern the potential reasons for the cross-country variation in parity-reversion rates. For this purpose we adopt a cross-sectional parametric approach. Our research fills an important gap in the field. In particular, a survey of the relevant literature reveals that studies on the drivers of the persistence of real exchange rate misalignments are limited in number, with virtually no existing work of the global and parametric nature.

The results indicate that higher inflation, nominal exchange rate volatility and trade openness are associated with faster real exchange rate mean-reversion. Conversely, for bilateral exchange rates, it is found that countries located further away from the reference country are characterised by greater real exchange rate inertia. Some modest evidence of a positive relation between productivity growth and persistence is also posited. The degree of international financial openness only matters at the country group level, with differences across groups perhaps obscuring results in full samples. Further elaborating, developing economies exhibit a positive comovement between the two variables, while more advanced economies display signs of a negative link. In the case of the former cohort of nations, the relation appears to be driven by the debt and reserve components when the analysis is based on bilateral exchange rates. Additional scrutiny also reveals that foreign exchange reserves are positively correlated with real exchange rate inertia in the non-industrialised world.

Chapter 4 contributes to the literature on external imbalances by analysing the bivariate relation between large current account imbalances and the real exchange rate over different degrees of nominal exchange rate variability. The study is conducted using a panel framework for a large group of advanced and non-advanced economies over the post Bretton Woods period. Employing linear and non-linear estimation procedures our findings unequivocally suggest that nominal exchange rate flexibility or volatility plays an influential role in the aforementioned relation. Specifically, at lower nominal exchange rate rigidity levels, an inverse correlation between large imbalances and the real exchange rate can be observed. This is in contrast to the often non-existent

or positive comovement that materialises under regimes that entail lower nominal exchange rate variation. From our results, we infer that greater nominal exchange rate adjustment can induce a stabilising current account-real exchange rate relation, in the sense that it helps to establish a negative link between the two variables. The results are ultimately interpreted as offering evidence of more effective and immediate expenditure-switching-based adjustment at higher nominal exchange rate flexibility levels.¹

Controlling for the real exchange rate, we also find that current account persistence decreases with nominal exchange rate flexibility or volatility. This is consistent with the notion that there can also be greater scope for interest rate-based output-shifting effects under more flexible exchange rate arrangements. Put differently, there may be added potential for the expenditure-shifting channel to act as another outlet for current account adjustment in such an environment.²

The final part of the chapter executes further checks along the cross-section. The most salient findings in this latter section are a) the striking positive relation between current account persistence and real exchange rate persistence based on country-specific estimates and b) the inverse correlation between persistence in either the current account or real exchange rate and nominal exchange rate volatility.

Lastly, chapter 5 reiterates the general findings and conclusions of this dissertation and offers directions for future research. The next section provides a discussion of the relevant literature related to each of the three studies that follow in chapters 2-4.

¹ Broadly, expenditure-switching in our context refers to the mechanism through which real exchange rate changes can engender movements in the current account. For instance, if the home country undergoes a real currency depreciation vis-à-vis the rest of the world (or foreign country), expenditure-switching would entail the transfer of domestic and foreign residents' spending towards the goods of the home country. See chapter 4 for further information, including caveats.

² The terms "output-shifting" and "expenditure-shifting" are used synonymously in our analysis. To briefly elaborate, a change in a country's output and total expenditure can result in a change in its external imbalance via the residents' demand for imports, provided that there are no symmetric developments in the nations' exports (foreign import demand). For example, a number of the peripheral euro area economies narrowed their current account deficits through recessions post-2008. Under less rigid exchange rate systems (and capital mobility), interest rate movements might occur more frequently given monetary sovereignty. If these interest rate changes have an impact on output/expenditure, the current account balance may ultimately be affected. Hence the term "interest rate-based (or induced) output shifting". Naturally, the interest rate-based output shifting effect can be of the variety that aids current account reversion to equilibrium, or of the type that acts in the offsetting direction to the adjustment process.

1.2 Related Literature

1.2.1 Mean-Reversion in Real Exchange Rates: A Cross-Country Analysis

Initially advocated by the 16th century scholars of the University of Salamanca, the purchasing power parity (PPP) hypothesis was revitalised during the interwar period as debate concerning the level at which international exchange rate parities should be re-established ensued (Taylor and Taylor 2004). The concept, in its original formulation, indicates that the price levels of two countries should be equal when converted to the same currency. Generally it is said that if absolute PPP holds, the real exchange rate should equal one. However, in the literature, what are often examined are deviations from relative PPP, a weaker version of the theory, given the use of price indices in the construction of real exchange rate series. With price indices equalised in an arbitrary base year, studies analyse how fast relative prices denominated in the same currency revert to a constant long-run mean not necessarily equal to one (Alba and Papell 2007). In particular, relative PPP requires that any changes in relative prices be proportional to changes in the nominal exchange rate. A further point to note is that, in the literature, the concept of the half-life is frequently used as a measure of real exchange rate persistence. Formally, the half-life is defined as the amount of time required for a unit impulse to dissipate permanently by one half from the occurrence of an initial deviation from equilibrium.

Indeed, a plethora of empirical papers exist in this field, with the majority of work focusing on the industrialised world. Most of the investigations into PPP in the past two decades have adopted a linear panel approach and reported evidence in favour of the doctrine. Examples of such studies include those by Wu (1996), MacDonald (1996), Jorion and Sweeney (1996), Papell (1997), Papell and Theodoridis (1998, 2001) and Muray and Papell (2005b) to mention but a few. Other studies, such as that of Imbs et al. (2005), have contended that an upward bias arises in persistence estimates with use of aggregate real exchange rates. These analyses instead have employed sectoral data and found much shorter half-lives. Nevertheless, a recent paper by Carvalho and Nechio (2011) shows that real exchange rate adjustment occurs very slowly even at the sectoral level. On the other hand, O'Connell (1998) suggests that support for PPP diminishes once cross-sectional dependence is accounted for in the panel setting. In univariate time series cases, studies such as that of Culver and Papell (1995) and

Cheung and Lai (1998) have also incorporated deterministic breaks in the search for long-run PPP. In particular, the trend-break hypothesis can be important in PPP frameworks when substantial changes in differential productivity growth in tradables and non-tradables arise across countries.

A number of authors, such as Dumas (1992) and Sercu et al. (1995), have developed theoretical models that advocate non-linear real exchange rate adjustment arising from transactions costs in international (goods) arbitrage. As we explain in the next chapter, these non-linearities can be rationalised in both traded goods and financial asset market contexts, although the latter of the two appears to be empirically more important. Two notable empirical contributions that account for such non-linearities are the works of Michael et al. (1997) and Taylor et al. (2001). These studies employed univariate exponential smooth transition autoregressive (ESTAR) time series models that treat real exchange rate dynamics symmetrically across appreciations and depreciations relative to equilibrium. Crucially, the model implies that when deviations from relative PPP are small, the real exchange rate meanders like a random walk, while exhibiting increasing parity-reversion with larger misalignments. Across bilateral rates for the UK, US, Germany, France and Japan, both groups of authors obtain support in favour of this representation of real exchange rate dynamics.

In contrast to the smooth transition models, other early studies, such as those of Obstfeld and Taylor (1997) and Michael et al. (1994a), adopted discrete regime-switching models. Specifically, the authors use threshold autoregressive (TAR) specifications that entail a sharp switch between the inner band of real exchange rate inaction and the outer band of adjustment characterised by large PPP deviations. Indeed, the ESTAR model may be viewed as a generalisation of a particular form of the two-threshold TAR model employed by Michael et al. (1994a).

Global country-specific exchange rate persistence analyses of the variety we conduct are few and far between. To the best of our knowledge, only two global studies examining parity reversion on a country-by-country basis have been produced to date. These include papers by Cheung and Lai (2000a) and Cashin and McDermott (2006). The first of these empirical papers assesses the dynamics of monthly bilateral real exchange rates vis-à-vis the US during the post-1973 period for a group of 94 advanced and developing countries. According to ADF, DF-GLS, fractional and sequential unit

root tests, around two-thirds of the countries display evidence of statistically significant mean-reversion. The authors highlight the significant heterogeneity in country-specific mean-reverting dynamics and note the limitations of a panel approach in such a scenario. Their estimates indicate that industrial countries are characterised by half-lives ranging between 2 to 5 years, in contrast to those of developing economies, which are mostly found to be less than 3 years.

The second analysis investigates the dynamics of monthly multilateral real exchange rate parity deviations for 90 developed and developing economies over the post-Bretton Woods period. Using median-unbiased estimates from linear autoregressive models, Cashin and McDermott report that the typical half-life for advanced economies is about 8 years. On the other hand, they find estimates for developing nations that suggest permanent deviations from parity. Unlike Cheung and Lai (2000a), they conclude that industrial countries display the fastest rates of real exchange rate adjustment and find this pattern to hold in the case of standard estimates also.

Our study improves upon these two pieces of work in a number of ways. First, we model both adjustment non-linearities and deterministic structural breaks in our empirical real exchange rate specifications. Second, we conduct the analysis across a much broader range of countries (151 to be exact) and significantly update the sample period (1973:1-2010:12). Third, we report findings across different specifications for both bilateral and multilateral exchange rates in order to draw comparisons and avoid bias.

Alluding to the second point, it is worth highlighting that our time series cover the early to middle stages of the recent global crisis during which significant aggregate demand and exchange rate shifts occurred as untenable large global imbalances began to unwind. To the extent that mean (or equilibrium)-reversion in the current account is associated with mean-reversion in the real exchange rate, the exchange rate swings that materialised should have acted to attenuate the degree of persistence in relative prices. Indeed, many economic analysts and policy-makers contended that euro area real exchange rates were heavily misaligned in the lead up to the crisis. Although we do not explicitly report results from truncated samples that exclude the ‘Great Recession’ period and that are, more generally, comparable to those of the two aforementioned

global studies, we do note that such sensitivity analyses in previous versions of our paper indicate no major changes in the central conclusions.

1.2.2 Country Characteristics and the Persistence of Real Exchange Rate Parity Deviations

What factors can help account for cross-country differences in real exchange rate parity reversion rates? According to Cheung et al. (2001), this is a question that has received relatively little attention despite its significance. In the second section of their study, Cheung and Lai (2000a) non-parametrically document the cross-sectional link between half-lives and structural characteristics. The authors find a negative Spearman rank correlation between the half-life and inflation, and the opposite correlation when considering government expenditure instead. Although they do not explicitly examine the link between real exchange rate persistence and nominal exchange rate rigidity, Cheung and Lai (2000a) do highlight that the PPP rejection rate is significantly lower for currencies pegged to the US dollar.

However, in a later study Cheung and Lai (2007) directly investigate whether greater nominal exchange rate flexibility aids real exchange rate adjustment based on data from dual exchange rates in 24 developing economies. In particular, noting the higher variability in parallel market rate changes than in official rate changes, the authors enquire if the more flexible parallel market rates yield faster real exchange rate convergence than the more rigid official rates. Employing fractional time series procedures, half-life estimates suggest no systematic differences in rates of real exchange rate adjustment across official and parallel rates over both Bretton Woods and post-Bretton Woods periods. Based on the unconventional dual exchange rate system analysis, Cheung and Lai (2007) conclude that there is no significant evidence that greater nominal exchange rate flexibility engenders either faster or slower real rate adjustment.

Indeed, an important factor that has long featured in hotly contested debates regarding its role in the adjustment process is nominal exchange rate flexibility or volatility. The issue dates back to the arguments of Nurkse (1944) and Friedman (1953) on the stabilising or destabilising nature of speculation. Nurkse (1944) contended that speculative exchange rate changes would have the tendency of amplifying and

protracting disequilibria rather than accelerating economic adjustment. Conversely, Friedman (1953) claimed that adjustment would occur more easily under greater flexibility, as the required changes in the real exchange rate would be achieved through the nominal exchange rate channel rather than through relatively sluggish price adjustment. Friedman notes that speculative forces could actually enhance the rate of real exchange rate adjustment and thereby hasten the equilibrating process in the wider economy. As Frankel and Rose (2002), Razin and Rubinstein (2004), Clark et al. (2004), as well as others have shown, real exchange rate variation has important implications for consumption, investment, economic growth and trade flows.

Hussain et al. (2005) suggest that the value of an increasingly flexible exchange rate system rises as a country becomes richer and more financially developed. The authors report that for advanced economies, floats appear to produce somewhat higher growth without instigating higher inflation. However, for developing countries at a relatively early stage of financial development and integration, and therefore little exposure to international capital markets, more rigid regimes tend to offer some anti-inflation credibility without compromising the planned growth trajectory.

Achy (2003) empirically inspects the drivers of bilateral real exchange rate parity-reversion in the particular context of middle-income economies. Using weighted least squares regression techniques, the author posits a number of factors that help account for cross-country differences in half-lives of parity deviations. More specifically, for the sample of 38 nations, higher nominal exchange rate volatility, productivity growth and government spending lead to slower mean-reversion in the real exchange rate, while higher inflation and capital mobility tend to attenuate the persistence of deviations from parity. Together, the five significant variables explain 70 percent of the observed variability in the half-life.

Regarding nominal exchange rate volatility, Cashin and McDermott (2006) obtain a contrasting result. These authors report an inverse relation between nominal exchange rate volatility and the persistence of real exchange rate misalignments. Moreover, Alba and Papell (2007) find that countries with moderate nominal exchange rate volatility exhibit stronger evidence of (relative) PPP. Utilising the Spearman rank correlation test, Cashin and McDermott (2006) also find that mean-reversion tends to be faster in high-inflation than in low-inflation countries. Conversely, discrepancies in

productivity growth, government expenditure, and trade openness are not significantly related to the observed heterogeneity in half-lives in their study.

Aside from aggregate-level analyses, some research has also scrutinised the covariates of sectoral real exchange rate persistence. Cheung et al. (2001) investigate the empirical link between market structure and the persistence of US dollar-based sectoral real exchange rates for 14 OECD countries and find the relation to be statistically significant based on their maximum likelihood and OLS estimates. Specifically, countries characterised by a larger price-cost margin and a greater degree of intra-industry trade display higher sectoral real exchange rate persistence. Thus the findings imply that an imperfectly competitive market structure can contribute to persistence at the aggregate level. Amongst other findings, the authors interestingly further report a non-robust positive effect of nominal exchange rate volatility on sectoral persistence.

Certainly, very few studies have attempted to examine the determinants of the persistence of real exchange rate misalignments. Moreover, as a caveat, of those few that address this particular research avenue, not a single one has allowed for potential non-linearities in the real exchange rate adjustment process when obtaining measures of equilibrium convergence rates. A survey of this literature also reveals that cross-sectional analyses of the global and parametric variety are virtually non-existent. In this sense, our research fills an important gap in the field.

1.2.3 On the Relation between the Current Account and Real Exchange Rate: A Role for Nominal Exchange Rate Variability?

Academic textbooks in international economics often refer to a J-curve phenomenon when discussing the relation between the current account and real exchange rate. Indeed, the concept has also featured in a large number of empirical papers which have posited mixed evidence in its favour. The J-curve effect predicts that after a currency devaluation there will be an initial deterioration in the current account or trade balance followed by an eventual improvement in the external position.

In particular, in the presence of insufficient or no offsetting movements in nominal prices, a currency depreciation raises the relative price of imports to home

consumers while decreasing the relative price of home exports to foreign consumers. However, in the immediate short run, the quantity or volume of exports and imports is largely governed by previously determined trade contracts. Given the currency devaluation this results in a decrease in the value of exports and an increase in the value of imports, and thus a deterioration in the current account balance in the short run. Once trade contracts are re-negotiated, taking into account the new prices, demands for exports and imports adjust accordingly generating a tendency for a current account improvement in the presence of sufficiently high demand elasticities. Put differently, assuming the elasticity conditions hold, the so-called Marshall-Lerner condition, the volume effect ultimately dominates the value effect of a currency depreciation.

Krugman and Baldwin (1987) provide empirical support for the notion of a J-curve relation between the current account and exchange rate. Examining the US, they find that current account deficits in the initial stages persist for approximately four quarters following a depreciation. Koray and McMillan (1999) also offer evidence in favour of the J-curve. Building on the study of Eichenbaum and Evans (1995), the authors' VAR analysis for the US and a European aggregate shows that a negative monetary shock results in a currency appreciation that is associated with an initial trade balance surplus followed subsequently by deficits. Going 'back to basics', Leonard and Stockman (2002) examine bivariate statistical correlations between current accounts, real exchange rates, and cross-country ratios of GDP using distribution-free non-parametric methods. Their work yields weak evidence of a J-curve effect with the reversal from larger current account deficit to surplus following a currency depreciation occurring after a single lag (1 quarter). Nevertheless, they find that this evidence is inconsistent with the standard theoretical model of the J-curve. Specifically, an improvement in the relative current account is generally associated with a decline in relative GDP (even after a lag). This result opposes the implications of the standard theoretical model that a rise in the current account surplus stems from a rise in foreign demand due to a home real currency depreciation, which in turn raises home GDP.

In contrast, Moffett (1989) and Rose and Yellen (1989) obtain no significant evidence of a J-curve pattern in the case of the US. In fact, Rose and Yellen (1989) find little evidence of even a long-run relation between the exchange rate and trade balance. From more of a general equilibrium perspective, Backus et al. (1994) indicate that the link hinges on the source of the fluctuations. Their empirical findings suggest that the

trade balance is counter-cyclical and that it negatively comoves with current and future changes in the terms of trade while comoving positively with past changes in the terms of trade.

A more recent analysis by Lane and Milesi-Ferretti (2012) reports that the real exchange rate did not play a significant role in the external adjustment process during the global crisis of the late 2000s. Notably, real exchange rate movements over 2005/08-2010 were destabilising in the case of fixed exchange rate economies, in the sense that pegger countries characterised by negative pre-crisis current account gaps experienced real exchange rate appreciation. In an updated version of the paper, Lane and Milesi-Ferretti (2013) extend the study to 2012 and even over this medium-term period still observe that real exchange rates have not moved in a consistently stabilising direction. Nonetheless, the authors caution that they underscore discrepancies in adjustment dynamics across exchange rate arrangements and that further exploration of the sources of these discrepancies is warranted.

Chinn and Wei (2013) examine current account dynamics for a large number of countries across different nominal exchange rate arrangements and find that current account persistence does not significantly vary with the degree of exchange rate flexibility. Moreover, the authors hypothesise that the current account responds to the real exchange rate, not the nominal exchange rate. They explain that if real exchange rate adjustment, in the form of mean-reversion, is unaffected by the choice of nominal exchange rate regime, then one should not expect current account adjustment to be affected by it either. The authors corroborate this point with some empirical evidence. Conversely, Ghosh et al. (2010) show that once one allows for threshold effects, along the lines of surpluses versus deficits and large versus small imbalances, the nominal exchange rate regime becomes highly relevant for current account dynamics in ways that are generally supportive of Friedman's (1953) arguments. In addition, using a Probit model Pancaro (2013) finds that the triggers of current account reversals in industrial countries differ significantly across exchange rate systems. In the second section of the paper, the author also estimates a treatment effects model which shows that such reversals in these countries have not imparted a significant effect on economic growth under any regime, nor in the overall sample.

Nominal exchange rate rigidity, at least in principle, does not necessarily imply limited real exchange rate adjustment since nominal prices and wages can move to produce corrections if they are sufficiently flexible. Nevertheless, in reality, changes in prices and costs are much more sluggish than those in nominal exchange rates. Consequently, a more rigid exchange rate regime may shift the burden of external adjustment towards economic activity. That is, ‘output shifting’, rather than ‘expenditure switching’ via real exchange rate changes, may become the central channel of adjustment and potentially result in sharp domestic economic contractions. In fact, in a sample of mostly developing economies, Edwards (2004a) and Edwards (2004b) report that current account reversals lead to lower GDP growth only under hard pegs or intermediate exchange rate systems. Edwards (2007) also notes that realignments of global growth rates would have only a modest impact on current account imbalances and that significant real exchange rate movements are likely to be needed. Somewhat similarly, Lane and Milesi-Ferretti (2012) contend that if current account deficit corrections during the latest crisis were stimulated by an undershooting of output and demand (below potential), some of the decline in excess deficits could prove to be temporary (with a symmetric argument applicable to surpluses) unless more meaningful expenditure-switching occurs through the real exchange rate. Of course, as the authors emphasise, another possible outcome is that countries characterised by high external liabilities may encounter persistent external financing constraints. In this instance, if price and exchange rate rigidities prevent effective expenditure switching, output may remain below its natural level for much longer.

Building on the work of Obstfeld and Rogoff (2007), Méjean et al. (2011) analytically show in a three-country setup that a decline in the US current account deficit of 1 percent of GDP vis-à-vis emerging Asia must be associated with a 15 percent improvement in the terms of trade of all of emerging Asia and with a similar depreciation of the US real exchange rate. It is also argued that if only China allows its export prices to rise, a larger appreciation in the terms of trade would be required as US buyers would substitute Chinese goods in favour of tradables in the rest of emerging Asia.

Devereux and Engel (2007) present exchange rate policy as a trade-off between the desire to smooth changes in real exchange rates in order to mitigate distortions in cross-country consumption allocations, and the need to allow for nominal exchange rate

flexibility so as to accommodate adjustment in the terms of trade. The authors demonstrate in this setting that optimal nominal exchange rate volatility is a function of these competing objectives.

For a group of East and Southeast Asian economies, Cuestas and Regis (2013) test for the presence of a cointegrating relation between the current account and multilateral real exchange rate on a country-by-country basis. Their results point to the existence of a long-run relation with the direction of causality running from the exchange rate to the current account in most cases. Examining the determinants of current account balances, Chinn and Prasad (2003) find real exchange rate appreciation to have a negative and significant effect only in industrial countries.

Lee and Chinn (2006) assess current account and real exchange rate dynamics in G7 countries using a structural VAR, and minimal identifying assumptions, in order to test the predictions of intertemporal open economy macro models. Consistent with theoretical models, the authors find that permanent shocks impart large long-term effects on the real exchange rate but relatively small effects on the current account, while temporary shocks entail large effects on both the exchange rate and current account in the short run but not on either variable in the long run. In particular, temporary shocks, interpreted as monetary innovations, depreciate the real exchange rate and ameliorate the current account balance. On the other hand, permanent shocks, interpreted as technology innovations, appreciate the real exchange rate and, in some countries, improve the current account position (in opposition to the predictions of many models). Lee and Chinn (2006) explain that the differing roles of temporary and permanent shocks provide some insight into the difficulty associated with empirically unveiling a relation between the current account and real exchange rate. According to the authors' results, an unequivocal comovement would have been obtained in empirical studies had most of the exchange rate changes stemmed from temporary shocks. However, in most countries and periods, the authors find that real exchange rate fluctuations are predominantly driven by permanent shocks, which tend to have unsubstantial effects on the current account or even ones in the opposite direction to that of theory or temporary shocks.

Our final research project contributes to this literature by empirically assessing the implications of greater nominal exchange rate variability for the bivariate relation

between large current account imbalances and the real exchange rate using both linear and, rather novel, non-linear panel techniques. As far as we are aware, no research to date has systematically scrutinised this particular issue, thus making our study relatively unique. Furthermore, we provide qualitative evidence on the relation between current account persistence and real exchange rate persistence over the cross section for the first time in the literature. Continuing along the cross-section, we also focus on how current account and real exchange rate persistence are associated with nominal exchange rate volatility. In particular, given the limited amount of existing work on the matter, we devote special attention to the former relation in the same manner that we do for the latter relation in chapter 3.

1.3 References

Achy, L. 2003. Parity Reversion Persistence in Real Exchange Rates: Middle Income Country Case. *Applied Economics*, Vol.35, No.5, pp541-553.

Alba, J.D. and Papell, D.H. 2007. Purchasing Power Parity and Country Characteristics: Evidence from Panel Data Tests. *Journal of Development Economics*, Vol.83, No.1, pp240-251.

Backus, D.K., Kehoe, P.J. and Kydland, F.E. 1994. Dynamics of the Trade Balance and the Terms of Trade: The J-Curve? *American Economic Review*, Vol.84, No.1, pp84-103.

Carvalho, C. and Nechio, F. 2011. Aggregation and the PPP Puzzle in a Sticky-Price Model. *American Economic Review*, Vol.101, No.6, pp2391-2424.

Cashin, P. and McDermott, C.J. 2006. Parity Reversion in Real Exchange Rates: Fast, Slow, or Not at All? *IMF Staff Papers*, Vol.53, No.1, pp89-119.

Cheung, Y.-W., Chinn, M. and Fujii, E. 2001. Market Structure and the Persistence of Sectoral Real Exchange Rates. *International Journal of Finance and Economics*, Vol.6, No.2, pp95-114.

Cheung, Y.-W. and Lai, K.S. 1998. Parity Reversion in Real Exchange Rates during the post-Bretton Woods Period. *Journal of International Money and Finance*, Vol.17, No.4, pp597-614.

Cheung, Y.-W. and Lai, K.S. 2000a. On Cross-Country Differences in the Persistence of Real Exchange Rates. *Journal of International Economics*, Vol.50, No.2, pp375-397.

Cheung, Y.-W. and Lai, K.S. 2007. Nominal Exchange Rate Flexibility and Real Exchange Rate Adjustment: New Evidence from Dual Exchange Rates in Developing Countries. Hong Kong Institute for Monetary Research Working Paper No.9/2007.

Chinn, M. and Prasad, E. 2003. Medium-Term Determinants of Current Accounts in Industrial and Developing Countries: An Empirical Exploration. *Journal of International Economics*, Vol.59, No.1, pp47-76.

- Chinn, M. and Wei, S.-J. 2013. A Faith-based Initiative: Do We Really Know that a Flexible Exchange Rate Regime Facilitates Current Account Adjustment? *Review of Economics and Statistics*, Vol.95, No.1, pp168-184.
- Clark, P., Sadikov, A., Tamirisa, N., Wei, S.-J. and Zeng, L. 2004. A New Look at Exchange Rate Volatility and Trade Flows. IMF Occasional Paper No.235.
- Cuestas, J.C. and Regis, P.J. 2013. On the Relationship between Exchange Rates and External Imbalances: East and Southeast Asia. Working Papers on International Economics and Finance, Working Paper DEFI 13-08.
- Culver, S.E. and Papell, D.H. 1995. Real Exchange Rates Under the Gold Standard: Can they be Explained by the Trend Break Model? *Journal of International Money and Finance*, Vol.14, No.4, pp539-548.
- Devereux, M.B. and Engel, C. 2007. Expenditure Switching versus Real Exchange Rate Stabilization: Competing Objectives for Exchange Rate Policy. *Journal of Monetary Economics*, Vol.54, No.8, pp2346-2374.
- Dumas, B. 1992. Dynamic Equilibrium and the Real Exchange Rate in Spatially Separated World. *The Review of Financial Studies*, Vol.5, No.2, pp153-180.
- Edwards, S. 2004a. Financial Openness, Sudden Stops, and Current-Account Reversals. *American Economic Review*, Vol.94, No.2, pp59-64.
- Edwards, S. 2004b. Thirty Years of Current Account Imbalances, Current Account Reversals, and Sudden Stops. *IMF Staff Papers*, Vol.51, No.1, pp1-49.
- Eichenbaum, M. and Evans, C. 1995. Some Empirical Evidence on the Effects of Monetary Policy Shocks on Exchange Rates. *Quarterly Journal of Economics*, Vol.110, No.4, pp.975-1009.
- Frankel, J. and Rose, A. 2002. An Estimate of the Effect of Common Currencies on Trade and Income. *Quarterly Journal of Economics*, Vol.117, No.2, pp437-466.
- Friedman, M. 1953. The Case for Flexible Exchange Rates. In *Essays in Positive Economics*, ed. by Friedman, M. (Chicago: The University of Chicago Press).

Ghosh, A.R., Terrones, M. and Zettelmeyer, J. 2010. Exchange Rate Regimes and External Adjustment: New Answers to an Old Debate. In *The New International Monetary System: Essays in Honor Of Alexander Swoboda*, ed. by Wyplosz, C. (London: Routledge).

Husain, A.M., Mody, A. and Rogoff, K.S. 2005. Exchange Rate Regime Durability and Performance in Developing versus Advanced Economies. *Journal of Monetary Economics*, Vol.52, No.1, pp35-64.

Imbs, J.M., Mumtaz, H., Ravn, M.O. and Rey, H. 2005. PPP Strikes Back: Aggregation and the Real Exchange Rate. *The Quarterly Journal of Economics*, Vol.120, No.1, pp1-43.

Jorion, P. and Sweeney, R.J. 1996. Mean Reversion in Real Exchange Rates: Evidence and Implications for Forecasting. *Journal of International Money and Finance*, Vol.15, No.4, pp535-550.

Koray, F. and McMillan, W.D. 1999. Monetary Shocks, the Exchange Rate, and the Trade Balance. *Journal of International Money and Finance*, Vol.18, No.6, pp925-940.

Krugman, P. and Baldwin, R.E. 1987. The Persistence of the US Trade Deficit. *Brookings Papers on Economic Activity*, Vol.18, No.1, pp1-56.

Lane, P.R. and Milesi-Ferretti, G.M. 2012. External Adjustment and the Global Crisis. *Journal of International Economics*, Vol.88, No.2, pp252-265.

Lane, P.R. and Milesi-Ferretti, G.M. 2013. Global Imbalances and External Adjustment After the Crisis. Prepared for Central Bank of Chile's Annual Research Conference.

Lee, J. and Chinn, M.D. 2006. Current Account and Real Exchange Rate Dynamics in the G7 Countries. *Journal of International Money and Finance*, Vol.25, No.2, pp257-274.

Leonard, G. and Stockman, A.C. 2002. Current Accounts and Exchange Rates: A New Look at the Evidence. *Review of International Economics*, Vol.10, No.3, pp483-496.

MacDonald, R. 1996. Panel Unit Root Tests and Real Exchange Rates. *Economics Letters*, Vol.50, No.1, pp7-11.

Méjean, I., Rabanal, P. and Sandri, D. 2011. Current Account Rebalancing and Real Exchange Rate Adjustment Between the U.S. and Emerging Asia. IMF Working Paper 11/46.

Michael, P., Nobay, A.R. and Peel, D.A. 1994a. Exchange Rates, Transactions Bands and Cassel's Doctrine of PPP. University of Liverpool, Department of Economics, Research Paper No.9403.

Michael, P., Nobay, A.R. and Peel, D.A. 1997. Transactions Costs and Nonlinear Adjustment in Real Exchange Rates: An Empirical Investigation. *Journal of Political Economy*, Vol.105, No.4, pp862-879.

Moffet, M.H. 1989. The J-Curve Revisited: An Empirical Examination for the United States. *Journal of International Money and Finance*, Vol.8, No.3, pp425-444.

Murray, C.J. and Papell, D.H. 2005b. Do Panels Help Solve the Purchasing Power Parity Puzzle? *Journal of Business and Economic Statistics*, Vol.23, No.4, pp410-415.

Nurkse, R. 1944. *International Currency Experience: Lessons of the Inter-War Period*. Geneva: League of Nations.

Obstfeld, M. and Rogoff, K. 2007. The Unsustainable U.S. Current Account Position Revisited. In *G7 Current Account Imbalances: Sustainability and Adjustment*, ed. by Clarida, R.H. (Chicago, IL: University of Chicago Press).

Obstfeld, M. and Taylor, A.M. 1997. Nonlinear Aspects of Goods-Market Arbitrage and Adjustment: Heckscher's Commodity Points Revisited. *Journal of the Japanese and International Economies*, Vol.11, No.4, pp441-479.

O'Connell, P.G.J. 1998. The Overvaluation of Purchasing Power Parity. *Journal of International Economics*, Vol.44, No.1, pp1-19.

Pancaro, C. 2013. Current Account Reversals in Industrial Countries: Does the Exchange Rate Regime Matter? European Central Bank Working Paper Series No.1547.

Papell, D.H. 1997. Searching for Stationarity: Purchasing Power Parity Under the Current Float. *Journal of International Economics*, Vol.43, No.3-4, pp313-332.

Papell, D.H. and Theodoridis, H. 1998. Increasing Evidence of Purchasing Power Parity Over the Current Float. *Journal of International Money and Finance*, Vol.17, No.1, pp41-50.

Papell, D.H. and Theodoridis, H. 2001. The Choice of Numeraire Currency in Panel Tests of Purchasing Power Parity. *Journal of Money, Credit, and Banking*, Vol.33, No.3, pp790-803.

Razin, A. and Rubinstein, Y. 2004. Growth Effects of the Exchange-Rate Regime and Capital-Account Openness in a Crisis-Prone World Market: A Nuanced View. National Bureau of Economic Research Working Paper No.10555.

Rose, A.K. and Yellen, J.L. 1989. Is There a J-Curve? *Journal of Monetary Economics*, Vol.24, No.1, pp53-68.

Sercu, P., Uppal, R. and Hulle, C.V. 1995. The Exchange Rate in the Presence of Transaction Costs: Implications for Tests of Purchasing Power Parity. *The Journal of Finance*, Vol.50, No.4, pp1309-1319.

Taylor, A.M. and Taylor, M.P. 2004. The Purchasing Power Parity Debate. *Journal of Economic Perspectives*, Vol.18, No.4, pp135-158.

Taylor, M.P., Peel, D.A. and Sarno, L. 2001. Nonlinear Mean-Reversion in Real Exchange Rates: Toward a Solution to the Purchasing Power Parity Puzzles. *International Economic Review*, Vol.42, No.4, pp1015-1042.

Wu, Y. 1996. Are Real Exchange Rates Nonstationary? Evidence from a Panel-Data Test. *Journal of Money, Credit, and Banking*, Vol.28, No.1, pp54-63.

Chapter 2

Mean-Reversion in Real Exchange Rates:

A Cross-Country Analysis

2.1 Introduction

The fundamental question of how exchange rates adjust in response to shocks lies at the heart of exchange rate policy. In particular, the speed at which the real exchange rate reverts to a level established by purchasing power parity (PPP) determines the degree to which the international macroeconomic system is self-equilibrating (Taylor and Taylor 2004). Although a large body of empirical work in this field exists, most of it has been oriented towards the case of the industrialised world. The relatively few studies that have considered developing countries have reached opposing conclusions about their rates of parity reversion. Importantly, much of this work has failed to correctly capture the dynamics of the real exchange rate, which in turn has led to very high estimates of the persistence of parity deviations.³ In fact, most of the investigations since 1996 adopt a linear panel data approach without recognising the heterogeneous nature of cross-country real exchange rate series.⁴

Our analysis indeed shows that a one-size-fits-all setup may not be suitable when it comes to examining real exchange rate dynamics globally. Specifically, we find that while for some countries linear specifications of real exchange rate adjustment suffice, non-linear dynamics are more appropriate for others. Moreover, some series exhibit deterministic structural breaks while others do not.⁵ Therefore, neglecting such discrepancies and imposing homogeneous dynamics may be detrimental to any cross-country study of real exchange rate parity convergence.

Take for instance the case of Poland. Due to hyperinflation during the early 1990s, the Polish currency was redenominated in January of 1995. Consequently, we observe a large discrete jump in Poland's real exchange rate vis-à-vis the US at this

³ A recent paper by Carvalho and Nechio (2011) shows that real exchange rate adjustment occurs very slowly even at the sectoral level.

⁴ Examples of such studies include those by Wu (1996), Frankel and Rose (1996), Murray and Papell (2005b), Alba and Papell (2007), and Chinn and Wei (2013) to mention but a few.

⁵ The former is particularly true in the case of transitional and developing economies.

point in time. Conversely, the CFA Franc users of Central and West Africa observed a large discrete fall in their respective real exchange rates in January of 1994 as the currency was sharply devalued by 100 percent in an attempt to aid exports in the region.⁶ Further examples include the sudden devaluation of the Egyptian pound against the US dollar in 1990; and the inflation-driven significant real currency appreciation in Ghana during the early 1980s that stemmed from the political and economic turmoil in the country, followed by a return to normal real exchange rate levels once economic recovery in the form of currency devaluations commenced. As indicated by the estimates, ignoring these level intercept breaks results in one finding overly exaggerated rates of real exchange rate persistence. Meanwhile, adjustment non-linearities appear to be a particularly pertinent feature for advanced economies, that is, in terms of obtaining significant mean-reverting dynamics.⁷ Linear models typically yield non-stationary dynamics or highly persistent deviations for this cohort of nations.

Non-linear adjustment of the real exchange rate can be rationalised from both a traded goods and financial market perspective. To illustrate in the first instance, if international commodity trade only commences once price differentials between countries exceed a specific threshold, which is determined by the costs of trading (e.g. taxes, transport costs, purchase of foreign exchange/forward cover, sunk costs for entering a market etc.), then the real exchange rate can exhibit non-linear dynamics. Below this threshold, the marginal cost of international arbitrage surpasses the marginal benefit leading to no trade, and the real exchange rate consequently fluctuates freely just like a random walk. However, outside this inner band, international trade becomes profitable and the real exchange rate begins to revert back to a long-run equilibrium.⁸

From the asset market viewpoint, non-linear exchange rate behaviour may be driven by the existence of heterogeneous foreign exchange traders. Specifically, when the exchange rate is in the local neighbourhood of its equilibrium level, its dynamics are driven by technical analyses as ‘Chartist’ tendencies prevail amongst market participants. This results in non-stationarity for small disequilibria. Equally, the closer the exchange rate is to its ‘latent’ equilibrium within some defined interval, the greater

⁶ This was the only parity revision in the effective single currency area during the period 1973-2010.

⁷ On the other hand, for a group of currencies belonging to the G-20, Béreau et al (2010) estimate a panel smooth transition error correction model and find that the real exchange rate dynamics of industrial countries exhibit a linear pattern in the long run.

⁸ See for example Heinen et al. (2011) for a further discussion on non-linear real exchange rate dynamics.

the uncertainty and discrepancy in beliefs surrounding whether it is under or overvalued, and the more the real exchange rate meanders like a random walk as the influence of noise traders begins to dominate.⁹ On the other hand, for increasingly larger misalignments with the equilibrium, focus is more likely to switch to fundamentals and consensus among traders regarding models to be employed is more likely to rise. Thus, as beliefs concerning the direction of the deviation converge (i.e. become more homogeneous), speculation by ‘Fundamentalists’ prompts reversion towards equilibrium.¹⁰

Given that real exchange rates are constructed using aggregate national price indices (which are equalised in an arbitrary base year), as opposed to price levels, one can only examine the persistence of deviations from relative PPP. If the real exchange rate is a mean-reverting process, implying that deviations from equilibrium (broadly speaking some constant not necessarily equal to one) ultimately peter out over time, then changes in relative prices between countries should on average be proportional to changes in nominal exchange rates (i.e. percentage changes or growth rates across the two should be equal).¹¹

Even today, most economists advocate some form of PPP as an approximate indicator of the long run level of the real exchange rate. For instance, when valuing portfolios and making decisions regarding security holdings, investors often consider whether the real exchange rate of the country in question is, or is expected to be, over or under appreciated relative to its long run PPP value. Indeed, most models in international macroeconomics (both traditional and new) rely on some variant of PPP holding in the medium to long-term. Moreover, the concept of PPP is important in gauging the degree of misalignment in the nominal exchange rate and formulating appropriate policy responses, the setting of exchange rate pegs, and cross-country comparisons of national income levels.

In this paper, we compile a brand new global data set on rates of both bilateral and effective real exchange rate parity reversion pertaining to the period 1973-2010. We

⁹ See Kilian and Taylor (2003).

¹⁰ Survey data such as that from the World Economic Survey administered quarterly by the ifo Institute for Economic Research offers some indication that market participants’ views become more homogeneous as the exchange rate deviates further away from its PPP equilibrium.

¹¹ Long-run real exchange rate reversion to PPP is only a first approximation in the presence of a time-varying equilibrium (Taylor 2003).

assess the distribution of these rates of persistence across the world. The study distinguishes between different country groups, including industrial, emerging, and developing, and formally examines whether these sets of nations exhibit significant differences in speeds of real exchange rate mean-reversion. In particular, we analyse how the half-life of parity deviations changes as one augments the empirical specification of the real exchange rate to account for features such as adjustment non-linearities, (deterministic) structural breaks, serial correlation in the error terms, and/or trends.

Our findings indicate that the augmented (linear and non-linear) models of real exchange rate dynamics can produce persistence levels consistent with the notion of nominal rigidities presiding over the short-run. The analysis suggests that the rates of mean-reversion are typically higher for effective exchange rates. Specifically, the median half-life is about 1.5 years for bilateral rates, and 0.7 years for multilateral rates. Furthermore, we ascertain that the real exchange rate half-lives are significantly different across country cohorts. For instance, we find that industrial countries observe the lowest speeds of parity-reversion with bilateral and multilateral rate half-lives of around 2.5 and 1.5 years respectively. At the other end of the spectrum, developing countries display the lowest levels of persistence and, according to our summary statistics, are typically characterised by bilateral and multilateral rate half-lives of about 1.5 and 0.4 years respectively. With regards to regions, Latin America and Africa exhibit the fastest rates of real exchange rate convergence. In the former, the central tendency among countries lies around a half-life of 0.9 years in the case of the bilateral rate, and 0.7 years in the case of the effective rate. In the latter region, the corresponding figures are 1.5 and 0.4 years.

As far as we are aware, only two global studies examining parity reversion on a country-by-country basis have been produced to date. These include papers by Cheung and Lai (2000) and Cashin and McDermott (2006). The first of these empirical papers examines the dynamics of monthly bilateral real exchange rates during the post-1973 period for 94 countries vis-à-vis the USA. Using ADF, DF-GLS, fractional, and sequential unit root tests, Cheung and Lai are able to obtain evidence in favour of parity reversion for 66 of the real exchange rate series. The authors' calculations indicate that the industrial country group is characterised by a half-life ranging between 2 to 5 years. Conversely, most of the half-lives for developing countries are less than 3 years. Based

on these estimates, the authors report that PPP deviations tend to peter out faster for developing nations than for industrial countries. The second paper by Cashin and McDermott (2006) examines the persistence of real exchange rate parity deviations across 90 developed and developing countries using median-unbiased estimates of the half-life attained from an AR(p) model.¹² Employing monthly real effective exchange rate data over the post-Bretton Woods period, the authors find that the average half-life for advanced economies is about 8 years, twice as long as the downwardly biased estimates of previous studies. In comparison, the half-life estimates for developing countries are shown to be evenly spread, with most of the deviations from parity being permanent. This difference in the rate of parity reversion between the two country groups is found to be statistically significant. The authors' result of slower parity reversion for lower-income nations defies the findings of Cheung and Lai (2000a) but coincides with the conclusions of Froot and Rogoff (1995).

Our study builds on these two pieces of empirical work in three respects. First, we allow for adjustment non-linearities and structural breaks (single or multiple) in real exchange rates. Second, we consider a much broader range of countries and more recent data. Third, we show how measures of persistence vary across specifications as well as both bilateral and multilateral real exchange rates in order to avoid bias and draw comparisons.

The remainder of the paper is organised as follows. Section 2.2 provides a thorough description of the empirical methodology employed. Section 2.3 describes the underlying data set used. In section 2.4, we discuss results and in particular provide a cross-country descriptive analysis of the estimated half-lives. Section 2.5 concludes.

2.2 Empirical Methodology

The empirical study we conduct in this paper ultimately entails two phases. The first step is to define a measure of the persistence of real exchange rate parity deviations and subsequently obtain estimates of this measure for different countries. The second stage involves ascertaining whether different country groups are characterised by disparate

¹² AR(p) denotes an autoregressive process of order p. This specification only considers serial correlation in the error terms.

rates of mean-reversion and relies on standard differences-in-mean and median hypothesis tests.

In order to achieve our first objective, we assume three different but plausible processes for the real exchange rate and proceed to estimate each one separately, commencing with the simplest specification. Afterwards, we are able to gauge the degree of shock persistence based on the parameters of the model in question. The measure of persistence we employ in our investigation is the half-life. The concept of the half-life may be defined as the duration of time it takes for a unit impulse to dissipate permanently by one half from the occurrence of an initial shock (Cashin and McDermott 2006). In the analysis that follows, we do not distinguish between nominal and real shocks, such as monetary shocks in the case of the former and preference or technology shocks in the case of the latter. Rather, the error term in our equations will always refer to a ‘composite shock’ that incorporates the various individual disturbances. If the real exchange rate is a stationary mean-reverting process, no type of shock should impart a permanent effect on the series in the long run.¹³ The first specification of the real exchange rate we consider for each country is the following simple AR(1) process:

$$\Delta r_t = \alpha + \rho r_{t-1} + \varepsilon_t \quad (2.1)$$

In particular, r_t denotes the natural logarithm of either the bilateral or multilateral real exchange rate. In the special limiting case of $\rho = -1$, complete mean-reversion in the real exchange rate occurs (i.e. within the month). That is to say, deviations from relative PPP are purely transitory (Frankel and Rose 1996). At the other end of the spectrum, a value of $\rho = 0$ (usually formulated as the null hypothesis) implies a complete absence of mean-reversion, behaviour that is typical of a martingale. Intermediate values of ρ however represent different speeds of parity reversion. The estimate of the half-life, $\hat{h}$, is obtained from:

¹³ Using vector autoregression techniques and long-run restrictions within the framework to identify shocks, Craighead (2013) finds that the role of nominal shocks in the US-UK real exchange rate has declined significantly since the end of the classical gold standard period. On the basis of counterfactual analysis, the author shows that the difference between the pre and post-1913 periods is principally due to the size of the nominal shocks rather than structural changes in the economy. More generally, the results indicate that real shocks, in particular demand shocks, have been dominant in explaining the variability of the real exchange rate in both periods. In addition, these real shocks have been more durable, or persistent. Examining the behaviour of relative prices both across and within countries, Bayoumi and MacDonald (1999) conclude that while monetary shocks may be mean-reverting over the medium term, underlying real factors can generate long-term trends or longer-lasting effects in real exchange rates.

$$\hat{h} = \frac{\ln(0.5)}{\ln(\hat{\gamma})} \quad (2.2)$$

where $\hat{\gamma} = 1 + \hat{\rho}$ is a complete scalar measure of persistence. Essentially, under mean-reversion a proportion $\hat{\gamma}$ of any shock will remain after one period, $\hat{\gamma}^2$ of it will remain after two periods and, more generally, $\hat{\gamma}^n$ of the deviation will persist after n periods.

Next, we augment equation (2.1) to account for the possibility of serial correlation in the error terms, a trend, structural breaks in the mean or trend line, and structural shifts in the slope of the trend.¹⁴ Specifically, we estimate the following general higher-order specification:

$$\Delta r_t = \alpha + \mu t + \sum_{i=1}^m \theta_i D_{B(i)} + \sum_{j=1}^n \lambda_j D_{T(j)}(t) + \rho r_{t-1} + \sum_{k=1}^q \beta_k \Delta r_{t-k} + \varepsilon_t \quad (2.3)^{15}$$

where, defining τ as the time to break, D_B is a level intercept break dummy that equals 1 when $t > \tau$ and 0 otherwise, and D_T is a trend slope break dummy that equals $t - \tau$ if $t > \tau$ and 0 otherwise.¹⁶ We adopt the procedure advocated by Campbell and Perron (1991) when selecting the lag length q . Starting with a reasonable upper bound for monthly data of $q_{\max} = 12$, we check if the last lag included is significant at the 10 percent level. If it is, we set $q = q_{\max}$. If not, we then proceed to pare down the model by 1 lag until the final lag becomes significant. If no lag is significant, we set $q = 0$.¹⁷

As suggested by Andrews (1993) and Andrews and Chen (1994), one can again employ the formula in (2.2) to obtain the half-life of parity deviations.¹⁸ However, this formula assumes a monotonic rate of decay which is not necessarily a feature of higher-order AR models. Crucini et al. (2014) examine the dynamics of the real exchange rate

¹⁴ See Culver and Papell (1995), Cheung and Lai (1998) or Astorga (2012) who examine structural breaks in real exchange rate data.

¹⁵ $q = p - 1$ where p is the order of the AR process.

¹⁶ Structural breaks are detected through the use of country chronologies, visual inspection of real exchange rate series, and subsequent tests of significance in line with the techniques of Perron (1989) and the sequential methods of Zivot and Andrews (1992) and Perron (1993), as well as those of Bai (1997) and Bai and Perron (1998) in the case of multiple breaks. Selected break points typically minimise the p -value of ρ and result in the greatest reduction in the sum of squared residuals.

¹⁷ Other lag length determination techniques such as the Schwarz criterion and modified AIC methods are also considered (in addition, the maxlag yielded by DFGLS tests is inspected). After estimation, diagnostic checks are performed by examining the residuals plot and correlogram (autocorrelation and partial autocorrelation functions).

¹⁸ γ now represents the sum of the autoregressive coefficients in the non-ADF representation of the model i.e. representation in which the levels of the (log) real exchange rate are present on the left and right hand sides of the equality instead of changes.

in response to monetary and real shocks using a new open economy macroeconomics-style framework.¹⁹ The authors illustrate that regardless of whether nominal rigidities are present in the form of sticky prices or sticky wages, monetary disturbances engender monotonically decaying impulse responses. By contrast, technology and government spending shocks may generate a more persistent, hump-shaped response of the real exchange rate by leading to immediate real interest rate changes that reinforce the initial impact of the shock soon afterwards.²⁰ Consequently, in such cases it is preferable to compute the half-life directly from the impulse response function (IRF). Formally, the IRF half-life, denoted by l_h^{IRF} , is given by $IR(l_h^{IRF}) \leq 0.5$ such that $IR(l_{h+x}^{IRF}) < 0.5$ for $x = 1, 2, \dots$, where the IRF is given by $IR(h) = f_{11}^h$ for $h = 0, 1, 2, \dots$, and f_{11}^h denotes the $(1, 1)$ element of F^h with F given by the $(p \times p)$ matrix:²¹

$$\begin{bmatrix} \gamma + \beta_1 & \beta_2 - \beta_1 & \beta_3 - \beta_2 & \cdots & \beta_{p-1} - \beta_{p-2} & -\beta_{p-1} \\ 1 & 0 & 0 & \cdots & 0 & 0 \\ 0 & 1 & 0 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 0 & 0 \\ 0 & 0 & 0 & \cdots & 1 & 0 \end{bmatrix} \quad (2.4)$$

The final specification we estimate in addition incorporates potential nonlinearities in the dynamics of the real exchange rate as mentioned in Section 2.1. In particular, we focus on an exponential smooth transition autoregressive (ESTAR) representation of the real exchange rate:

$$\begin{aligned} \Delta r_t = & \alpha + \rho r_{t-1} + \sum_{k=1}^q \beta_k \Delta r_{t-k} + \Phi Z + \\ & + \left(\alpha^* + \rho^* r_{t-1} + \sum_{k=1}^q \beta_k^* \Delta r_{t-k} + \Phi^* Z \right) F(\varphi, c; r_{t-d}) + \varepsilon_t \end{aligned} \quad (2.5)$$

¹⁹ Also see Steinsson (2008) who emphasises the role of real shocks in real exchange rate movements under the assumption of Calvo-style nominal price rigidities.

²⁰ Specifically, while both types of real shock can yield non-monotonic responses under price stickiness (with flexible wages), only government expenditure can produce such dynamics via its effects on labour demand under wage stickiness (with flexible prices). Assuming the latter nominal rigidity holds, the initial movement of the real interest rate in response to a technology shock establishes real exchange rate convergence from the outset.

²¹ The dimension of the square matrix is determined by the order p of the AR process. Moreover, if the IRF displays an oscillatory pattern, we locate the final point at which the 0.5 threshold is crossed. See Appendix B for further information on the derivation of matrix F and the impulse responses.

where $F(\varphi, c; r_{t-d}) = 1 - \exp(-\varphi(r_{t-d} - c)^2)$ is the exponential transition function which is bounded between zero and unity, and $\mathbf{Z}$ is a $(z \times 1)$ vector of structural terms that were employed in (2.3).²² The transition function governs the non-linear behaviour of the series and ultimately the rate of mean-reversion via the transition parameter $\varphi > 0$, with higher values of φ implying faster adjustment. r_{t-d} is the transition variable with d acting as the delay parameter, while c is a threshold parameter representing the equilibrium level of $\{r_t\}$.²³ Equivalently, one may view φ as determining the speed of the transition process between the two extreme inner and outer regimes corresponding to the lower and upper bounds respectively of $F(\cdot)$. When $r_{t-d} = c$ for a given $\varphi > 0$, the inner regime is realised and (2.5) reduces to the linear AR(p) model:

$$\Delta r_t = \alpha + \rho r_{t-1} + \sum_{k=1}^q \beta_k \Delta r_{t-k} + \Phi \mathbf{Z} + \varepsilon_t \quad (2.6)$$

Of course, if φ is insignificantly different from zero the model of concern is also linear, with a specification of the form of (2.6). On the other hand, we attain the outer regime and a different AR(p) model:

$$\Delta r_t = (\alpha + \alpha^*) + (\rho + \rho^*) r_{t-1} + \sum_{k=1}^q (\beta_k + \beta_k^*) \Delta r_{t-k} + (\Phi + \Phi^*) \mathbf{Z} + \varepsilon_t \quad (2.7)$$

as $(r_{t-d} - c) \rightarrow \pm\infty$ for a given $\varphi > 0$.²⁴ Further note that as $\varphi \rightarrow \infty$, the exponential function approaches the indicator function $I(r_{t-d} = c)$ and the model becomes linear yet again. The fundamental idea behind the ESTAR model in (2.5) is that the larger the deviation from relative PPP, the higher will be the prevailing rate of parity-reversion. This has implications for the critical parameters ρ and ρ^* . In this case, although $\rho \geq 0$ is acceptable, it must be true that $\rho^* < 0$ and the whole series is globally stationary or stable with $-2 < \rho + \rho^* < 0$. Simply put, $\{r_t\}$ may be highly persistent, follow a random walk, or even be characterised by explosive behaviour for sufficiently small

²² We can see that the values of the transition function lie in the closed interval $[0, 1]$ as $F(z; z = 0) = 0$ and $\lim_{z \rightarrow \mp\infty} F(z) = 1$ where the argument of the function is the deviation from the threshold. Graphically, this function is symmetrically U-shaped around c .

²³ Specifically, d is the amount of time required for the real exchange rate to respond to a deviation from equilibrium.

²⁴ (2.7) will have a different rate of parity-reversion so long as at least one of the AR(p) slope coefficients in the non-linear component of the ESTAR is different from zero.

disequilibria.²⁵ In our empirical work, we set $\rho = 0$ and generally find that $\mathbf{Z}$ does not have a significant role to play in the non-linear component of the ESTAR model. We subsequently estimate the following non-linear least squares regression using the Levenberg-Marquardt algorithm (LMA):²⁶

$$\Delta r_t = \alpha + \sum_{k=1}^q \beta_k \Delta r_{t-k} + \Phi \mathbf{Z} + \left(\alpha^* + \rho^* r_{t-1} + \sum_{k=1}^q \beta_k^* \Delta r_{t-k} \right) F(\varphi, c; r_{t-d}) + \varepsilon_t \quad (2.8)$$

Implementing the approach of Kiliç (2005), we compute the half-life for the ESTAR model conditional on the value of the transition variable, and thus transition function, using the following formula:

$$\hat{hl}_{t|r_{t-d}} = \frac{\ln(0.5)}{\ln(1 + \hat{\rho}^*(1 - \exp(-\hat{\varphi}(r_{t-d} - c)^2)))} \quad (2.9)$$

Note again that this measure of the half-life is approximate. We obtain results for the 100th percentile and mean of the transition function respectively, that is, conditional on higher and lower deviations from equilibrium. The other approach to obtaining the half-life in the non-linear case is to infer it from an estimated generalised impulse response function (GIRF).²⁷ However, the technique we adopt provides a number of advantages over the GIRF method. For instance, as Kiliç (2005) points out, unlike the latter approach, it does not necessitate extensive dynamic stochastic simulations. Moreover, our half-life estimates are directly comparable to those of the linear AR(p) models, and thus to the majority of those reported in the literature.

At this point, it is worth explicitly mentioning that smooth transition models are effectively a generalisation of threshold autoregressive (TAR) models. Specifically, the ESTAR may be viewed as a generalisation of a special case of the double-threshold TAR model. In the context of aggregate real exchange rate modelling, the ESTAR model is appealing for the reason that it allows a smooth transition between regimes and symmetric treatment of deviations above and below the equilibrium. To elaborate,

²⁵ We say ‘may’ as this is naturally contingent on the value of ρ .

²⁶ First, the condition we imposed on ρ was initially a theoretical assumption. However, we later found out that the model attains its best fit under this assumption, with ρ being insignificant in most cases when (2.5) is estimated. Second, the LMA is a lot more robust than the Gauss-Newton algorithm (GNA) as in many cases it retrieves a solution even if the starting point is quite a distance away from the final minimum. Third, convergence of estimates is always achieved.

²⁷ Specifically, the IRF in the non-linear setup is computed conditional on the average initial history of the series and for various sizes of the shock.

discrete switching models may not be suitable when assessing the effects of international arbitrage on aggregated goods (basket) prices, particularly in the case of multilateral real exchange rates, given that firms and traded goods are clearly not all homogeneous. Furthermore, from the financial asset point of view, foreign exchange traders might learn at different speeds, thus leading to non-synchronised developments in individual information sets such that a relatively smooth transition in real exchange rate adjustment between regimes may be more appropriate. As Taylor et al. (2001) note, in an environment with proportional transactions costs, non-uniform adjustment²⁸ by heterogeneous agents, and time aggregation effects, much of the theory suggests that smooth aggregate regime switching is more likely. As far as the symmetry point is concerned, there are few reasons, a priori, to believe that real currency devaluations should be treated any differently to real overvaluations given the arbitrage argument. Hence, we do not consider real exchange rate models of the logistic smooth transition autoregressive (LSTAR) variety.²⁹

Before applying the ESTAR model to the real exchange rate series in question, we test whether the series is linear. Setting a fixed value for d , we first estimate the artificial OLS regression:

$$r_t = \phi_0 + \sum_{l=1}^p (\phi_{1l}r_{t-l} + \phi_{2l}r_{t-l}r_{t-d} + \phi_{3l}r_{t-l}r_{t-d}^2) + \epsilon_t \quad (2.10)$$

and afterwards test the following null hypothesis of linearity:

$$H_{0L}: \phi_{2l} = \phi_{3l} = 0 \quad \forall \quad l = 1, 2, \dots, p \quad (2.11)$$

against the general alternative that H_{0L} is not true. If the null is rejected, we proceed to estimating the non-linear model. To select a value for d , we repeat the linearity test for

²⁸ With respect to both size and timing.

²⁹ Nevertheless, in a different version of this paper we do check for asymmetric adjustment but do not find any evidence of such dynamics for any country. One potential justification for asymmetric real exchange rate adjustment is that nominal prices tend to be more downward inflexible than upward inflexible, with the distinction mattering most for economies that have a fixed nominal exchange rate. Note that the LSTAR model nests the single threshold or two-regime TAR model as a special case (i.e. in the limiting case of the model, as the transition parameter tends to infinity). In addition, we attempted to estimate an LSTAR model with two location parameters, that is, a model with the transition function $F(\phi, c_1, c_2; r_{t-d}) = 1/(1 + \exp(-\phi(r_{t-d} - c_1)(r_{t-d} - c_2)))$ where $c_1 \leq c_2$. One salient feature of this model is that as $\phi \rightarrow \infty$ in the limit, the model becomes a three-regime or band TAR model characterised by symmetric outer regimes that are different from the middle regime. Thus, the nested model is essentially the type of TAR model that has been employed in tests of the law of one price with disaggregated data. However, in estimation of the LSTAR variant we failed to achieve convergence.

$d = 1, 2, \dots, 12$ and choose the value of d that minimises the p-value of the test.³⁰ When estimating the ESTAR model, we set the initial values of φ and c to 1 and the mean of the considered series respectively but also vary them in order to ensure the location of a global minimum.³¹ Moreover, if necessary, we estimate the model with a grid search over pre-specified values for φ and c .

2.3 Description of Data Set

The analysis employs both average monthly bilateral real exchange rates (BRERs) and real effective exchange rates (REERs) over the period 1973:1 to 2010:12.³² Both real exchange rates are CPI-based. In the case of the bilateral rate 141 countries are employed, while for the multilateral rate we have lower country coverage with only 93 countries available.³³ Of these countries, 83 are common to both BRER and REER series. We note that monthly real exchange rate data are used in order to avoid any temporal aggregation bias issues and also to assist in the computation of half-lives from IRFs.³⁴ All data pertaining to real exchange rates are obtained from the IMF's International Financial Statistics (IFS). The BRER index for a given country i is not readily available and is therefore constructed by us as follows:

$$\frac{BRER_{i,t}}{BRER_{i,2005:1}} = \frac{\left(\frac{P_{i,t}}{P_{i,2005:1}}\right)}{\left(\frac{E_{i,t}}{E_{i,2005:1}}\right)\left(\frac{P_{US,t}}{P_{US,2005:1}}\right)} \quad (2.12)$$

where the base period is January of the year 2005 and the base or foreign country for all BRERs is the US, P_i is country i 's price index, P_{US} is the US price index, and E_i is the nominal exchange rate between the currencies of country i and the US quoted in

³⁰ Economic intuition would suggest a low value for d . That is, there is no apparent reason why a long time should elapse before the real exchange rate begins to react to a shock. As an additional check, we also estimate the ESTAR model for the rejected values of d within the specified range and draw comparisons. Ultimately, we obtain inferior fits using these values.

³¹ If a global optimum is initially found, then the parameter estimates should not change significantly when the initial values are altered.

³² We provide a more comprehensive analysis by employing both bilateral and multilateral rates. Indeed, most studies in the literature are divided along this line, which may be a contributing factor to the conflicting general conclusions in certain instances. Moreover, Black (1986) notes that although it is true that bilateral PPP with all trading partners implies multilateral PPP, bilateral deviations from PPP do not necessarily suggest multilateral deviations from PPP. This may also imply differences in mean-reverting dynamics across BRER and REER series.

³³ See Appendix A for the list of countries used.

³⁴ See Ahmad and Craighead (2011) for a discussion on temporal aggregation bias (which arises with lower frequency data).

national currency per US dollar terms. Nominal exchange rate series for euro zone countries end with the year 1998 and consequently must be synthetically extended to the end of 2010. This is achieved by applying individual monthly growth rates in the Euro per USD series (1998:12 value in this series is attained from the ECU exchange rate) to the euro zone national currency per USD series from 1998:12 onwards. That is, the 1999:1-2010:12 missing values in the individual series are generated as follows:

$$(NC \text{ per USD})_{i,t} = (NC \text{ per USD})_{i,t-1} \left[\frac{(Euro \text{ per USD})_t}{(Euro \text{ per USD})_{t-1}} \right] \quad (2.13)$$

where $(NC \text{ per USD})_{it}$ is the national currency per US dollar of eurozone country i at time t . The REER indices are directly available from the IMF database and thus require no construction on our part. Every REER index is rebased to the period 2005:1 and rescaled accordingly for consistency with the BRER series. The REER represents the weighted geometric average of a country's currency relative to a basket of other major currencies adjusted for the effects of inflation. The weight attached to each foreign country in the index is determined by its share in trade. In essence, this multilateral real exchange rate captures the domestic country's trade linkages with the rest of the world and acts as an indicator of its international competitiveness. Formally, the IMF's definition of the REER for country i is:

$$REER_{i,t} = \prod_{i \neq j} \left(\frac{E_{i,t} P_{i,t}}{E_{j,t} P_{j,t}} \right)^{W_{ij}} \quad (2.14)$$

where j is an index that runs over country i 's trade partners, W_{ij} is the competitiveness weight attached by country i to country j that is updated discretely and is based on the composition of trade in commodities, manufactures and tourism/non-tourism services, and E_i and E_j are the nominal exchange rates of countries i and j respectively now expressed in (period-average) US dollars per unit of national currency terms.³⁵ Thus, the IMF's REER is dollar denominated. An increase in either the BRER or REER indicates a real currency appreciation and so a decrease in either competitiveness relative to the

³⁵ Commodities, manufactures and tourism/non-tourism services are weighted by their relative importance in each country's total trade. Commodity weights are based on non-oil primary products. Manufacturing weights include third-market effects. Non-tourism services trade is assumed to be distributed in the same manner as manufactures trade, and uses the same weights. W_{ij} may be interpreted as the sum over all markets of a gauge of the degree of competition between producers of countries i and j respectively, divided by the sum over all markets of a gauge of the degree of competition between producers of country i and all other producers.

US or international competitiveness. We also note that given the start and end values of a series, any in-between missing values are linearly interpolated.³⁶

Before proceeding to our findings, it is worth stressing that the utilised time series extend over the early to middle stages of the recent global crisis during which significant aggregate demand and exchange rate shifts developed as untenable large global imbalances began to unwind. To the extent that current account adjustment is associated with real exchange rate adjustment in the form of mean or equilibrium-reversion, the exchange rate swings that materialised should have acted to attenuate the degree of persistence in relative prices. Certainly, many economic analysts and policy-circle members contended that euro area real exchange rates were heavily misaligned in the lead up to the crisis, with much discussion on the need for internal devaluation in the peripheral economies in particular. Although we do not explicitly report results from truncated samples that exclude the ‘Great Recession’ period and that are, more generally, comparable to those of Cheung and Lai (2000a) and Cashin and McDermott (2006), we do note that such sensitivity analyses in earlier versions of our work indicate no major revisions of the central conclusions.

2.4 Discussion of Empirical Results

2.4.1 On the stationarity of real exchange rates

Estimation results reveal that the AR(1) process typically does a poor job at yielding mean-reverting real exchange rates. The final column of tables 2.1 and 2.2 respectively shows that one is able to reject non-stationarity for only 30 countries in the case of BRERs and 24 in the case of REERs.³⁷ Interestingly, all of these economies are either transitional or developing with the exception of France and Norway which have stationary AR(1) REERs. Consequently, finding slow mean-reverting real exchange rate dynamics in panels of the AR(1) variety, particularly for the industrialised world, should not be surprising.³⁸

³⁶ In the few cases where this occurs, cubic-spline interpolation does not alter the results. The use of non-interpolated series, resulting in reduced sample sizes, does not significantly change findings either.

³⁷ The results do not cohere with the claims of Ventosa-Santaulà et al. (2012) that it is more difficult to find evidence of PPP in multilateral exchange rate data.

³⁸ See Chinn and Wei (2013) for instance.

Linear augmented AR models on the other hand tend to have a better success rate in attaining a significant ρ coefficient. In fact, under these specifications we attain parity-reversion for 72 economies when using BRERs, and 55 economies when employing REERs (roughly half of the respective samples). It is worth noting that 11/72 from the former sample are advanced countries of which 9 have significant ρ coefficients at only the 10 percent level, while this is true for 12/55 and only 3/12 from the latter sample. For emerging and developing nations in particular, one can see the importance of taking into account structural changes in the series. Indeed, Froot and Rogoff (1995) present a two-sector model of the Harrod-Balassa-Samuelson effect and illustrate how trend breaks in the real exchange rate can be associated with changes in the relative price structure between tradable and non-tradable goods. They contend that the rapid income growth frequently associated with low-income countries can stimulate such strong changes in the relative price of tradables and non-tradables that the probability of parity-reversion holding in any given nation will rise with the amount of income. That is, parity-reversion may be non-existent in developing countries if one does not allow for structural breaks in the data.

Scrutinising the estimated ESTAR specifications, we find that both the mean-reversion and transition parameters (ρ^* and φ) respectively are significant for 106 countries in the case of bilateral rates, and 76 in the case of effective rates.³⁹ In the first instance, 16 of the economies are advanced (80 percent of industrialised sample), while in the second instance 15 are advanced (65 percent of industrialised sample). In most of these industrial country cases, the linearity test result coincides with the significance of the transition parameter, thus providing additional evidence of the presence of non-linearities.⁴⁰ We noted earlier that most of the advanced economies are characterised by a mean-reversion coefficient that is either insignificant or marginally significant at the 10 percent level under a linear augmented AR model. This result in itself may be viewed as consistent with the existence of non-linearities due to transaction costs for example. If the true process for the real exchange rate is given by the ESTAR specification, the mean-reversion coefficient in the augmented AR will lie between ρ and $\rho + \rho^*$ in the ESTAR (or 0 and ρ^* in our case). Therefore, even if the true non-

³⁹ Note that under the null hypothesis that the transition parameter is not different from zero, the series is not mean-reverting. See Kapetanios et al. (2003) on tests of non-stationarity against ESTAR global stationarity.

⁴⁰ Ultimately, we place greater weight on the significance of the transition parameter as an indicator of non-linearity than on the linearity test itself.

linear process is globally stationary, one may still find an insignificant parity-reversion coefficient in the linear specification. In other words, the estimated linear augmented AR model may to a certain extent be reflecting the non-stationary or slower mean-reverting inner regime dynamics of the ESTAR.

The real exchange rate specification selected for each country is highlighted in the final column of tables 2.1 and 2.2 respectively. Two factors determine our choice of model: 1. linearity vs. non-linearity and 2. stationarity vs. non-stationarity. First, we identify whether a linear or non-linear model is appropriate on the basis of the significance of the transition parameter in the ESTAR model and the linearity test. If the two indicators are not consistent with one another, we place greater weight on the former and choose accordingly. However, in the rare event that the indicators point to non-linearity but the mean-reversion coefficient is insignificant while that of the linear model is significant, we choose the stationary linear model. Second, whenever we are led to a linear model we choose between the simple AR(1) and augmented AR on the basis of the p-value of ρ . Specifically, we select the specification that rejects $H_0: \rho = 0$ at the lowest significance level. Of the elected models, mean-reversion is attained in 125 cases when considering BRERs and 87 cases when inspecting REERs, with 71/83 countries achieving convergence across both series. From the final column of tables 2.1 and 2.2, we also see that the selected models are predominantly non-linear, with the ESTAR making 106 appearances under BRERs and 76 appearances under REERs (of which only 1 in either case does not display significant mean-reverting dynamics).

2.4.2 Bilateral vs. Multilateral real exchange rate persistence

Figures 2.1-2.3 display the plots of BRER persistence estimates against those of REERs for the 83 countries common to both sets of series. A cursory glance at the graphs reveals that the half-life estimates over bilateral rates are unequivocally positively correlated with the estimates over effective rates. Indeed, this prominent visual feature is further supported by the positive and highly significant Spearman rank correlation coefficients.⁴¹ As the persistence rates are nowhere near perfectly positively correlated,

⁴¹ In our data there are no rank ties and Spearman's rank correlation coefficient (Spearman's rho) is given by:

$$\rho_s = 1 - \frac{6 \sum_{i=1}^n (r(x_{1i}) - r(x_{2i}))^2}{n(n^2 - 1)}$$

we might expect to find some notable discrepancies between the estimates in the graphs. Using the dashed reference lines on the x and y axes (each representing a half-life of 1 year), one can clearly see that REERs exhibit much lower inertia in adjustment towards parity than BRERs. This is visually deducible from the graphs by noting that the lower right quadrants are almost devoid of observations while the upper left quadrants are normally more densely populated. For instance, in the case of selected model I, 52 of the REER half-lives are in fact below 1 year whereas only 23 BRER half-lives are found to lie below 1. This ratio of more than 2:1 roughly holds throughout most of the specifications.⁴²

The observed pattern indicates that mean reversion in the real exchange rate vis-à-vis a basket of trading partners is more pronounced than in the case where the US is the sole reference country. Noting that the multilateral real exchange rate is effectively a geometrically weighted average of bilateral real exchange rates, it may be that the rate of adjustment is significantly higher for bilateral rates vis-à-vis the most important trading partners of the home country. With those more heavily-weighted bilateral rates dictating the dynamics of the effective rate, this ‘might’ be resulting in faster REER convergence. In cases where the US has been convincingly the leading export market and import source, we do find that the US-based bilateral and multilateral rates of persistence can be similar. One such example is the Dominican Republic which is characterised by a half-life of less than 9 months and almost identical real exchange rate specifications across both our bilateral and effective series.⁴³

2.4.3 Cross-Country Analysis of Half-Lives

In order to achieve an unwinding of global imbalances, significant real exchange rate movements, in addition to realignments in cross-country growth rates, are likely to be necessary (Edwards 2007). As Freund and Warnock (2007) point out, current account

where $r(x_{vi})$ ($v = 1, 2$) is the rank of the i th observation of the variable x_v and $r(x_{vi}) = 1$ if x_{vi} is the smallest observed value of x_v . $\rho_s \in [-1, 1]$ and $\rho_s n^{1/2}$ follows a standard normal distribution asymptotically. The advantage of the Spearman correlation is that it is less sensitive than the Pearson correlation to strong outlier observations. This is evident due to the fact that Spearman’s rho limits the outlier to the value of its rank. We also note that $|\rho_s| = 1$ when the two variables in question are monotonically related, even if their relation is not linear. Conversely, this does not yield a perfect Pearson correlation.

⁴² Non-parametric tests indicate that differences between BRER and REER half-lives are statistically significant.

⁴³ Other similar examples include St. Lucia and Trinidad and Tobago.

deficit reversals in industrial countries tend to involve currency depreciation and a decrease in GDP growth. Currently, many European economies have overvalued real currencies making it difficult for them to compete on the international stage.⁴⁴ Given the important role of the real exchange rate in the adjustment of external imbalances, our analysis of cross-country real exchange rate inertia levels should also be interesting to those studying the persistence of current account imbalances.

Tables 2.3-2.5 present the relevant descriptive statistics in the case of the BRER sample of countries. In particular, tables marked by the letters A and B report the average and median half-life estimates based on the different real exchange rate specifications for the overall sample and each country group, while tables marked by the letters C and D give the means and medians based on the selected specifications for the same categories. In the final row of each table, we also provide the results of group differences tests. Tables 2.6-2.8 provide the same information in the case of REER samples.⁴⁵ In the tables and any accompanying notes, TF is always used to denote ‘transition function’.

Referring to these tables, we first note that as one augments the real exchange rate specification, the half-life dramatically decreases for all samples. In particular, after allowing for all of the possible features in the real exchange rate process discussed in section 2.2, we find that the half-life is reduced to a level that is consistent with the theoretical predictions of both traditional and DSGE sticky-price macroeconomic models.⁴⁶ Importantly, recent years have seen a wealth of rich micro price data become available which have offered fresh evidence on the notion of nominal rigidities in the form of staggered price adjustment. Based on both quantitative and qualitative micro-level data, Álvarez et al. (2005) obtain evidence that firms in the euro area change their prices rather infrequently with adjustments taking place approximately once a year. In the specific case of Belgium for example, Aucremanne and Dhyne (2004) find that the

⁴⁴ With one exception being Ireland which has seen significant declines in price levels/unit labour costs in years following the global crisis.

⁴⁵ Repeating the analysis, appendix C (tables C2.1-C2.8) provides these results for the 83 countries common to both BRER and REER series. This is done for the purposes of a more direct comparison across the two types of real exchange rate. The conclusions based on these sub-samples are broadly consistent with those drawn from the respective full sample analyses.

⁴⁶ Trends and structural breaks are typically not present in the real exchange rate process for industrial countries. According to Cashin and McDermott (2006), if a half-life is greater than the time span of the data, the deviation from parity is said to be permanent. DSGE denotes dynamic stochastic general equilibrium.

median duration of a price spell is close to 13 months. Using unpublished disaggregated data on US import and export prices at the dock over the period 1994-2005, Gopinath and Rigobon (2008) assert that prices are sticky in the currency in which they are reported as priced. More precisely, they estimate the trade-weighted average price duration for market transactions to be almost 11 months for imports and 13 months for exports.⁴⁷ Reviewing the recent literature that studies data underlying consumer and producer price indices, scanner and online data garnered from retailers, and information gleaned from surveys of price setters, Klenow and Malin (2010) indicate that prices change around once a year ‘on average’ and that they are strongly linked to wage changes.^{48,49} Returning to the tables, the half-lives tend to be at their lowest when considering ESTAR models in the case of larger real exchange rate misalignments i.e. at the maximum of the ESTAR transition function. Moreover, our results are further strengthened by the fact that the literature has produced more evidence in favour of faster PPP reversion for German-based than US-based real exchange rates. In general, it appears that US-based real exchange rates display higher persistence than others. Thus, in this sense, one may regard our BRER half-lives as upper bound estimates.

Second, we observe that the arithmetic mean is not the best measure of central tendency in the distribution of half-lives for the different country cohorts. In fact, we find that the median is often substantially lower than the mean. Specifically, conclusions based on mean statistics can be misleading due to the significant degree of positive skewness present particularly in the emerging and developing country group distributions.⁵⁰ Figures 2.4-2.7 visually illustrate this point in the case of selected model I and II half-lives. The figures also indicate that the variance of these persistence levels is much lower for REERs than BRERs. Given that heavy right-sided outliers are inflating the average rate of mean-reversion, in some cases more than others, and distorting comparison-making between groups, we concentrate on median estimates.

⁴⁷ For the US, another notable study is that of Nakamura and Steinsson (2008). Their analysis yields regular consumer price duration estimates in the region of 8 to 11 months over the period 1998-2005. In addition, the authors also match 153 entry level items from the CPI with product codes from the producer price index (PPI) and report that the frequency of price changes is similar across the two (with a correlation of 0.83).

⁴⁸ Naturally, higher-inflation emerging and developing economies are characterised by more frequent price changes.

⁴⁹ As these authors point out, the additional factor of a ‘contract multiplier’, stemming from counter-cyclical mark-ups, sticky plans, or sticky information for instance, can help explain excessive sluggishness in aggregate prices.

⁵⁰ We do note however that the augmented models provide better fits and reduce much of the skewness and variance of half-lives present in the simple AR and AR(p) specifications (not shown here).

Examination of the median half-lives in tables 2.3 and 2.6 overall indicates that group differences are statistically significant with developing nations exhibiting the lowest rate of real exchange rate persistence, followed by emerging, and then industrial countries. Evidence in favour of faster parity convergence for developing economies than in either of the other two groups is especially overwhelming in the REER sample. In the BRER sample on the other hand, although developing countries converge faster to parity than industrial countries, the same cannot be said when they are compared to transitional economies. In this latter instance, the bilateral difference is insignificant. Focusing on the selected model estimates, we see that the half-life of BRER parity deviations stands at around 2.5 years for industrial countries and around 1.5 years for emerging and developing countries. Doing the same for REERs, we see that the half-life tends to be less than 2 years for industrial countries, less than 1 year for emerging economies, and less than 6 months for developing nations. These findings corroborate those of Cheung and Lai (2000a), although the estimates we produce are much smaller. Conversely, they oppose the results of Cashin and McDermott (2006).

Figure 2.8 graphs the transition function of the BRER ESTAR model against both the transition variable and time for selected industrial, emerging and developing economies. Inspection of the graphs reveals that countries visit both extreme regimes. In addition, those on the left confirm that the higher the transition parameter, the faster the transition between regimes. From these graphs we also observe that advanced economies spend more time in the local neighbourhood of the extreme inner regime than both emerging and developing nations. Put differently, industrial countries on average display smaller, yet more persistent, deviations from parity than the other two groups of countries. In the case of BRERs, we find that the average value of the transition function for the typical industrial country is 0.60, the typical emerging country is 0.65, and the typical developing country is 0.72 (while they are 0.66, 0.72, and 0.81 respectively for the median country).⁵¹ A similar pattern holds for REERs. Similarly, in a recent paper, Berka and Devereux (2013) found that over the period 1995-2009 Western European countries had highly persistent deviations from absolute PPP (taken as the average of 15 EU nations) that averaged around 15 percent. In contrast, transitional Southern and Eastern European economies during 1999-2009

⁵¹ This is why we also estimate ESTAR half-lives contingent on the maximum value of the transition function.

displayed substantial convergence in the real exchange rate towards the European mean, although on average they were more than 34 percent away from this target over the entire sample.

Alternatively, when we categorise countries by income (tables 2.4 and 2.7), in line with the World Bank's income classification scheme, we find that group differences are no longer significant in the case of BRERs, though high income countries do display greater persistence on the basis of the selected model estimates alone. Our result shows that Cheung and Lai's (2000a) finding of significant differences across these groups may have been subject to sample selection bias. Conversely, group differences are highly significant when one considers REER selected model half-lives with high income countries needing around 1 year, middle income countries less than a year, and low income countries less than 6 months for a deviation from equilibrium to dissipate by 50 percent.

Tables 2.5 and 2.8 also show results for different regions of the world. Yet again, group differences only appear to be significant in the REER case. Overall, the speed of real exchange rate parity convergence seems to be fastest in Latin America and Africa, followed by Europe, and then Asia and Oceania. Looking at the median statistics for the BRER sample, Latin America has the lowest half-life which may not come as a surprise given its geographical proximity with the US, while African nations, many of which are heavily indebted poor countries, have the highest rate of mean reversion in the REER case (followed closely by Latin America). Figure 2.9 graphs the BRER selected model rates of persistence against countries' respective distances (in kilometres) from the US. The plots indicate a weak positive correlation between the two variables, where the x-axis dashed reference line now marks the distance of 8000 kilometres.

We observe that many of the South American, Central American and small Caribbean nations are located in the lower left quadrant of the graphs in figure 2.9, or close to its borders. A salient feature of the Latin American region has been its experience with high inflation, and in particular hyperinflation. In effect, a large number of these economies over different periods have surrendered monetary sovereignty to the Federal Reserve of the United States, opting to use the dollar, in either a narrow or broad sense, as an anchor for financial stability. The combination of high price volatility and a relatively stringent exchange rate regime (in the polar case) however has often

been a potent recipe for high real exchange rate variation. Moreover, abandonment or relaxation of tighter currency arrangements towards greater flexibility, for instance due to institutional credibility issues (as was the case with the Argentine currency board and ultimate ‘pesoisation’), in the region led to sharp devaluations that were also responsible for amplifying real exchange rate variability.

Large transitional South and Central American economies specifically have been characterised by extremely high levels of macroeconomic volatility. This high volatility/instability has partly been manifested in the form of high price and nominal exchange rate volatility, which may in turn have contributed to accelerated real exchange rate convergence.⁵² Examples include the hyperinflation experiences between 1975 and 1990 of Argentina that resulted primarily from the unsustainable monetisation of the country’s large fiscal deficits and those of Brazil up until 1994 in our sample that stemmed from energy and political crises.

Some of the small island nations of the Caribbean have found it beneficial to dollarise (Panama) or to establish a currency union with an explicit peg to the US dollar (East Caribbean dollar area), while others have adopted a soft peg vis-à-vis their large neighbour. Such anchoring has made sense because of this cohort’s degree of integration with the US (in terms of tourism, an important sector for these economies etc.). The tight monetary link with the US has resulted in smaller deviations from relative PPP as far as the bilateral rate is concerned. At the same time, countries that have successfully imported a credible low and stable inflation rate have limited the ability of price adjustment in eliminating small deviations from PPP. This has resulted in small but persistent real exchange rate deviations for such economies. For example, Panama and St. Kitts and Nevis observed typical inflation rates of about 3 and 4 percent per annum over the period of study and BRER persistence rates of around 15 and 7 years respectively, with both real exchange rates varying within relatively small intervals. Conversely, St. Lucia, another minnow, had an average inflation rate of approximately 6 percent and persistence rate of roughly 1 year, while a similar narrow range for the real exchange rate.

⁵² We note that the connection between inflation crises and exchange rate crises is greater in the presence of chronic inflation, when the pass-through from exchange rates to prices is at its highest.

Along with Latin America, Africa has been plagued by bouts of extremely high inflation. In fact, since World War II, the incidence of high inflation episodes (defined as an annual inflation rate of 20 percent or higher) has been greater in these two parts of the world than in any other region, with this trend intensifying notably during the 1980s and 1990s (Reinhart and Rogoff, 2009). In contrast, however, many of the African economies have adopted pegs or managed their exchange rate against currencies other than the US dollar which perhaps explains why relative PPP holds better and mean-reversion is fastest in the effective exchange rate for this region (collectively). In particular, the currency unions of Central and Western Africa peg at the same fixed rate against the euro, and formerly the French franc (two separate monetary unions that maintain separate currencies but conduct common policy), while the South African rand is the anchor currency in the Multilateral or Common Monetary Area (in our sample of countries, Botswana also fixes against the rand).⁵³

In modern times, Asia has been characterised by relatively low inflation, with countries like Hong Kong and Malaysia exhibiting particularly good track records that stretch back to even before the starting date of our sample. Nevertheless, the region has observed its share of macroeconomic volatility even in the contemporary era, most markedly during the Asian crisis of the late 1990s when large currency depreciations inevitably materialised. Having said this, exchange rates over the sample period have generally been stable. In particular, Asian economies have preferred a fixed exchange rate system, either using the greenback or some weighted basket of currencies in which the dollar is dominant (e.g. Malaysia, Singapore, Thailand) as the target.⁵⁴ Importantly, the United States is not the most prominent trading partner of East and Southeast Asian economies.

Europe's relatively low rate of persistence is being driven by the region's transitional Central and Eastern European (CEE) economies, the majority of which in recent times experienced structural changes in strides towards a market-based system. Western European economies, which form the bulk of the advanced country group,

⁵³ 11 African countries in the sample use the CFA franc (5 Central and 6 West African nations). The South African rand, alongside own national currencies (which are at parity with the rand), also circulates outside of South Africa in the Multilateral Monetary Area. 3 of the 4 southern African countries forming the Multilateral Monetary Area are present in our sample (Botswana withdrew from the formerly known Rand Monetary Area in 1976).

⁵⁴ Apart from stability, this is also beneficial due to the pervasive use of the US dollar as the invoice currency in trade.

typically display higher levels of real exchange rate persistence. Interestingly, a number of these economies have also displayed large and chronic current account deficits. Similarly, Asia is characterised by a relatively higher degree of real exchange rate inertia and has observed highly persistent current account surpluses. Such an observation prompts the question of how important real exchange rate persistence is for the speed at which global imbalances unwind.

2.5 Conclusion

The analysis of real exchange rate dynamics has always been important in international macroeconomics especially in the context of external imbalances. Certainly, the rate of mean-reversion in the real exchange rate in emerging and developing countries (particularly African nations) has become of special interest to economists for the reason that many of these economies have been implementing World Bank and IMF proposed monetary and macroeconomic reform policies (Kargbo 2003, 2006). The chief aim of such programs is to initiate exchange rate policy reform devised to mitigate distortions in the foreign exchange market and enhance the external competitiveness positions of these nations. Fundamentally, a vital assumption of the exchange rate policy reforms, as economists have noted, is that deviations from long-run parity be non-permanent (*ibid*).

This paper contributes to the literature on real exchange rate parity reversion in a number of ways. Firstly, we construct a large new global set of half-life estimates pertaining to the period 1973-2010 in the case of both BRERs and REERs using different empirical specifications of the real exchange rate. Such data may prove to be useful in future studies attempting to relate the persistence of other real macroeconomic variables to real exchange rate inertia. Second, we show that augmenting the real exchange rate model to account for the possibility of features such as structural breaks or adjustment non-linearities can reduce the half-life estimate to a level consistent with the predictions of sticky-price models (that is, 1 or 2 years). Third, we find that developing countries typically display the fastest rate of mean reversion in both the bilateral and effective real exchange rate, followed by emerging, and then industrial countries. Given the vast heterogeneity present in cross-country real exchange rate

specifications, we conclude that global homogeneous panel studies of exchange rate dynamics may lead to erroneous reports.⁵⁵

⁵⁵ Particularly in the case of higher frequency data. By homogeneous panels we mean longitudinal studies that do not allow for the aforementioned specification features to vary over cross-sectional units, such as linear vs. non-linear dynamics (including slope coefficients that differ across countries).

2.6 References

- Ahmad, Y. and Craighead, W.D. 2011. Temporal Aggregation and Purchasing Power Parity Persistence. Wesleyan Economic Working Papers, No.2011-001.
- Alba, J.D. and Papell, D.H. 2007. Purchasing Power Parity and Country Characteristics: Evidence from Panel Data Sets. *Journal of Development Economics*, Vol.83, No.1, pp240-251.
- Álvarez, L.J., Dhyne, E., Hoeberichts, M.M., Kwapil, C., Le Bihan, H., Lünemann, P., Martins, F., Sabbatini, R., Stahl, H., Vermeulen, P. and Vilmunen, J. 2005. Sticky Prices in the Euro Area: A Summary of New Micro Evidence. European Central Bank Working Paper Series No.563.
- Andrews, D. 1993. Exactly Median-Unbiased Estimation of First Order Autoregressive / Unit Root Models. *Econometrica*, Vol.61, No.1, pp139-165.
- Andrews, D. and Chen, H.-Y. 1994. Approximately Median-Unbiased Estimation of Autoregressive Models. *Journal of Business and Economic Statistics*, Vol.12, No.2, pp187-204.
- Aucremanne, L. and Dhyne, E. 2004. How Frequently Do Prices Change? Evidence Based on the Micro Data Underlying the Belgian CPI. European Central Bank Working Paper Series No.331.
- Bai, J. 1997. Estimating Multiple Breaks One at a Time. *Econometric Theory*, Vol.13, No.3, pp315-352.
- Bai, J. and Perron, P. 1998. Estimating and Testing Linear Models with Multiple Structural Changes. *Econometrica*, Vol.66, No.1, pp47-78.
- Bayoumi, T. and MacDonald, R. 1999. Deviations of Exchange Rates from Purchasing Power Parity: A Story Featuring Two Monetary Unions. *IMF Staff Papers*, Vol.46, No.1, pp89-102.
- Béreau, S., Villavicencio, A.L. and Mignon, V. 2010. Nonlinear Adjustment of the Real Exchange Rate Towards its Equilibrium Value: A Panel Smooth Transition Error Correction Modelling. *Economic Modelling*, Vol.27, No.1, pp404-416.

Berka, M. and Devereux, M.B. 2013. Trends in European real exchange rates. *Economic Policy*, Vol.28, No.74, pp193-242.

Black, S. 1986. Real Exchange Rates and Deviations from Purchasing Power Parity Under Floating Exchange Rates. A Comment. *Carnegie-Rochester Conference Series on Public Policy*, Vol.25, No.1, pp215-220.

Campbell, J.Y. and Perron, P. 1991. Pitfalls and Opportunities: What Macroeconomists Should Know About Unit Roots. NBER Working Paper Series, Technical Working Paper No.100.

Carvalho, C. and Nechio, F. 2011. Aggregation and the PPP Puzzle in a Sticky-Price Model. *American Economic Review*, Vol.101, No.6, pp2391-2424.

Cashin, P. and McDermott, C.J. 2006. Parity Reversion in Real Exchange Rates: Fast, Slow, or Not at All? *IMF Staff Papers*, Vol.53, No.1, pp89-119.

Cheung, Y.-W. and Lai, K.S. 1998. Parity reversion in real exchange rates during the post-Bretton Woods period. *Journal of International Money and Finance*, Vol.17, No.4, pp597-614.

Cheung, Y.-W. and Lai, K.S. 2000a. On Cross-Country Differences in the Persistence of Real Exchange Rates. *Journal of International Economics*, Vol.50, No.2, pp375-397.

Cheung, Y.-W. and Lai, K.S. 2000b. On the purchasing power parity puzzle. *Journal of International Economics*, Vol.52, No.2, pp321-330.

Chinn, M. and Wei, S.-J. 2013. A Faith-based Initiative: Do We Really Know that a Flexible Exchange Rate Regime Facilitates Current Account Adjustment? *Review of Economics and Statistics*, Vol.95, No.1, pp168-184.

Craighead, W.D. and Tien, P.-L. 2013. Nominal Shocks and Real Exchange Rates: Evidence from Two Centuries. Wesleyan Economic Working Papers, No.2013-002.

Crucini, M.J., Shintani, M. and Tsuruga, T. (2014). Real exchange rate dynamics in sticky wage models. *Economic Letters*, Vol.123, No.2, pp160-163.

- Culver, S.E. and Papell, D.H. 1995. Real exchange rates under the gold standard: can they be explained by the trend break model? *Journal of International Money and Finance*, Vol.14, No.4, pp539-548.
- Dumas, B. 1992. Dynamic Equilibrium and the Real Exchange Rate in a Spatially Separated World. *The Review of Financial Studies*, Vol.5, No.2, pp153-180.
- Edwards, S. 2007. On Current Account Surpluses and the Correction of Global Imbalances. National Bureau of Economic Research Working Paper No.12904.
- Engel, C. 2012. Real Exchange Rate Convergence: The Roles of Price Stickiness and Monetary Policy. Working Paper, University of Wisconsin.
- Frankel, J.A. and Rose, A.K. 1996. A Panel Project on Purchasing Power Parity: Mean Reversion Within and Between Countries. *Journal of International Economics*, Vol.40, No.1-2, pp209-224.
- Freund, C. and Warnock, F. 2007. Current Account Deficits in Industrial Countries: The Bigger They Are, The Harder They Fall? In *G7 Current Account Imbalances: Sustainability and Adjustment*, ed. by Clarida, R.H., (NBER Inc.), pp133-168.
- Froot, K.A. and Rogoff, K.S. 1995. Perspectives on PPP and Long-Run Real Exchange Rates. In *Handbook of International Economics*, Vol.3, ed. by Grossman, G. and Rogoff, K., (Amsterdam: Elsevier Press), pp1647-1688.
- Gopinath, G. and Rigobon, R. 2008. Sticky Borders. *Quarterly Journal of Economics*, Vol.123, No.2, pp531-575.
- Heinen, F., Kaufmann, H. and Sibbertsen, P. 2011. The dynamics of real exchange rates – A reconsideration. Presented at the 19th Symposium of the Society for Nonlinear Dynamics and Econometrics in Washington, D.C..
- Kapetanios, G., Shin, Y. and Snell, A. 2003. Testing for a Unit Root in the Nonlinear STAR Framework. *Journal of Econometrics*, Vol.112, No.2, pp359-379.
- Kargbo, J.M. 2003. Cointegration Tests of Purchasing Power Parity in Africa. *World Development*, Vol.31, No.10, pp1673-1685.

Kargbo, J.M. 2006. Purchasing Power Parity and Real Exchange Rate Behaviour in Africa. *Applied Financial Economics*, Vol.16, No.1-2, pp169-183.

Kilian, L. and Taylor, M. 2003. Why is it so difficult to beat the random walk forecast of exchange rates? *Journal of International Economics*, Vol.60, No.1, pp85-107.

Kiliç, R. (February) 2005. Confidence Intervals for half-life deviations from Purchasing Power Parity in a nonlinear model. Georgia Institute of Technology.

Klenow, P.J. and Malin, B.A. 2010. Microeconomic Evidence on Price-Setting. National Bureau of Economic Research Working Paper No.15826.

Michael, P., Nobay, A.R. and Peel, D.A. 1997. Transactions Costs and Nonlinear Adjustment in Real Exchange Rates: An Empirical Investigation. *Journal of Political Economy*, Vol.105, No.4, pp862-879.

Murray, C.J. and Papell, D.H. 2005b. Do Panels Help Solve the Purchasing Power Parity Puzzle? *Journal of Business and Economic Statistics*, Vol.23, No.4, pp410-415.

Nakamura, E. and Steinsson, J. 2008. Five Facts About Prices: A Re-Evaluation of Menu Cost Models. *Quarterly Journal of Economics*, Vol.123, No.4, pp1415-1464.

Perron, P. 1989. The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica*, Vol.57, No.6, pp1361-1401.

Perron, P. 1993. Trend Unit Root and Structural Change in Macroeconomics Time Series. Unpublished Manuscript, University of Montreal.

Reinhart, C.M. and Rogoff, K.S. 2009. *This Time Is Different: Eight Centuries of Financial Folly*. Princeton and Oxford: Princeton University Press.

Sercu, P., Uppal, R. and Hulle, C.V. 1995. The Exchange Rate in the Presence of Transaction Costs: Implications for Tests of Purchasing Power Parity. *The Journal of Finance*, Vol.50, No.4, pp1309-1319.

Steinsson, J. 2008. The dynamic behaviour of the real exchange rate in sticky price models. *American Economic Review*, Vol.98, No.1, pp519-533.

Taylor, A.M. and Taylor, M.P. 2004. The Purchasing Power Parity Debate. *Journal of Economic Perspectives*, Vol.18, No.4, pp135-158.

Taylor, M.P., Peel, D.A. and Sarno, L. 2001. Nonlinear Mean-Reversion in Real Exchange Rates: Toward a Solution to the Purchasing Power Parity Puzzles. *International Economic Review*, Vol.42, No.4, pp1015-1042.

Taylor, M.P. 2003. Purchasing Power Parity. *Review of International Economics*, Vol.11, No.3, pp436-452.

Ventosa-Santaulària, D., Wallace, F. and Gómez-Zaldívar, M. 2012. Is the real effective exchange rate biased against the PPP hypothesis? MPRA Paper No.42488.

Wu, Y. 1996. Are Real Exchange Rates Nonstationary? Evidence from a Panel-Data Test. *Journal of Money, Credit, and Banking*, Vol.28, No.1, pp54-63.

Zivot, E. and Andrews, D. 1992. Further Evidence on the Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Journal of Business and Economic Statistics*, Vol.10, No.3, pp251-270.

Table 2.1: Country BRER Econometric Specification Details

COUNTRY	TREND	LEVEL INTERCEPT BREAK	TREND SLOPE BREAK	LAG LENGTH (Perron)	MODEL SELECTED
Afghanistan	Yes	0	0	8	AR(1), augmented AR*, <i>ESTAR</i> *** [†]
Albania	Yes	0	0	11	AR(1)**, AR(1) with trend***, augmented AR, <i>ESTAR</i> *** [†]
Algeria	Yes	0	0	12	AR(1), augmented AR, <i>ESTAR</i> *****
Angola	Yes	0	0	12	AR(1)***, augmented AR, <i>ESTAR</i> *****
Argentina	Yes	0	0	10	AR(1), augmented AR, <i>ESTAR</i> *****
Armenia	Yes	1	0	12	AR(1)***, augmented AR*, <i>ESTAR</i> *****
Austria	No	0	0	11	AR(1), augmented AR*, <i>ESTAR</i> ***
Bahamas, The	No	0	0	12	AR(1), augmented AR, <i>ESTAR</i> *** [†]
Bahrain, Kingdom of	Yes	0	0	12	AR(1), augmented AR, <i>ESTAR</i> *** [†]
Bangladesh	No	0	0	12	AR(1), augmented AR, <i>ESTAR</i> *****
Belgium	No	0	0	12	AR(1), augmented AR*, <i>ESTAR</i> ***
Benin	No	1	0	0	AR(1), <i>augmented AR</i> , <i>ESTAR</i> ** [‡]
Bhutan	Yes	0	0	1	AR(1), augmented AR, <i>ESTAR</i> ***
Bolivia	No	0	0	12	AR(1)***, augmented AR, <i>ESTAR</i> *****
Botswana	No	0	0	1	AR(1), augmented AR, <i>ESTAR</i> **
Brazil	No	1	0	8	AR(1), augmented AR, <i>ESTAR</i> **
Bulgaria	Yes	0	0	6	AR(1), augmented AR*, <i>ESTAR</i> *****
Burundi	Yes	0	0	0	AR(1), <i>augmented AR</i> , <i>ESTAR</i> ** ^{‡†}
Cambodia	No	0	0	5	AR(1), augmented AR, <i>ESTAR</i> ***

Cameroon	No	1	0	0	AR(1), <i>augmented AR**</i> , ESTAR ^{*, ††}
Canada	No	0	0	12	AR(1), augmented AR, ESTAR****
Cape Verde	No	0	0	1	AR(1), <i>augmented AR</i> , ESTAR ^{†, ††}
Central African Republic	No	1	0	0	AR(1), augmented AR***, ESTAR*****
Chad	No	1	0	8	AR(1), augmented AR, ESTAR*****[†]
Colombia	No	0	0	10	AR(1), augmented AR, ESTAR*****[†]
Congo, Dem. Rep.	No	1	0	2	AR(1)**, augmented AR***, ESTAR*****
Costa Rica	No	1	0	11	AR(1), augmented AR***, ESTAR*****
Cote d'Ivoire	No	1	0	0	AR(1), <i>augmented AR**</i> , ESTAR ^{***, ††}
Croatia	No	1	0	4	AR(1)***, augmented AR***, ESTAR*****
Cyprus	No	0	0	12	AR(1), <i>augmented AR*</i> , ESTAR ^{***, ††}
Czech Republic	Yes	0	0	7	AR(1), augmented AR, ESTAR*****
Denmark	No	0	0	12	AR(1), <i>augmented AR*</i> , ESTAR ^{†, †}
Djibouti	No	0	0	11	AR(1), augmented AR, ESTAR****
Dominica	No	0	0	12	AR(1)***, <i>augmented AR***</i> , ESTAR ^{†, †}
Dominican Republic	No	1	0	0	AR(1), augmented AR***, ESTAR*****
Ecuador	No	1	0	6	AR(1), augmented AR***, ESTAR*****
Egypt	Yes	5	0	11	AR(1), <i>augmented AR***</i> , ESTAR ^{***, †}
El Salvador	Yes	2	0	2	AR(1), augmented AR ESTAR*****
Equatorial Guinea	No	1	0	11	AR(1), augmented AR, ESTAR****
Estonia	Yes	0	0	1	AR(1)***, <i>augmented AR**</i> , ESTAR ^{***, ††}

Ethiopia	No	1	0	0	AR(1), augmented AR***, ESTAR*****
Fiji	No	2	0	4	AR(1), augmented AR**, ESTAR*****
Finland	No	0	0	12	AR(1), augmented AR*, ESTAR*****
France	No	0	0	12	AR(1), augmented AR*, ESTAR***
Gabon	No	1	0	0	AR(1), <i>augmented AR**</i> , ESTAR***.†
Gambia, The	Yes	0	0	0	AR(1), augmented AR, ESTAR***.‡
Germany	No	0	0	12	AR(1), augmented AR, ESTAR***
Ghana	Yes	0	0	12	AR(1)***, augmented AR*, ESTAR*****
Greece	No	0	0	12	AR(1), augmented AR, ESTAR**
Grenada	No	0	0	12	AR(1)**, augmented AR***, ESTAR*****
Guatemala	Yes	1	0	0	AR(1), augmented AR***, ESTAR*****
Guinea-Bissau	No	0	0	5	AR(1)*, <i>augmented AR**</i> , ESTAR***.†
Guyana	Yes	0	0	0	AR(1), <i>augmented AR</i> , ESTAR†.††
Haiti	Yes	1	0	12	AR(1), augmented AR*, ESTAR***.‡
Honduras	Yes	1	0	8	AR(1), augmented AR***, ESTAR*****
Hong Kong	Yes	1	1	10	AR(1), augmented AR, ESTAR*****
Hungary	Yes	0	0	12	AR(1), augmented AR, ESTAR***.‡
Iceland	No	0	0	10	AR(1), augmented AR**, ESTAR***
India	No	0	0	3	AR(1), augmented AR, ESTAR*****
Indonesia	No	3	0	11	AR(1), augmented AR*, ESTAR*****
Iran, Islamic Rep.	Yes	2	0	2	AR(1), augmented AR***, ESTAR*****
Ireland	No	0	0	1	AR(1), <i>augmented AR</i> , ESTAR†.†

Israel	No	0	0	2	AR(1) ^{***} , <i>augmented AR^{***}</i> , <i>ESTAR^{***, †}</i>
Italy	No	0	0	12	AR(1), <i>augmented AR[*]</i> , <i>ESTAR^{†, ‡}</i>
Jamaica	Yes	2	2 (only in ESTAR)	11	AR(1), augmented AR ^{***} , <i>ESTAR^{*****}</i>
Japan	No	0	0	11	AR(1), augmented AR, <i>ESTAR^{***, *†}</i>
Jordan	No	0	0	12	AR(1), augmented AR, <i>ESTAR^{*****}</i>
Kazakhstan	Yes	2	0	1	AR(1), augmented AR ^{**} , <i>ESTAR^{*****}</i>
Kenya	No	0	0	1	AR(1), augmented AR, <i>ESTAR^{***, †}</i>
Korea, Rep.	No	0	0	8	AR(1), augmented AR [*] , <i>ESTAR^{*****}</i>
Kuwait	No	1	0	1	AR(1), augmented AR ^{***} , <i>ESTAR^{*****}</i>
Kyrgyz Republic	No	0	0	4	AR(1), augmented AR, <i>ESTAR^{***}</i>
Lao PDR	No	0	0	5	AR(1), augmented AR, <i>ESTAR^{***}</i>
Latvia	Yes	0	0	12	AR(1) ^{***} , augmented AR [*] , <i>ESTAR^{*****}</i>
Lesotho	Yes	0	0	8	AR(1), augmented AR, <i>ESTAR^{***, *†}</i>
Libya	No	1	0	7	AR(1), augmented AR ^{***} , <i>ESTAR^{*****}</i>
Lithuania	Yes	0	0	1	AR(1) ^{***} , augmented AR ^{***} , <i>ESTAR^{*****}</i>
Luxembourg	No	0	0	12	AR(1), augmented AR, <i>ESTAR^{*****}</i>
Macedonia, FYR	No	0	0	1	AR(1), augmented AR, <i>ESTAR^{***}</i>
Madagascar	Yes	0	0	1	AR(1), augmented AR, <i>ESTAR^{*****}</i>
Malawi	Yes	0	0	12	AR(1), augmented AR ^{**} , <i>ESTAR^{*****}</i>
Malaysia	Yes	0	0	8	AR(1), augmented AR, <i>ESTAR^{***}</i>
Maldives	No	0	0	11	AR(1) ^{***} , augmented AR, <i>ESTAR^{†, ‡}</i>
Malta	No	1	0	12	AR(1), augmented AR ^{***} , <i>ESTAR^{*****}</i>

Mauritania	No	0	0	6	AR(1), augmented AR, <i>ESTAR</i> ****
Mauritius	No	0	0	10	AR(1), <i>augmented AR</i> , ESTAR ^{†, ‡}
Mexico	Yes	5	0	5	AR(1)**, augmented AR**, <i>ESTAR</i> *****
Moldova	Yes	1	0	5	AR(1), augmented AR*, <i>ESTAR</i> ****
Mongolia	No	0	0	10	AR(1)***, augmented AR***, <i>ESTAR</i> *****
Morocco	No	0	0	12	AR(1), augmented AR, <i>ESTAR</i> *** [†]
Mozambique	No	0	0	12	AR(1), augmented AR**, <i>ESTAR</i> *****
Namibia	No	0	0	6	AR(1)*, <i>augmented AR*</i> , ESTAR*** [†]
Nepal	No	0	0	11	AR(1), <i>augmented AR</i> , ESTAR* ^{†, ‡}
Netherlands	No	0	0	11	AR(1), augmented AR*, <i>ESTAR</i> ****
Nicaragua	No	0	0	3	AR(1), augmented AR, <i>ESTAR</i> ^{†, ***[†]}
Niger	No	1	0	0	AR(1), augmented AR, <i>ESTAR</i> *** [*]
Nigeria	Yes	3	2	3	AR(1), augmented AR***, <i>ESTAR</i> *****
Norway	No	0	0	1	AR(1), augmented AR**, <i>ESTAR</i> ****
Pakistan	No	0	0	12	AR(1), <i>augmented AR</i> , ESTAR ^{†, ‡}
Panama	No	0	0	0	<i>AR(1)</i> **, augmented AR ^{NA} , ESTAR*** [*]
Paraguay	No	5	4	9	AR(1), augmented AR, <i>ESTAR</i> *****
Peru	No	1	0	12	AR(1)***, augmented AR, <i>ESTAR</i> *****
Philippines	No	0	0	8	AR(1), augmented AR, <i>ESTAR</i> ** [*]
Poland	No	1	0	0	AR(1), <i>augmented AR</i> ***, ESTAR*** [*]
Portugal	No	0	0	9	AR(1), augmented AR, <i>ESTAR</i> ** [*]
Qatar	Yes	0	0	1	<i>AR(1)</i> , augmented AR, ESTAR ^{†, ‡}

Romania	Yes	0	0	12	AR(1), augmented AR***, ESTAR *****
Russian Federation	Yes	1	0	3	AR(1), augmented AR***, ESTAR *****
Rwanda	No	3	0	1	AR(1), augmented AR***, ESTAR ****
Samoa	No	0	0	1	AR(1), <i>augmented AR</i> , ESTAR** ^{††}
San Marino	Yes	0	0	3	AR(1)*, <i>augmented AR</i> *, ESTAR*** [*]
Saudi Arabia	No	0	0	12	AR(1)***, <i>augmented AR</i> **, ESTAR** [*]
Senegal	No	1	0	10	AR(1), augmented AR*, ESTAR ** ^{****}
Seychelles	No	3	0	10	AR(1), augmented AR**, ESTAR *****
Sierra Leone	Yes	0	0	10	AR(1)***, augmented AR, ESTAR *****
Singapore	No	0	0	12	AR(1), augmented AR*, ESTAR ** ^{***†}
Slovak Republic	Yes	0	0	2	AR(1), <i>augmented AR</i> , ESTAR ^{††}
Slovenia	No	0	0	1	AR(1), <i>augmented AR</i> , ESTAR ^{††}
Solomon Islands	No	0	0	0	AR(1), augmented AR ^{NA} , ESTAR ** ^{***†}
South Africa	Yes	0	0	8	AR(1), augmented AR, ESTAR *****
Spain	No	0	0	3	AR(1), <i>augmented AR</i> , ESTAR ^{††}
Sri Lanka	No	1	0	7	AR(1)*, augmented AR***, ESTAR *****
St. Kitts & Nevis	No	1	0	0	AR(1), <i>augmented AR</i> , ESTAR ^{††}
St. Lucia	No	0	0	12	AR(1)***, augmented AR***, ESTAR *****
St. Vincent & the Grenadines	No	0	0	0	<i>AR(1)</i> *, augmented AR ^{NA} , ESTAR*** [†]
Suriname	Yes	3	0	0	AR(1)***, augmented AR***, ESTAR *****
Sweden	No	0	0	10	AR(1), augmented AR, ESTAR ** ^{****}
Switzerland	No	0	0	11	AR(1), augmented AR*, ESTAR *****

Syrian Arab Republic	Yes	1	0	0	AR(1), augmented AR*, ESTAR****
Tanzania	No	0	0	10	AR(1), augmented AR, ESTAR****
Thailand	No	2	1	7	AR(1), augmented AR***, ESTAR*****
Togo	No	1	0	9	AR(1), augmented AR, ESTAR***†
Tonga	No	0	0	1	AR(1), augmented AR , ESTAR‡,‡‡
Trinidad & Tobago	Yes	1	0	2	AR(1), augmented AR***, ESTAR*****
Tunisia	Yes	0	0	1	AR(1), augmented AR* , ESTAR***,‡‡
Turkey	Yes	3	1	11	AR(1)*, augmented AR, ESTAR*****
Uganda	No	0	0	12	AR(1)***, augmented AR, ESTAR*****†
United Kingdom	No	0	0	6	AR(1), augmented AR*, ESTAR****
Uruguay	No	1	0	11	AR(1)***, augmented AR, ESTAR*****
Venezuela	Yes	5	0	1	AR(1), augmented AR**, ESTAR*****
Zambia	Yes	0	0	0	AR(1), augmented AR** , ESTAR***,‡

Notes:
*significant at 10% level; **significant at 5% level; ***significant at 1% level.
Model selected is in bold and italics. For linear ‘AR(1)’ and ‘augmented AR’ models, statistical significance of ρ is shown. In the case of the ‘ESTAR’ model only: ‡ insignificant; † failed to reject null of linearity. For the ‘ESTAR’ model, moving from left to right we have: significance of ρ^* , significance of φ , and an indication if we fail to reject the null hypothesis of linearity in the linearity test (indication via the aforementioned symbol is only given if we fail to reject the null). NA denotes not applicable. We separately show the ‘AR(1) with trend’ model result for Albania in order to distinguish it from the ‘augmented AR’ model which also included lags. Also note: *borderline significant at 10% level; ‡borderline insignificant.

Table 2.2: Country REER Econometric Specification Details

COUNTRY	TREND	LEVEL INTERCEPT BREAK	TREND SLOPE BREAK	LAG LENGTH (Perron)	MODEL SELECTED
Algeria	Yes	2	2	8	AR(1), augmented AR, ESTAR *****
Antigua and Barbuda	Yes	2	0	1	AR(1), augmented AR***, ESTAR *****
Armenia	Yes	0	0	12	AR(1), augmented AR**, ESTAR ****
Australia	No	0	0	2	AR(1), augmented AR, ESTAR ^{‡, #}
Austria	No	0	0	10	AR(1), augmented AR**, ESTAR **** [†]
Bahamas, The	No	2	0	2	AR(1), augmented AR***, ESTAR *****
Bahrain, Kingdom of	Yes	0	0	1	AR(1), augmented AR, ESTAR ****
Belgium	No	0	0	3	AR(1), augmented AR, ESTAR *****
Belize	Yes	0	0	8	AR(1), augmented AR **, ESTAR **** [‡]
Bolivia	Yes	1	1	8	AR(1)***, augmented AR***, ESTAR *****
Brazil	No	0	0	10	AR(1), augmented AR, ESTAR ****
Bulgaria	Yes	0	0	6	AR(1)**, augmented AR ***, ESTAR **** [‡]
Burundi	Yes	0	0	5	AR(1), augmented AR, ESTAR *** [#]
Cameroon	No	1	0	0	AR(1), augmented AR***, ESTAR *****
Canada	Yes	1	1	8	AR(1), augmented AR , ESTAR **** [‡]
Central African Republic	Yes	1	1	0	AR(1), augmented AR***, ESTAR *****
Chile	No	0	0	9	AR(1), augmented AR, ESTAR *****
China	Yes	1	1	1	AR(1)**, augmented AR, ESTAR *****
Colombia	Yes	2	1	0	AR(1), augmented AR, ESTAR *****
Congo, Dem. Rep.	No	6	1	3	AR(1)*, augmented AR***, ESTAR *****

Costa Rica	No	0	0	9	AR(1) ^{***} , augmented AR ^{***} , ESTAR ^{*****}
Cote d'Ivoire	No	1	1	0	AR(1) [*] , augmented AR ^{***} , ESTAR ^{*****†}
Croatia	Yes	0	0	12	AR(1) ^{***} , augmented AR ^{***} , ESTAR ^{***.‡}
Cyprus	Yes	1	1	10	AR(1), augmented AR, ESTAR ^{*****}
Czech Republic	Yes	0	0	10	AR(1), augmented AR , ESTAR ^{***.*†}
Denmark	Yes	0	0	11	AR(1), augmented AR [*] , ESTAR ^{*,.††}
Dominica	No	0	0	8	AR(1), augmented AR, ESTAR ^{*****}
Dominican Republic	No	1	0	6	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Ecuador	No	1	0	10	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Equatorial Guinea	Yes	1	1	1	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Fiji	Yes	4	4	3	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Finland	No	4	3	10	AR(1), augmented AR ^{***} , ESTAR ^{*****}
France	No	0	0	8	AR(1) [*] , augmented AR ^{**} , ESTAR ^{***.††}
Gabon	No	2	0	1	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Gambia, The	No	2	2	2	AR(1), augmented AR, ESTAR ^{*****}
Georgia	No	2	1	10	AR(1) ^{***} , augmented AR ^{***} , ESTAR ^{*****}
Germany	No	0	0	1	AR(1), augmented AR, ESTAR ^{*****}
Ghana	Yes	3	2	4	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Greece	No	4	2	12	AR(1), augmented AR ^{***} , ESTAR ^{*****†}
Grenada	No	0	0	12	AR(1), augmented AR [*] , ESTAR ^{*****}
Guyana	Yes	7	1	10	AR(1), augmented AR ^{***} , ESTAR ^{*****}
Hungary	Yes	0	0	1 (0 in ESTAR)	AR(1), augmented AR , ESTAR ^{***.‡}

Iceland	No	1	0	5	AR(1), augmented AR***, ESTAR *****
Iran, Islamic Rep.	Yes	15	0	0	AR(1), augmented AR***, ESTAR *****
Ireland	No	5	0	1	AR(1), augmented AR, ESTAR *****
Israel	No	2	0	8	AR(1)***, augmented AR***, ESTAR *****
Italy	Yes	2	2	3	AR(1), augmented AR, ESTAR *****
Japan	No	0	0	8	AR(1), augmented AR, ESTAR ** * [†]
Lesotho	No	9	0	12	AR(1), augmented AR, ESTAR *****
Luxembourg	No	2	1	3	AR(1), augmented AR, ESTAR *****
Macedonia, FYR	No	2	0	12	AR(1)***, augmented AR***, ESTAR *****
Malawi	Yes	16	0	7	AR(1)**, augmented AR, ESTAR *****
Malaysia	Yes	2	0	3	AR(1), augmented AR, ESTAR *****
Malta	Yes	3	1	5	AR(1), augmented AR*, ESTAR ** * [†]
Mexico	Yes	7	0	11	AR(1)*, augmented AR, ESTAR *****
Moldova	Yes	0	0	5	AR(1)*, augmented AR*, ESTAR *****
Morocco	Yes	3	2	11	AR(1)***, augmented AR, ESTAR ** * [†]
Netherlands	No	0	0	10	AR(1), augmented AR**, ESTAR***. [†]
New Zealand	No	2	0	1	AR(1), augmented AR*, ESTAR *****
Nicaragua	Yes	2	2	1	AR(1), augmented AR***, ESTAR *****
Nigeria	Yes	5	5	0	AR(1), augmented AR***, ESTAR *****
Norway	No	0	0	1	AR(1)*, augmented AR**, ESTAR***. [†]
Pakistan	Yes	0	0	1	AR(1), augmented AR, ESTAR ** * [†]

Papua New Guinea	No	9	0	12	AR(1), augmented AR, ESTAR *****
Paraguay	Yes	2	2	6	AR(1), augmented AR, ESTAR *****
Philippines	Yes	0	0	8	AR(1), augmented AR, ESTAR ***** [†]
Poland	Yes	6	0	1	AR(1), augmented AR***, ESTAR *****
Portugal	Yes	6	0	11	AR(1), augmented AR, ESTAR *****
Romania	No	10	2	12	AR(1), augmented AR ***, ESTAR*****
Russian Federation	Yes	2	0	3	AR(1), augmented AR***, ESTAR *****
Samoa	No	0	0	5	AR(1)*, augmented AR *, ESTAR* [‡]
Saudi Arabia	Yes	0	0	3	AR(1)*, augmented AR, ESTAR ** [†]
Sierra Leone	Yes	4	2	10	AR(1), augmented AR***, ESTAR *****
Singapore	No	0	0	6	AR(1) ***, augmented AR*, ESTAR***
Slovak Republic	Yes	0	0	3	AR(1), augmented AR, ESTAR *****
Solomon Islands	No	0	0	1	AR(1), augmented AR, ESTAR *** [‡]
South Africa	No	11	0	8	AR(1), augmented AR, ESTAR ***** [†]
Spain	No	0	0	6	AR(1), augmented AR , ESTAR ^{‡, †}
St. Kitts & Nevis	No	2	0	10	AR(1)**, augmented AR***, ESTAR *****
St. Lucia	No	0	0	12	AR(1)**, augmented AR**, ESTAR *** [†]
St. Vincent & the Grenadines	Yes	0	0	10	AR(1)**, augmented AR*, ESTAR *****
Sweden	Yes	5	1	1	AR(1), augmented AR***, ESTAR *****
Switzerland	Yes	0	0	3	AR(1), augmented AR**, ESTAR *****
Togo	Yes	1	1	11	AR(1), augmented AR ***, ESTAR*** ^{‡†}
Trinidad & Tobago	Yes	5	3	2	AR(1), augmented AR*, ESTAR *****

Tunisia	Yes	1	0	11	AR(1), augmented AR, <i>ESTAR</i> *****
Uganda	No	2	0	12	AR(1)**, augmented AR***, <i>ESTAR</i> *****
Ukraine	No	0	0	12	AR(1)***, augmented AR**, <i>ESTAR</i> *****
United Kingdom	No	0	0	9	AR(1), augmented AR*, <i>ESTAR</i> *****
United States	No	0	0	10	AR(1), <i>augmented AR</i> , ESTAR ^{†, ‡}
Uruguay	Yes	2	0	6	AR(1), <i>augmented AR</i> ***, ESTAR ^{†, ‡}
Venezuela	Yes	11	0	2	AR(1), augmented AR***, <i>ESTAR</i> *****
Zambia	No	4	1	0	AR(1), augmented AR***, <i>ESTAR</i> *****

Notes:

*significant at 10% level; **significant at 5% level; ***significant at 1% level.

Model selected is in bold and italics. For linear 'AR(1)' and 'augmented AR' models, statistical significance of ρ is shown. In the case of the 'ESTAR' model only: ‡ insignificant; † failed to reject null of linearity. For the 'ESTAR' model, moving from left to right we have: significance of ρ^* , significance of ϕ , and an indication if we fail to reject the null hypothesis of linearity in the linearity test (indication via the aforementioned symbol is only given if we fail to reject the null). NA denotes not applicable. We separately show the 'AR(1) with trend' model result for Albania in order to distinguish it from the 'augmented AR' model which also included lags. Also note: *borderline significant at 10% level; ‡borderline insignificant.

Table 2.3A: Average Half-Life Estimates (in Years) for BRER Country Samples I

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	141	101.08	3.42	3.49	2.11	2.85
Industrial	20	4.21	3.12	3.49	1.92	2.80
Emerging	45	296.76	3.76	3.78	2.37	3.30
Developing	76	10.71	3.29	3.31	1.99	2.60
Test of Equal		1.02	0.23	0.19	0.26	0.46
Sub-Group Means		[0.37]	[0.80]	[0.83]	[0.77]	[0.63]

* significant at 10%; ** significant at 5%; *** significant at 1%
'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.3B: Median Half-Life Estimates (in Years) for BRER Country Samples I

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	141	4.32	1.93	2.17	1.11	1.54
Industrial	20	3.87	2.77	3.22	1.35	2.30
Emerging	45	5.07	1.93	2.03	0.88	1.37
Developing	76	4.43	1.45	1.53	1.10	1.55
Test of Equal		0.99	16.18***	20.48***	1.35	7.68**
Sub-Group Medians		[0.61]	[0.00]	[0.00]	[0.51]	[0.02]

* significant at 10%; ** significant at 5%; *** significant at 1%
'Test of equal sub-group medians' tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood's median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood's median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 2.4A: Average Half-Life Estimates (in Years) for BRER Country Samples II

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
High Income	42	315.51	3.16	3.50	1.84	2.82
Middle Income	74	10.86	3.33	3.37	2.34	3.05
Low Income	25	7.89	4.11	3.82	1.84	2.30
Test of Equal		1.00	0.29	0.09	0.56	0.38
Sub-Group Means		[0.38]	[0.75]	[0.91]	[0.58]	[0.69]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.4B: Median Half-Life Estimates (in Years) for BRER Country Samples II

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
High Income	42	4.57	2.60	3.08	1.15	1.79
Middle Income	74	3.91	1.34	1.43	0.90	1.44
Low Income	25	6.64	2.17	2.17	1.25	1.61
Test of Equal		0.57	10.51***	12.13***	2.73	1.76
Sub-Group Medians		[0.75]	[0.01]	[0.00]	[0.26]	[0.42]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 2.5A: Regional Average Half-Life Estimates (in Years) for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Africa	41	8.87	3.34	3.39	2.04	2.73
Asia	32	411.43	5.22	5.05	2.88	4.10
Europe	35	10.15	2.18	2.44	1.31	1.90
Latin America	28	5.48	2.59	2.69	1.96	2.49
Oceania	4	51.61	5.76	6.28	3.63	3.95
Test of Equal Sub-Group Means		1.00 [0.42]	2.10* [0.09]	1.82 [0.14]	1.34 [0.26]	1.58 [0.19]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.5B: Regional Median Half-Life Estimates (in Years) for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Africa	41	4.11	1.54	1.54	1.11	1.61
Asia	32	6.39	2.67	3.21	1.13	1.79
Europe	35	3.53	2.35	2.75	1.08	1.49
Latin America	28	3.85	1.11	1.22	0.38	1.01
Oceania	4	7.00	5.23	5.49	3.78	4.31
Test of Equal Sub-Group Medians		11.61** [0.02]	7.20 [0.12]	8.70* [0.07]	5.46 [0.24]	6.66 [0.16]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 2.6A: Average Half-Life Estimates (in Years) for REER Country Samples I

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	93	6.08	1.31	1.44	0.83	1.41
Industrial	23	4.37	1.87	2.10	1.28	1.91
Emerging	28	6.24	1.55	1.68	1.01	1.87
Developing	42	6.92	0.84	0.91	0.47	0.83
Test of Equal		0.75	4.01**	4.40**	5.43***	2.73*
Sub-Group Means		[0.48]	[0.02]	[0.02]	[0.01]	[0.08]

* significant at 10%; ** significant at 5%; *** significant at 1%
'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.6B: Median Half-Life Estimates (in Years) for REER Country Samples I

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	93	3.57	0.73	0.92	0.50	0.86
Industrial	23	3.65	1.68	1.89	1.22	1.88
Emerging	28	3.93	0.84	0.97	0.67	1.03
Developing	42	2.95	0.39	0.42	0.18	0.45
Test of Equal		1.98	15.62***	17.63***	13.51***	14.25***
Sub-Group Medians		[0.37]	[0.00]	[0.00]	[0.00]	[0.00]

* significant at 10%; ** significant at 5%; *** significant at 1%
'Test of equal sub-group medians' tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood's median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood's median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 2.7A: Average Half-Life Estimates (in Years) for REER Country Samples II

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>Augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
High Income	38	7.92	1.76	1.94	1.22	2.14
Middle Income	47	4.80	1.06	1.15	0.60	0.94
Low Income	8	5.08	0.64	0.72	0.37	0.68
Test of Equal Sub-Group Means		1.47 [0.24]	4.42** [0.02]	4.72*** [0.01]	6.83*** [0.00]	5.58*** [0.01]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.7B: Median Half-Life Estimates (in Years) for REER Country Samples II

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
High Income	38	3.67	1.29	1.37	0.78	1.51
Middle Income	47	3.03	0.48	0.52	0.34	0.64
Low Income	8	2.83	0.22	0.23	0.11	0.28
Test of Equal Sub-Group Medians		2.36 [0.31]	7.50** [0.02]	7.50** [0.02]	9.32*** [0.01]	9.72*** [0.01]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 2.8A: Regional Average Half-Life Estimates (in Years) for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Africa	20	6.69	0.60	0.67	0.39	0.58
Asia	13	10.48	2.49	2.72	1.48	2.95
Europe	30	5.06	1.24	1.41	0.90	1.43
Latin America	22	4.71	1.03	1.11	0.63	1.10
Oceania	6	4.62	1.92	2.00	0.60	1.17
Test of Equal Sub-Group Means		0.71 [0.60]	2.60* [0.06]	2.68* [0.06]	3.06** [0.04]	2.09 [0.13]

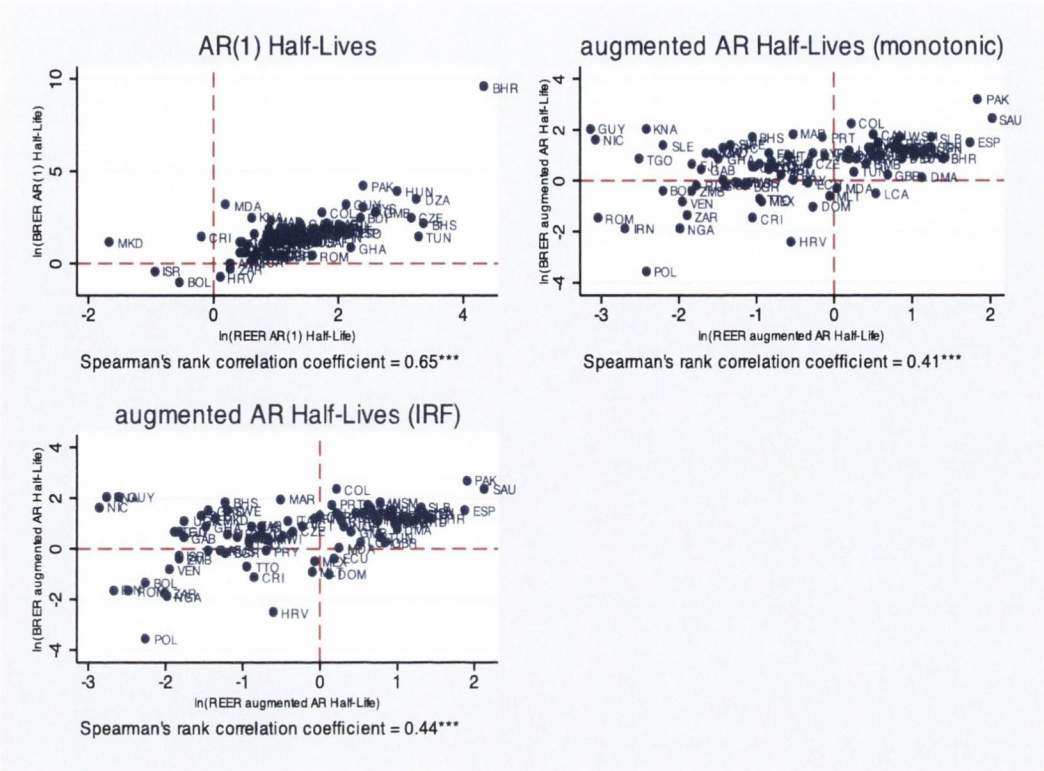
* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 2.8B: Regional Median Half-Life Estimates (in Years) for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Africa	20	3.09	0.32	0.38	0.17	0.37
Asia	13	4.11	1.61	1.78	1.10	1.11
Europe	30	3.63	1.01	1.22	0.61	1.10
Latin America	22	2.91	0.67	0.79	0.55	0.79
Oceania	6	4.33	1.88	1.85	0.24	1.00
Test of Equal Sub-Group Medians		4.91 [0.30]	6.99 [0.13]	7.84* [0.10]	10.54** [0.03]	11.69** [0.02]

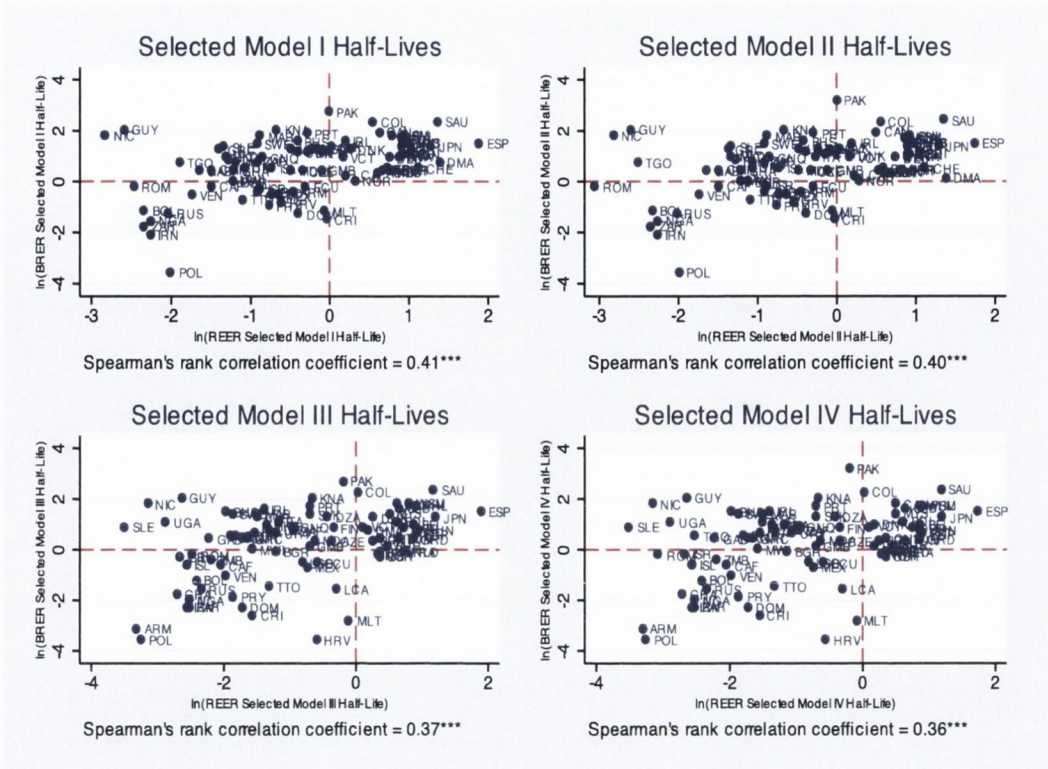
* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Figure 2.1: BRER vs REER Half-Life – Linear Model Estimates



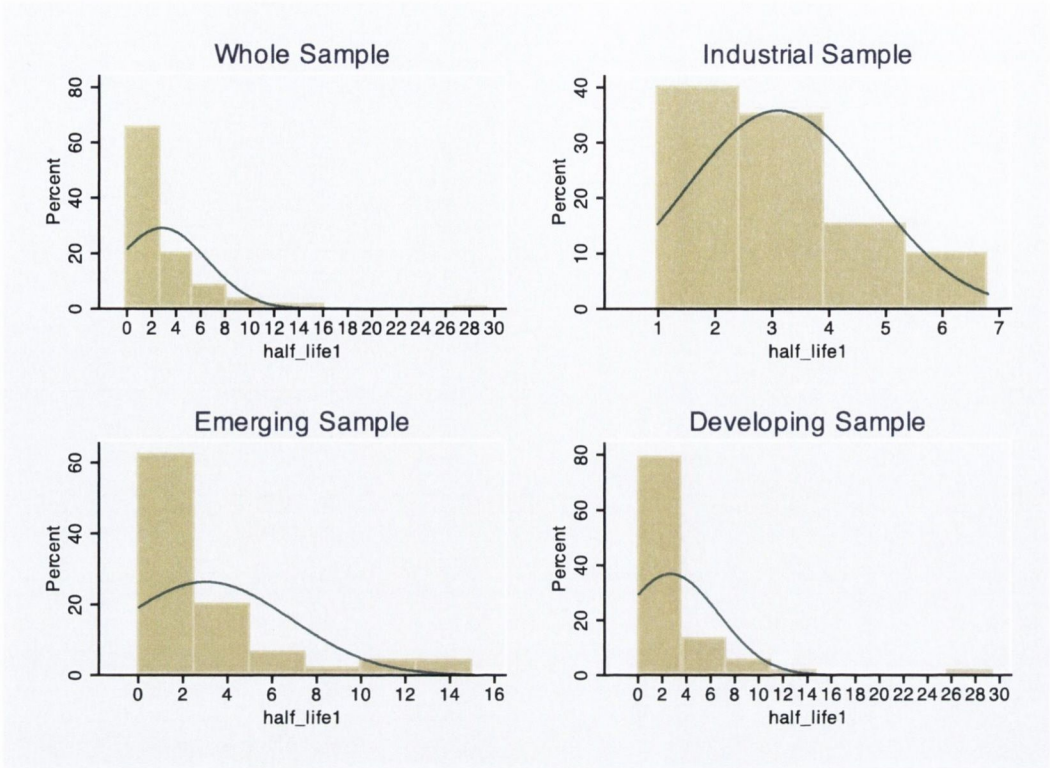
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. Sample consists of 83 countries. Time period: 1973:1-2010:12. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales i.e. half-life in years – our measure of real exchange rate persistence. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e).

Figure 2.3: BRER vs REER Half-Life – Selected Model Estimates



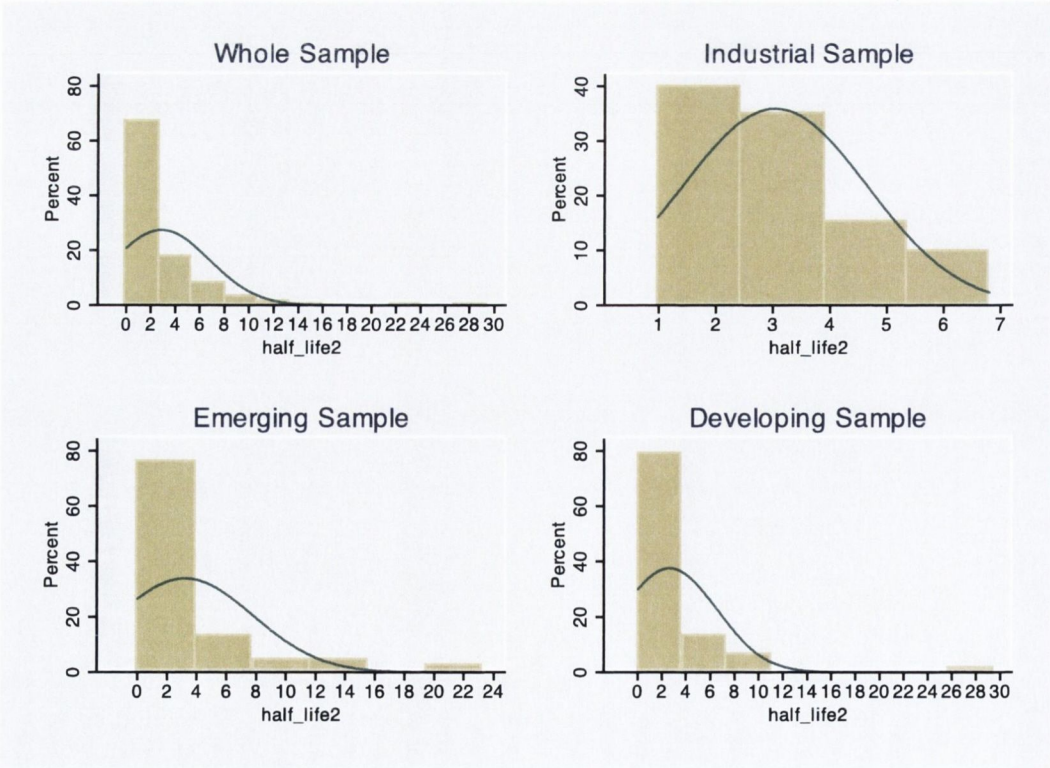
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. Selected Model I Half-Lives: whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen IRF half-life is employed. Selected Model II Half-Lives: whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen monotonic half-life is employed. Selected Model III Half-Lives: whenever non-linear model is chosen monotonic half-life is based on maximum of transition function, and whenever linear model is chosen IRF half-life is employed. Selected Model IV Half-Lives: whenever non-linear model is chosen monotonic half-life is based on maximum of transition function, and whenever linear model is chosen monotonic half-life is employed. Sample consists of 83 countries. Time period: 1973:1-2010:12. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales i.e. half-life in years – our measure of real exchange rate persistence. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e).

Figure 2.4: Selected Model I BRER Half-Life Distributions



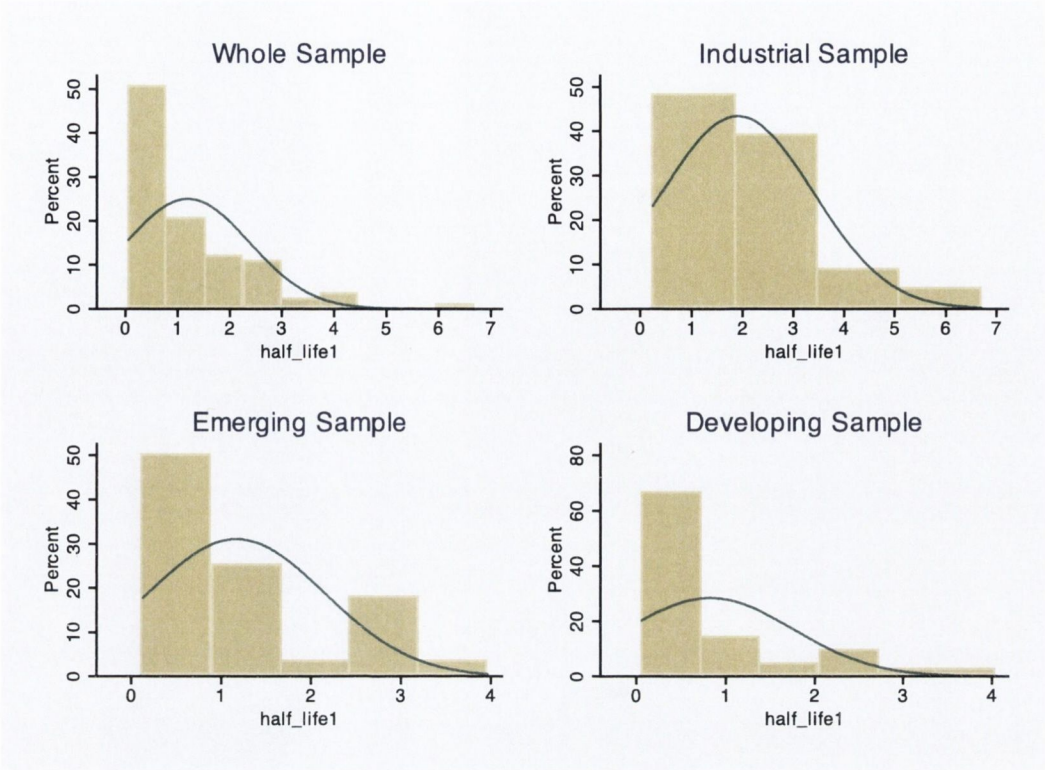
Notes: BRER denotes bilateral real exchange rate. Selected Model I Half-Life (in years); whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen IRF half-life is employed.

Figure 2.5: Selected Model II BRER Half-Life Distributions



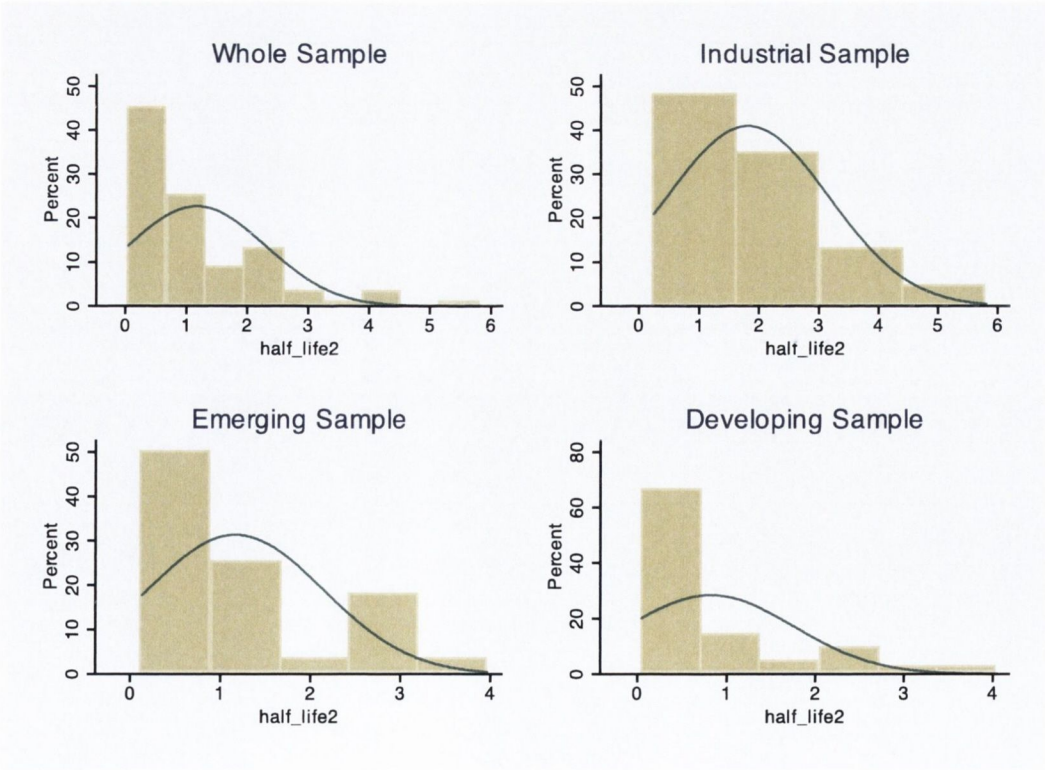
Notes: BRER denotes bilateral real exchange rate. Selected Model II Half-Life (in years); whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen monotonic half-life is employed.

Figure 2.6: Selected Model I REER Half-Life Distributions



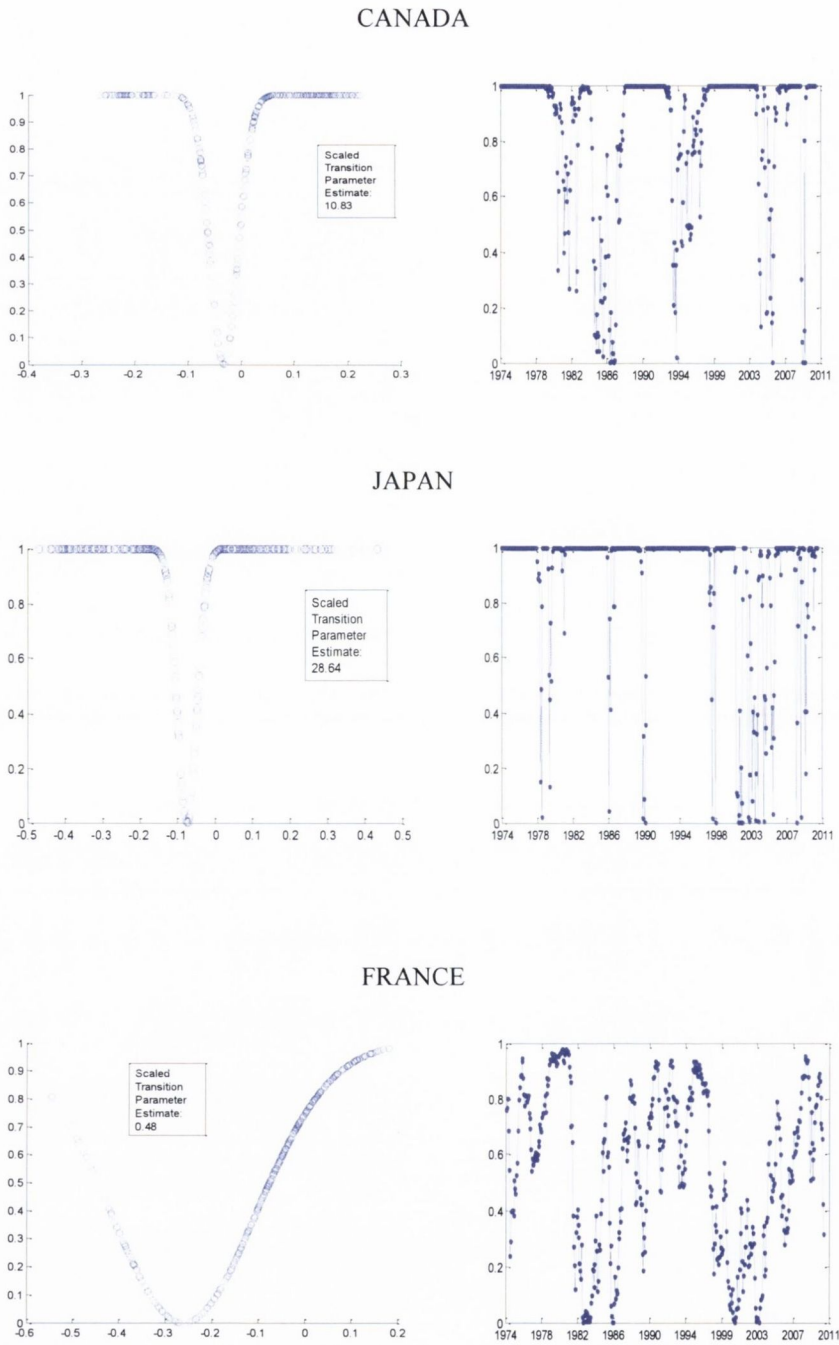
Notes: REER denotes real effective exchange rate. Selected Model I Half-Life (in years); whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen IRF half-life is employed.

Figure 2.7: Selected Model II REER Half-Life Distributions

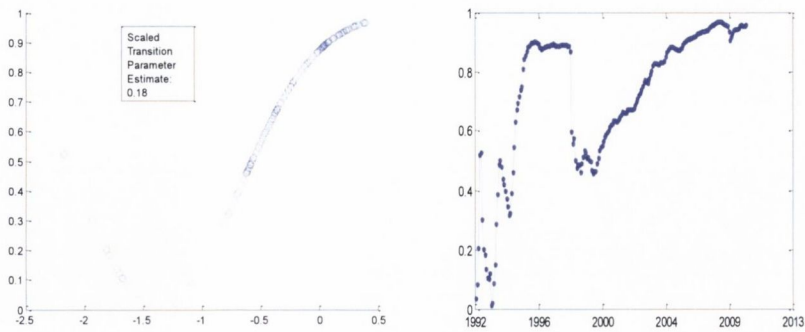


Notes: REER denotes real effective exchange rate. Selected Model II Half-Life (in years); whenever non-linear model is chosen monotonic half-life is based on mean of transition function, and whenever linear model is chosen monotonic half-life is employed.

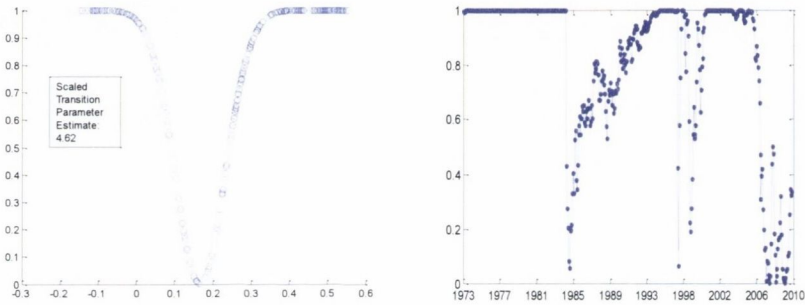
Figure 2.8: Transition Function vs. Transition Variable on Left, Transition Function vs Time on Right, BRERs (selected countries)



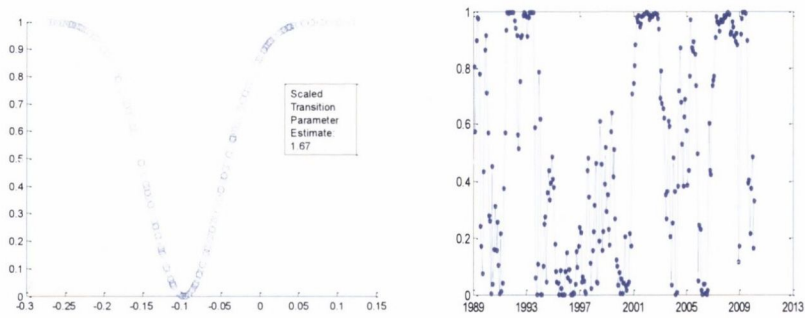
RUSSIA



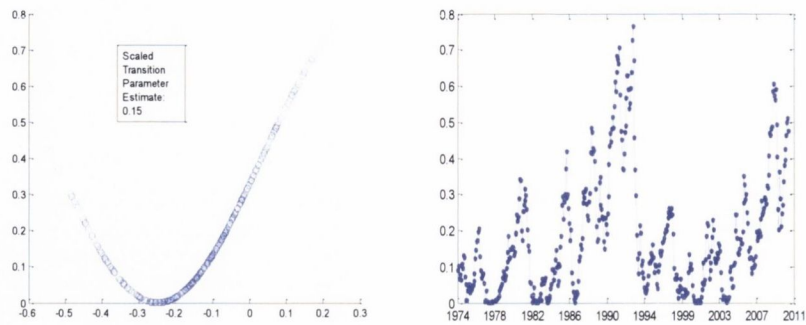
THAILAND



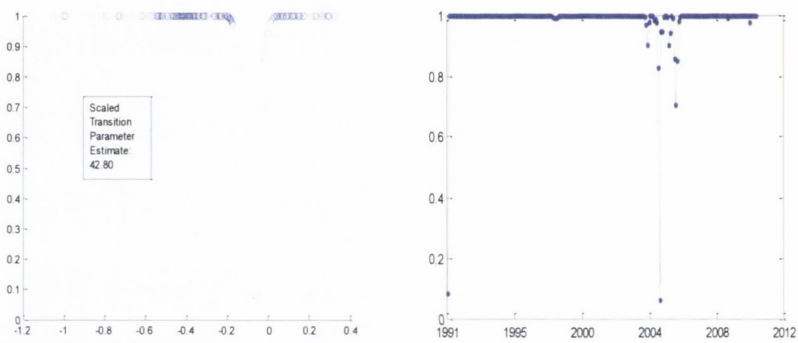
UK



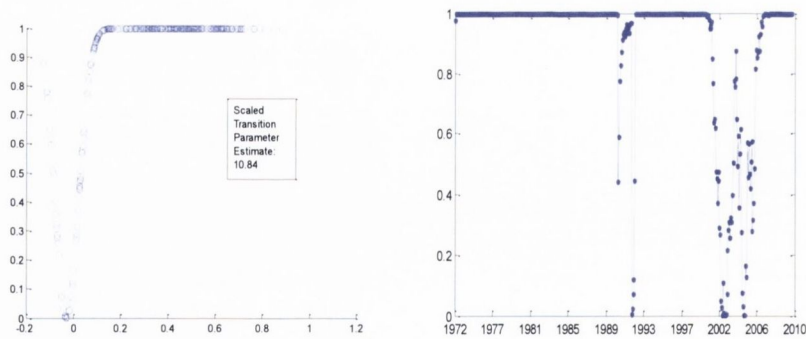
ITALY



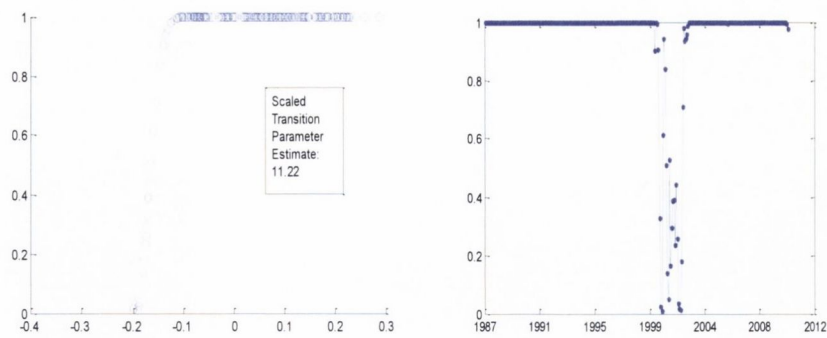
ROMANIA



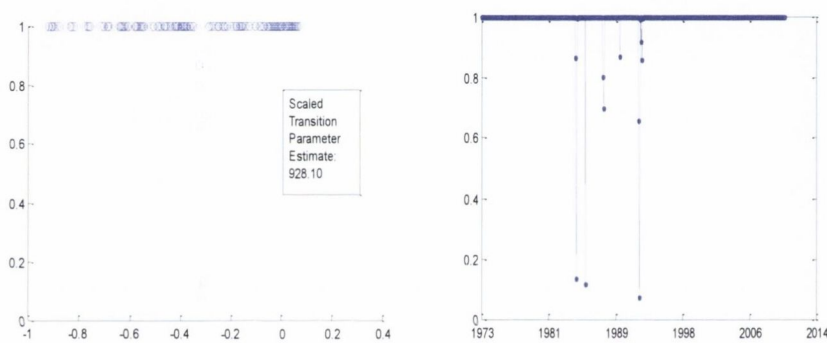
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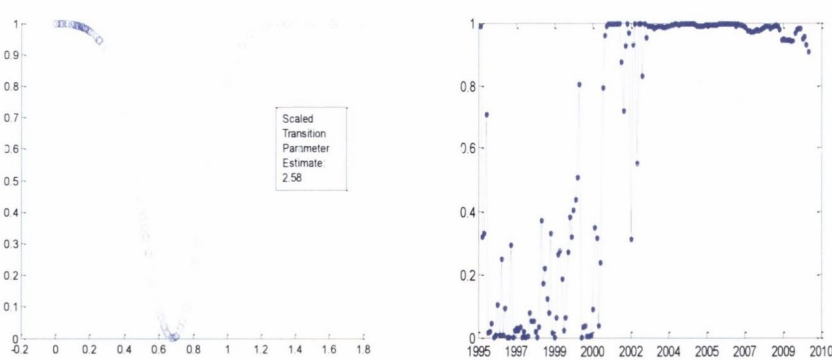
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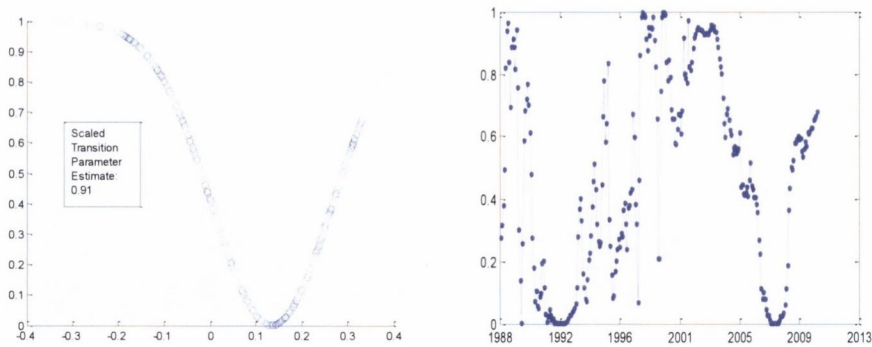
EL SALVADOR



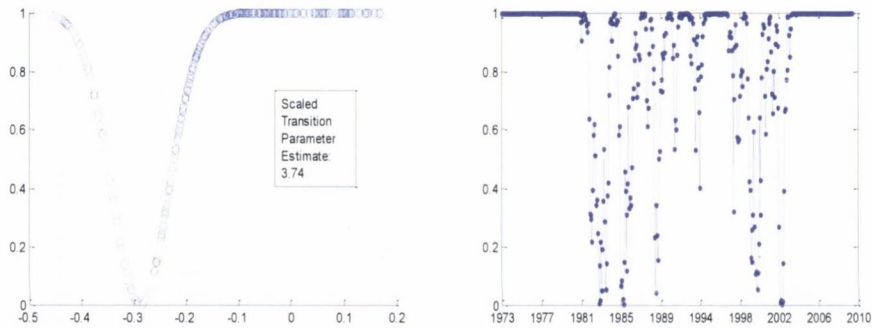
CONGO, DEM. REP.



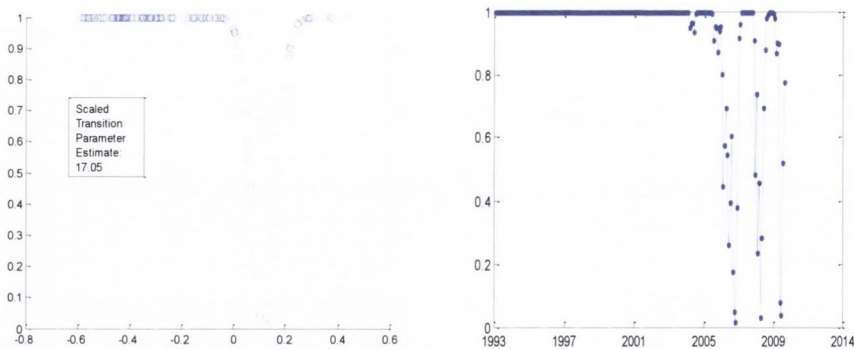
LAO, PDR



CYPRUS

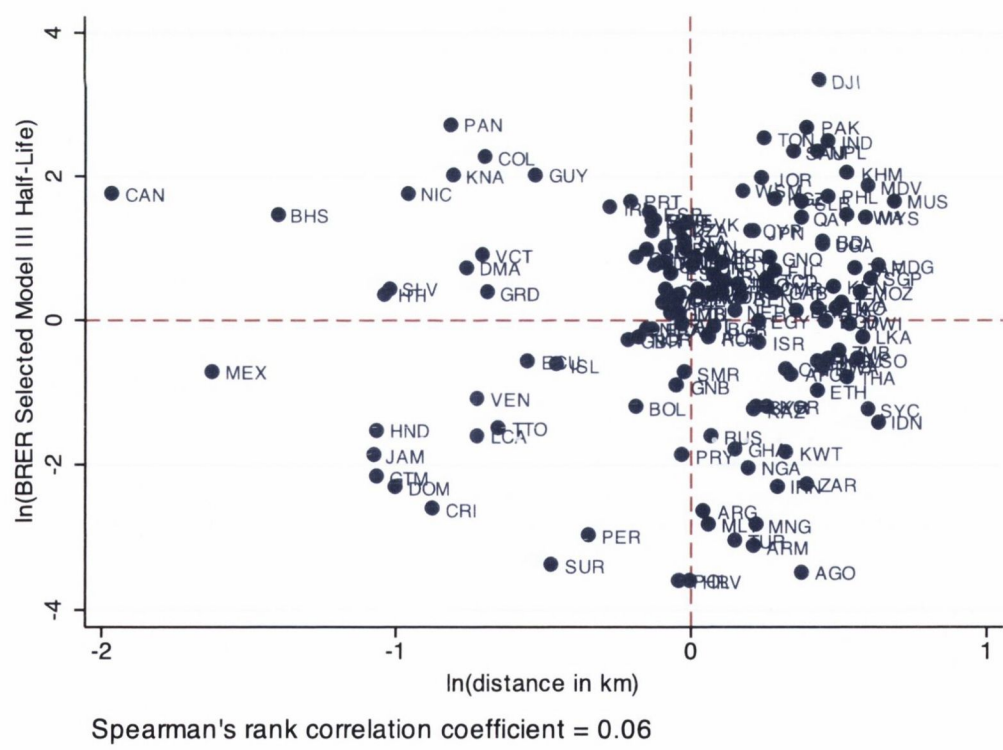
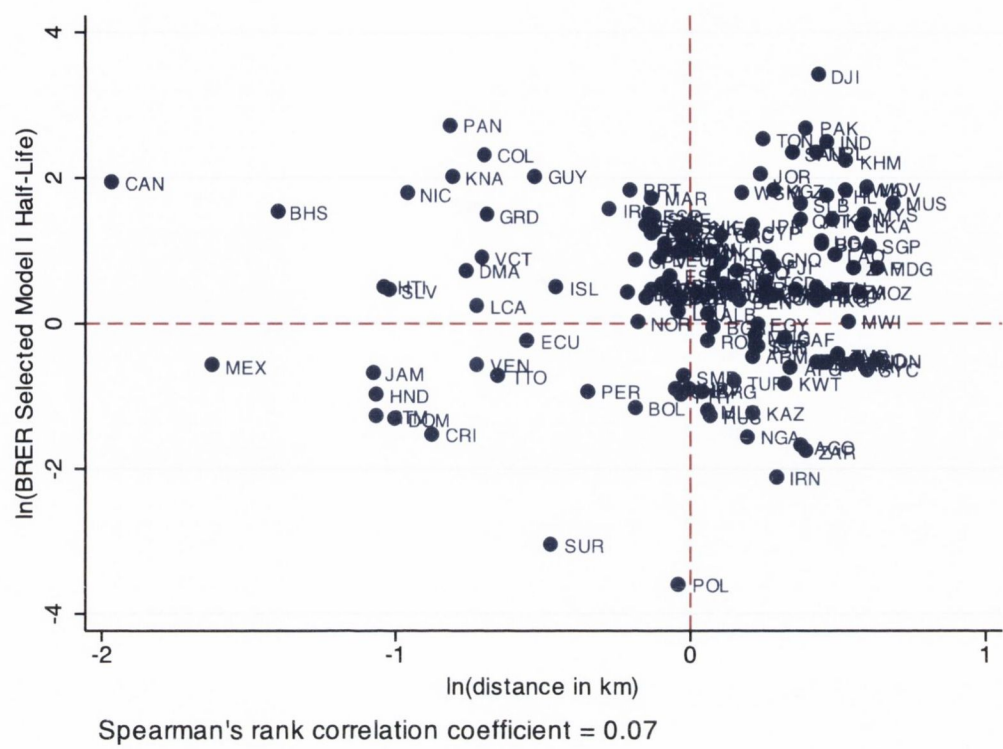


CZECH REPUBLIC



Notes: BRERs denotes bilateral real exchange rate sample. Industrial Countries: Canada, France, Italy, Japan, United Kingdom (UK). Emerging Countries: Cyprus, Czech Republic, Russia, Thailand. Developing Countries: Congo, Dem. Rep., El Salvador, Lao, PDR, Romania, Rwanda, Tunisia. Scaled transition parameter estimate is equal to the original transition parameter estimate multiplied by the variance of (the log of) the bilateral real exchange rate in question. Parameter estimate is scaled by real exchange rate variance as in Michael et al. (1997) for purposes of comparison.

Figure 2.9: BRER Selected Model Half-Life vs Distance from US



Note: BRER denotes bilateral real exchange rate. Selected Model I (III) Half-Life; whenever non-linear model is chosen monotonic half-life is based on mean (maximum) of transition function, and whenever linear model is chosen IRF half-life is employed. The distance (in kilometres) between the US and country j is based on bilateral distances between the largest cities of the two countries, with those inter-city distances being weighted by the share of the cities in the countries' respective overall populations - source: CEPII's GeoDist database (variable name: distwces). With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = "0.02", -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e), 4 = "54.60" (20.09 x e). Original distance data is divided by 8000 so that ln(1) = 0 on the x-axis represents approximately 8000km.

2.7 Appendix A: Country Lists

BRER sample of countries: Afghanistan (AFG), Albania (ALB), Algeria (DZA), Angola (AGO), Argentina (ARG), Armenia (ARM), Austria (AUT), Bahamas, The (BHS), Bahrain (BHR), Bangladesh (BGD), Belgium (BEL), Benin (BEN), Bhutan (BTN), Bolivia (BOL), Botswana (BWA), Brazil (BRA), Bulgaria (BGR), Burundi (BDI), Cambodia (KHM), Cameroon (CMR), Canada (CAN), Cape Verde (CPV), Central African Republic (CAF), Chad (TCD), Colombia (COL), Congo, Dem. Rep. (ZAR), Costa Rica (CRI), Cote d'Ivoire (CIV), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Djibouti (DJI), Dominica (DMA), Dominican Republic (DOM), Ecuador (ECU), Egypt, Arab Rep. (EGY), El Salvador (SLV), Equatorial Guinea (GNQ), Estonia (EST), Ethiopia (ETH), Fiji (FJI), Finland (FIN), France (FRA), Gabon (GAB), Gambia, The (GMB), Germany (DEU), Ghana (GHA), Greece (GRC), Grenada (GRD), Guatemala (GTM), Guinea-Bissau (GNB), Guyana (GUY), Haiti (HTI), Honduras (HND), Hong Kong S.A.R. (HKG), Hungary (HUN), Iceland (ISL), India (IND), Indonesia (IDN), Iran, Islamic Republic of (IRN), Ireland (IRL), Israel (ISR), Italy (ITA), Jamaica (JAM), Japan (JPN), Jordan (JOR), Kazakhstan (KAZ), Kenya (KEN), Korea (KOR), Kuwait (KWT), Kyrgyz Republic (KGZ), Lao, PDR (LAO), Latvia (LVA), Lesotho (LSO), Libya (LBY), Lithuania (LTU), Luxembourg (LUX), Macedonia, FYR (MKD), Madagascar (MDG), Malawi (MWI), Malaysia (MYS), Maldives (MDV), Malta (MLT), Mauritania (MRT), Mauritius (MUS), Mexico (MEX), Moldova (MDA), Mongolia (MNG), Morocco (MAR), Mozambique (MOZ), Namibia (NAM), Nepal (NPL), Netherlands (NLD), Nicaragua (NIC), Niger (NER), Nigeria (NGA), Norway (NOR), Pakistan (PAK), Panama (PAN), Paraguay (PRY), Peru (PER), Philippines (PHL), Poland (POL), Portugal (PRT), Qatar (QAT), Romania (ROM), Russia (RUS), Rwanda (RWA), Samoa (WSM), San Marino (SMR), Saudi Arabia (SAU), Senegal (SEN), Seychelles (SYC), Sierra Leone (SLE), Singapore (SGP), Slovak Republic (SVK), Slovenia (SVN), Solomon Islands (SLB), South Africa (ZAF), Spain (ESP), Sri Lanka (LKA), St. Kitts and Nevis (KNA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Suriname (SUR), Sweden (SWE), Switzerland (CHE), Syrian Arab Republic (SYR), Tanzania (TZA), Thailand (THA), Togo (TGO), Tonga (TON), Trinidad and Tobago (TTO), Tunisia (TUN), Turkey (TUR), Uganda (UGA), United Kingdom (GBR), Uruguay (URY), Venezuela, Rep. Bol. (VEN), Zambia (ZMB).

REER sample of countries: Algeria (DZA), Antigua and Barbuda (ATG), Armenia (ARM), Australia (AUS), Austria (AUT), Bahamas, The (BHS), Bahrain (BHR), Belgium (BEL), Belize (BLZ), Bolivia (BOL), Brazil (BRA), Bulgaria (BGR), Burundi (BDI), Cameroon (CMR), Canada (CAN), Central African Republic (CAF), Chile (CHL), China (CHN), Colombia (COL), Congo, Dem. Rep. (ZAR), Costa Rica (CRI), Cote d'Ivoire (CIV), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Dominica (DMA), Dominican Republic (DOM), Ecuador (ECU), Equatorial Guinea (GNQ), Fiji (FJI), Finland (FIN), France (FRA), Gabon (GAB), Gambia, The (GMB), Georgia (GEO), Germany (DEU), Ghana (GHA), Greece (GRC), Grenada (GRD), Guyana (GUY), Hungary (HUN), Iceland (ISL), Iran, Islamic Republic of (IRN), Ireland (IRL), Israel (ISR), Italy (ITA), Japan (JPN), Lesotho (LSO), Luxembourg (LUX), Macedonia, FYR (MKD), Malawi (MWI), Malaysia (MYS), Malta (MLT), Mexico (MEX), Moldova (MDA), Morocco (MAR), Netherlands (NLD), New Zealand (NZL), Nicaragua (NIC), Nigeria (NGA), Norway (NOR), Pakistan (PAK), Papua New Guinea (PNG), Paraguay (PRY), Philippines (PHL), Poland (POL), Portugal (PRT), Romania (ROM), Russia (RUS), Samoa (WSM), Saudi Arabia (SAU), Sierra Leone (SLE), Singapore (SGP), Slovak Republic (SVK), Solomon Islands (SLB), South Africa (ZAF), Spain (ESP), St. Kitts and Nevis (KNA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Sweden (SWE), Switzerland (CHE), Togo (TGO), Trinidad and Tobago (TTO), Tunisia (TUN), Uganda (UGA), Ukraine (UKR), United Kingdom (GBR), United States (USA), Uruguay (URY), Venezuela, Rep. Bol. (VEN), Zambia (ZMB).

Industrial Countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Iceland (ISL), Ireland (IRL), Italy (ITA), Japan (JPN), Luxembourg (LUX), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), United States (USA).

Emerging Countries: Argentina (ARG), Bahamas, The (BHS), Bahrain (BHR), Brazil (BRA), Bulgaria (BGR), Chile (CHL), China (Mainland) (CHN), Colombia (COL), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Ecuador (ECU), Egypt, Arab Rep. (EGY), Estonia (EST), Hong Kong S.A.R. (HKG), Hungary (HUN), India (IND), Indonesia (IDN), Israel (ISR), Korea Rep. (KOR), Kuwait (KWT), Latvia (LVA),

Lithuania (LTU), Malaysia (MYS), Maldives (MDV), Malta (MLT), Mexico (MEX), Mongolia (MNG), Pakistan (PAK), Panama (PAN), Peru (PER), Philippines (PHL), Poland (POL), Qatar (QAT), Russian Federation (RUS), San Marino (SMR), Saudi Arabia (SAU), Singapore (SGP), Slovak Republic (SVK), Slovenia (SVN), South Africa (ZAF), St. Kitts and Nevis (KNA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Thailand (THA), Turkey (TUR), Venezuela, Rep. Bol. (VEN).

Developing Countries: Afghanistan (AFG), Albania (ALB), Algeria (DZA), Angola (AGO), Antigua and Barbuda (ATG), Armenia (ARM), Bangladesh (BGD), Belize (BLZ), Benin (BEN), Bhutan (BTN), Bolivia (BOL), Botswana (BWA), Burundi (BDI), Cambodia (KHM), Cameroon (CMR), Cape Verde (CPV), Central African Republic (CAF), Chad (TCD), Congo, Dem. Rep. (ZAR), Costa Rica (CRI), Cote d'Ivoire (CIV), Djibouti (DJI), Dominica (DMA), Dominican Republic (DOM), El Salvador (SLV), Equatorial Guinea (GNQ), Ethiopia (ETH), Fiji (FJI), Gabon (GAB), Gambia, The (GMB), Georgia (GEO), Ghana (GHA), Grenada (GRD), Guatemala (GTM), Guinea-Bissau (GNB), Guyana (GUY), Haiti (HTI), Honduras (HND), Iran, Islamic Republic of (IRN), Jamaica (JAM), Jordan (JOR), Kazakhstan (KAZ), Kenya (KEN), Kyrgyz Republic (KGZ), Lao, PDR (LAO), Lesotho (LSO), Libya (LBY), Macedonia, FYR (MKD), Madagascar (MDG), Malawi (MWI), Mauritania (MRT), Mauritius (MUS), Moldova (MDA), Morocco (MAR), Mozambique (MOZ), Namibia (NAM), Nepal (NPL), Nicaragua (NIC), Niger (NER), Nigeria (NGA), Papua New Guinea (PNG), Paraguay (PRY), Romania (ROM), Rwanda (RWA), Samoa (WSM), Senegal (SEN), Seychelles (SYC), Sierra Leone (SLE), Solomon Islands (SLB), Sri Lanka (LKA), Suriname (SUR), Syrian Arab Republic (SYR), Tanzania (TZA), Togo (TGO), Tonga (TON), Trinidad and Tobago (TTO), Tunisia (TUN), Uganda (UGA), Ukraine (UKR), Uruguay (URY), Zambia (ZMB).

Note: The list of industrial countries is taken from the paper "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004" by Lane and Milesi-Ferretti (2007) published in the *Journal of International Economics*. Emerging countries are predominantly those that are included in the Morgan Stanley Capital International (MSCI), Standard and Poor's (S&P), Dow Jones, Financial Times Stock Exchange (FTSE), Russell Investments, Emerging Market Index, Columbia University Emerging Market Global Players (EMGP), Banco Bilbao Vizcaya Argentaria (BBVA) Research, The Economist, and International Monetary Fund (IMF) emerging market lists. The remaining economies form the developing countries group.

By Income, World Bank 2010 Classification*High Income*

Australia (AUS), Austria (AUT), Bahamas, The (BHS), Bahrain (BHR), Belgium (BEL), Canada (CAN), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Equatorial Guinea (GNQ), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hong Kong S.A.R. China (HKG), Hungary (HUN), Iceland (ISL), Ireland (IRL), Israel (ISR), Italy (ITA), Japan (JPN), Korea Rep. (KOR), Kuwait (KWT), Luxembourg (LUX), Macau S.A.R. China (MAC), Malta (MLT), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Poland (POL), Portugal (PRT), Qatar (QAT), San Marino (SMR), Saudi Arabia (SAU), Singapore (SGP), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), St. Kitts and Nevis (KNA), Sweden (SWE), Switzerland (CHE), Trinidad and Tobago (TTO), United Kingdom (GBR), United States (USA).

Middle Income

Albania (ALB), Algeria (DZA), Angola (AGO), Antigua and Barbuda (ATG), Argentina (ARG), Armenia (ARM), Belize (BLZ), Bhutan (BTN), Bolivia (BOL), Botswana (BWA), Brazil (BRA), Bulgaria (BGR), Cameroon (CMR), Cape Verde (CPV), Chile (CHL), China (Mainland) (CHN), Colombia (COL), Congo, Dem. Rep. (ZAR), Costa Rica (CRI), Côte d'Ivoire (CIV), Djibouti (DJI), Dominica (DMA), Dominican Republic (DOM), Ecuador (ECU), Egypt, Arab Rep. (EGY), El Salvador (SLV), Fiji (FJI), Gabon (GAB), Georgia (GEO), Ghana (GHA), Grenada (GRD), Guatemala (GTM), Guyana (GUY), Honduras (HND), India (IND), Indonesia (IDN), Iran Islamic Rep. of (IRN), Jamaica (JAM), Jordan (JOR), Kazakhstan (KAZ), Lao PDR (LAO), Latvia (LVA), Lesotho (LSO), Libya (LBY), Lithuania (LTU), Macedonia FYR (MKD), Malaysia (MYS), Maldives (MDV), Mauritius (MUS), Mexico (MEX), Moldova (MDA), Mongolia (MNG), Morocco (MAR), Namibia (NAM), Nicaragua (NIC), Nigeria (NGA), Pakistan (PAK), Panama (PAN), Papua New Guinea (PNG), Paraguay (PRY), Peru (PER), Philippines (PHL), Romania (ROM), Russian Federation (RUS), Samoa (WSM), Senegal (SEN), Seychelles (SYC), Solomon Islands (SLB), South Africa (ZAF), Sri Lanka (LKA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Suriname (SUR), Syrian Arab Republic (SYR), Thailand (THA), Tonga (TON),

Tunisia (TUN), Turkey (TUR), Ukraine (UKR), Uruguay (URY), Venezuela RB (VEN), Zambia (ZMB).

Low Income

Afghanistan (AFG), Bangladesh (BGD), Benin (BEN), Burundi (BDI), Cambodia (KHM), Central African Republic (CAF), Chad (TCD), Congo, Dem. Rep. of (ZAR), Ethiopia (ETH), Gambia, The (GMB), Guinea-Bissau (GNB), Haiti (HTI), Kenya (KEN), Kyrgyz Republic (KGZ), Madagascar (MDG), Malawi (MWI), Mauritania (MRT), Mozambique (MOZ), Nepal (NPL), Niger (NER), Rwanda (RWA), Sierra Leone (SLE), Tanzania (TZA), Togo (TGO), Uganda (UGA).

By Region, United Nations Classification

Africa

Algeria (DZA), Angola (AGO), Benin (BEN), Botswana (BWA), Burundi (BDI), Cameroon (CMR), Cape Verde (CPV), Central African Republic (CAF), Chad (TCD), Congo, Dem. Rep. of (ZAR), Côte d'Ivoire (CIV), Djibouti (DJI), Egypt, Arab Rep. (EGY), Equatorial Guinea (GNQ), Ethiopia (ETH), Gabon (GAB), Gambia, The (GMB), Ghana (GHA), Guinea-Bissau (GNB), Kenya (KEN), Lesotho (LSO), Libya (LBY), Madagascar (MDG), Malawi (MWI), Mauritania (MRT), Mauritius (MUS), Morocco (MAR), Mozambique (MOZ), Namibia (NAM), Niger (NER), Nigeria (NGA), Rwanda (RWA), Senegal (SEN), Seychelles (SYC), Sierra Leone (SLE), South Africa (ZAF), Tanzania (TZA), Togo (TGO), Tunisia (TUN), Uganda (UGA), Zambia (ZMB).

Asia

Afghanistan (AFG), Armenia (ARM), Bahrain (BHR), Bangladesh (BGD), Bhutan (BTN), Cambodia (KHM), China (Mainland) (CHN), Cyprus (CYP), Georgia (GEO), Hong Kong S.A.R. (HKG), India (IND), Indonesia (IDN), Iran, Islamic Rep. of (IRN), Israel (ISR), Japan (JPN), Jordan (JOR), Kazakhstan (KAZ), Korea, Rep. of (KOR), Kuwait (KWT), Kyrgyz Republic (KGZ), Lao PDR (LAO), Malaysia (MYS), Maldives (MDV), Mongolia (MNG), Nepal (NPL), Pakistan (PAK), Philippines (PHL), Qatar

(QAT), Saudi Arabia (SAU), Singapore (SGP), Sri Lanka (LKA), Syrian Arab Republic (SYR), Thailand (THA), Turkey (TUR).

Europe

Albania (ALB), Austria (AUT), Belgium (BEL), Bulgaria (BGR), Croatia (HRV), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Iceland (ISL), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Macedonia FYR (MKD), Malta (MLT), Moldova (MDA), Netherlands (NLD), Norway (NOR), Poland (POL), Portugal (PRT), Romania (ROM), Russian Federation (RUS), San Marino (SMR), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), Switzerland (CHE), Ukraine (UKR), United Kingdom (GBR).

Latin America

Argentina (ARG), Antigua and Barbuda (ATG), Bahamas, The (BHS), Belize (BLZ), Bolivia (BOL), Brazil (BRA), Chile (CHL), Colombia (COL), Costa Rica (CRI), Dominica (DMA), Dominican Republic (DOM), Ecuador (ECU), El Salvador (SLV), Grenada (GRD), Guatemala (GTM), Guyana (GUY), Haiti (HTI), Honduras (HND), Jamaica (JAM), Mexico (MEX), Nicaragua (NIC), Panama (PAN), Paraguay (PRY), Peru (PER), St. Kitts and Nevis (KNA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Suriname (SUR), Trinidad and Tobago (TTO), Uruguay (URY), Venezuela RB (VEN).

Northern America

Canada (CAN), United States (USA).

Oceania

Australia (AUS), Fiji (FJI), New Zealand (NZL), Papua New Guinea (PNG), Samoa (WSM), Solomon Islands (SLB), Tonga (TON).

2.8 Appendix B: Derivation of IRF matrix elements

Consider the following non-homogeneous stochastic p -th order difference equation (AR(p) process):

$$r_t = \alpha + \sum_{k=1}^p \gamma_k r_{t-k} + \varepsilon_t \quad (\text{B.1})$$

which can alternatively be written as:

$$\Delta r_t = \alpha + \rho r_{t-1} + \sum_{k=1}^q \beta_k \Delta r_{t-k} + \varepsilon_t \quad (\text{B.2})$$

where $\rho = -(1 - \sum_{k=1}^p \gamma_k) = -A(L) = -A(1)$ and $\beta_k = -\sum_{s=k}^{p-1} \gamma_{s+1}$.

The general solution (in the case of all distinct real characteristic roots lying inside the unit circle) to the non-homogeneous difference equation in (B.1) is composed of the particular integral (r_t^p) and complementary function (r_t^c):

$$r_t = r_t^p + r_t^c = \underbrace{\frac{\alpha}{1 - \sum_{k=1}^p \gamma_k}}_{\text{deterministic component}} + \underbrace{\sum_{i=0}^{\infty} \delta_i \varepsilon_{t-i}}_{\text{stochastic component}} + \underbrace{\sum_{j=1}^p A_j (b_j)^t}_{\text{complementary function}} \quad (\text{B.3})$$

particular solution

where $\delta_0 = 1$, $\delta_1 = \gamma_1 \delta_0$, $\delta_2 = \gamma_1 \delta_1 + \gamma_2 \delta_0$, $\delta_3 = \gamma_1 \delta_2 + \gamma_2 \delta_1 + \gamma_3 \delta_0$,

and $\delta_j = \gamma_1 \delta_{j-1} + \gamma_2 \delta_{j-2} + \gamma_3 \delta_{j-3} + \dots + \gamma_p \delta_{j-p} \quad \forall j \geq p$.

Let $\gamma = \sum_{k=1}^p \gamma_k \neq 1$ (implied inequality given the case analysed - assumption from outset).

The impulse responses of the real exchange rate to a one unit disturbance/shock (whether it be emanating from the real or nominal/monetary side) are given by:

$$\text{Impact Multiplier: } IR(0) = f_{11}^{(0)} = \frac{\partial r_t}{\partial \varepsilon_t} = \delta_0 = 1$$

$$\text{One-Period Multiplier: } IR(1) = f_{11}^{(1)} = \frac{\partial r_{t+1}}{\partial \varepsilon_t} = \delta_1 = \gamma_1 \delta_0 = \gamma_1 = \gamma + \beta_1$$

$$\begin{aligned} \text{Two-Period Multiplier: } IR(2) &= f_{11}^{(2)} = \frac{\partial r_{t+2}}{\partial \varepsilon_t} = \delta_2 = \gamma_1 \delta_1 + \gamma_2 \delta_0 = \gamma_1^2 + \gamma_2 \\ &= (\gamma + \beta_1)^2 + (\beta_2 - \beta_1) \end{aligned}$$

and so on with the n -period multiplier given by δ_n . More generally, $\frac{\partial r_{t+j}}{\partial \varepsilon_t} = \frac{\partial r_t}{\partial \varepsilon_{t-j}}$. The time path of all such multipliers yields the impulse response function. Stated differently (from a time series econometrics perspective), for the univariate linear model, the impulse response function is equivalent to a plot of the coefficients of the moving average (MA) representation.

We note that adding a structural/deterministic term to (B.1), such as a linear deterministic time trend, t , only influences the form of the deterministic part of the particular solution. Consequently, augmenting (B.1) in such a manner has no impact on the construction of the impulse response function. When (B.1) is augmented to include a linear time trend (like in (2.3)), one can easily show that the deterministic component of the particular solution changes to:

$$\underbrace{\frac{\alpha}{1-\gamma} - \frac{\mu \sum_{i=0}^{p-1} (p-i) \gamma_{p-i}}{(1-\gamma)^2} + \frac{\mu}{1-\gamma} t}_{\text{deterministic part of } r_t^p}$$

where μ is the original slope parameter on t .

We also note that the stability conditions underlie the conditions for stationarity. Specifically, if r_t is a linear stochastic difference equation, the stability condition for convergence (to equilibrium), that the roots of the inverse characteristic equation $1 - \sum \gamma_i L^i$ must lie outside the unit circle, is a necessary condition for the time series $\{r_t\}$ to be stationary. Moreover, the homogeneous solution(s) (complementary function in (B.3)) must drop out if the $\{r_t\}$ sequence is to be stationary. This occurs if the sequence started sufficiently long ago (i.e. t must be sufficiently large, that is, (one must assume that) the data generating process has been occurring for an infinitely/sufficiently long time) or the arbitrary constant(s) (A_j) is (are) zero.

2.9 Appendix C: Results for countries common to both BRER and REER series

Table C2.1: Average Half-Life Estimates (in Years) for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	83	163.17	2.77	2.86	1.90	2.68
Industrial	20	4.21	3.12	3.49	1.92	2.80
Emerging	26	509.35	3.59	3.44	2.33	3.55
Developing	37	5.83	2.01	2.11	1.58	2.00
Test of Equal Sub-Group Means		1.05 [0.37]	2.19* [0.10]	3.20** [0.05]	0.68 [0.51]	1.34 [0.28]
High Income	35	377.32	3.04	3.31	2.07	3.14
Middle Income	40	7.35	2.70	2.65	1.82	2.43
Low Income	8	5.36	1.95	1.96	1.53	1.87
Test of Equal Sub-Group Means		1.02 [0.37]	0.67 [0.51]	1.89 [0.16]	0.28 [0.76]	0.82 [0.44]
Africa	20	6.01	1.95	2.03	1.44	1.88
Asia	11	1177.22	5.05	4.49	3.46	5.66
Europe	29	11.92	2.34	2.61	1.38	2.06
Latin America	19	5.30	2.63	2.80	1.83	2.36
Oceania	3	6.33	4.07	4.29	3.41	3.66
Test of Equal Sub-Group Means		1.01 [0.45]	1.60 [0.22]	1.71 [0.18]	1.53 [0.23]	1.76 [0.20]

* significant at 10%; ** significant at 5%; *** significant at 1%

'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table C2.2: Median Half-Life Estimates (in Years) for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	83	4.11	2.29	2.42	1.13	1.61
Industrial	20	3.87	2.77	3.22	1.35	2.30
Emerging	26	5.60	2.36	2.79	1.22	1.48
Developing	37	3.86	1.54	1.54	0.97	1.51
Test of Equal Sub-Group Medians		3.93* [0.10]	15.87*** [0.00]	15.87*** [0.00]	1.46 [0.48]	1.19 [0.55]
High Income	35	4.89	2.75	3.17	1.31	1.98
Middle Income	40	3.87	1.50	1.61	0.94	1.48
Low Income	8	3.73	2.00	1.87	1.35	1.75
Test of Equal Sub-Group Medians		1.60 [0.45]	8.92*** [0.01]	11.82*** [0.00]	1.60 [0.45]	0.65 [0.72]
Africa	20	3.99	1.73	1.61	0.99	1.65
Asia	11	5.49	3.33	3.75	1.77	2.86
Europe	29	3.88	2.54	2.96	1.17	1.59
Latin America	19	3.83	1.11	1.75	0.48	1.33
Oceania	3	6.42	4.99	4.99	3.25	3.80
Test of Equal Sub-Group Medians		6.90* [0.10]	9.77** [0.04]	9.77** [0.04]	7.43* [0.10]	5.17 [0.27]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table C2.4: Median Half-Life Estimates (in Years) based on Selected Models for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Selected Model I half-life</i>	<i>Selected Model II half-life</i>	<i>Selected Model III half-life</i>	<i>Selected Model IV half-life</i>
Whole	83	1.99	1.95	1.54	1.48
Industrial	20	3.13	2.78	2.20	2.20
Emerging	26	2.27	2.27	1.57	1.57
Developing	37	1.51	1.48	1.46	1.39
Test of Equal Sub-Group Medians		4.13* [0.10]	4.13* [0.10]	1.46 [0.48]	1.46 [0.48]
High Income	35	2.86	2.62	2.10	2.10
Middle Income	40	1.53	1.47	1.44	1.38
Low Income	8	1.75	1.75	1.35	1.35
Test of Equal Sub-Group Medians		2.79 [0.25]	2.99 [0.22]	1.60 [0.45]	1.60 [0.45]
Africa	20	1.53	1.52	1.53	1.50
Asia	11	3.44	2.86	3.33	2.84
Europe	29	1.61	1.61	1.47	1.47
Latin America	19	1.95	1.25	1.38	1.11
Oceania	3	5.04	5.04	5.04	5.04
Test of Equal Sub-Group Medians		4.71 [0.32]	4.71 [0.32]	4.60 [0.33]	5.17 [0.27]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.
Selected Model I: whenever ESTAR is chosen, half-life is based on mean of TF; whenever linear augmented AR is chosen, IRF half-life is picked.
Selected Model II: whenever ESTAR is chosen, half-life is based on mean of TF; whenever linear augmented AR is chosen, monotonic half-life is picked.
Selected Model III: whenever ESTAR is chosen, half-life is based on max. of TF; whenever linear augmented AR is chosen, IRF half-life is picked.
Selected Model IV: whenever ESTAR is chosen, half-life is based on max of TF; whenever linear augmented AR is chosen, monotonic half-life is picked.

Table C2.5: Average Half-Life Estimates (in Years) for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	83	6.30	1.26	1.38	0.80	1.40
Industrial	20	4.24	1.69	1.94	1.16	1.79
Emerging	26	6.34	1.47	1.59	1.00	1.93
Developing	37	7.39	0.87	0.93	0.47	0.83
Test of Equal Sub-Group Means		0.89 [0.41]	2.35* [0.10]	2.79* [0.07]	4.75*** [0.01]	2.31* [0.10]
High Income	35	8.16	1.65	1.84	1.14	2.09
Middle Income	40	4.97	1.04	1.12	0.59	0.95
Low Income	8	5.08	0.64	0.72	0.37	0.68
Test of Equal Sub-Group Means		1.31 [0.28]	3.21** [0.05]	3.57** [0.03]	5.82*** [0.01]	4.49** [0.02]
Africa	20	6.69	0.60	0.67	0.39	0.58
Asia	11	11.84	2.79	3.04	1.64	3.30
Europe	29	5.23	1.27	1.44	0.91	1.44
Latin America	19	4.63	0.88	0.95	0.60	1.12
Oceania	3	4.74	2.05	2.06	0.78	1.26
Test of Equal Sub-Group Means		0.79 [0.55]	3.73** [0.03]	3.69** [0.03]	3.10** [0.05]	2.17 [0.13]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table C2.6: Median Half-Life Estimates (in Years) for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>simple AR model half-life</i>	<i>augmented AR model monotonic half-life</i>	<i>augmented AR model IRF half-life</i>	<i>augmented ESTAR model TF max. half-life</i>	<i>augmented ESTAR model TF mean half-life</i>
Whole	83	3.22	0.60	0.81	0.45	0.76
Industrial	20	3.61	1.51	1.65	1.26	1.82
Emerging	26	3.21	0.75	0.93	0.57	0.99
Developing	37	2.98	0.36	0.41	0.18	0.43
Test of Equal Sub-Group Medians		1.08 [0.58]	11.69*** [0.00]	13.42*** [0.00]	13.46*** [0.00]	11.69*** [0.00]
High Income	35	3.65	1.24	1.32	0.72	1.26
Middle Income	40	3.01	0.46	0.46	0.24	0.51
Low Income	8	2.83	0.22	0.23	0.11	0.28
Test of Equal Sub-Group Medians		1.96 [0.38]	7.05** [0.03]	7.05** [0.03]	7.05** [0.03]	9.32*** [0.01]
Africa	20	3.09	0.32	0.38	0.17	0.37
Asia	11	4.11	2.31	2.63	1.65	2.32
Europe	29	3.65	1.07	1.25	0.57	1.05
Latin America	19	2.85	0.40	0.51	0.49	0.69
Oceania	3	3.72	2.40	2.25	0.22	0.99
Test of Equal Sub-Group Medians		5.97 [0.20]	11.55** [0.02]	11.55** [0.02]	7.89* [0.10]	13.07*** [0.01]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table C2.7: Average Half-Life Estimates (in Years) based on Selected Models for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Selected Model I half-life</i>	<i>Selected Model II half-life</i>	<i>Selected Model III half-life</i>	<i>Selected Model IV half-life</i>
Whole	83	1.17	1.15	0.88	0.86
Industrial	20	1.83	1.73	1.52	1.42
Emerging	26	1.18	1.18	0.91	0.91
Developing	37	0.80	0.81	0.52	0.52
Test of Equal Sub-Group Means		4.73*** [0.01]	4.33** [0.02]	4.95*** [0.01]	4.68*** [0.01]
High Income	35	1.57	1.51	1.28	1.22
Middle Income	40	0.92	0.92	0.64	0.64
Low Income	8	0.69	0.68	0.38	0.38
Test of Equal Sub-Group Means		4.21** [0.02]	3.75** [0.03]	5.88*** [0.00]	5.47*** [0.01]
Africa	20	0.58	0.58	0.39	0.39
Asia	11	1.90	1.90	1.49	1.49
Europe	29	1.33	1.26	1.10	1.03
Latin America	19	1.00	1.00	0.58	0.59
Oceania	3	1.68	1.73	1.48	1.53
Test of Equal Sub-Group Means		2.76** [0.05]	2.78* [0.06]	2.97** [0.05]	2.94** [0.05]

* significant at 10%; ** significant at 5%; *** significant at 1%

'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Selected Model I: whenever ESTAR is chosen, half-life is based on mean of TF;
whenever linear augmented AR is chosen, IRF half-life is picked.

Selected Model II: whenever ESTAR is chosen, half-life is based on mean of TF;
whenever linear augmented AR is chosen, monotonic half-life is picked.

Selected Model III: whenever ESTAR is chosen, half-life is based on max. of TF;
whenever linear augmented AR is chosen, IRF half-life is picked.

Selected Model IV: whenever ESTAR is chosen, half-life is based on max of TF;
whenever linear augmented AR is chosen, monotonic half-life is picked.

Chapter 3

Country Characteristics and the Persistence of Real Exchange Rate Parity Deviations

3.1 Introduction

This paper investigates the link between the (univariate) real exchange rate persistence estimates of chapter 2 and a set of country-specific macroeconomic and geographic variables in order to ascertain the potential reasons for the variation of PPP/parity-reversion rates across countries. Our research fills an important gap in the field. A survey of the literature reveals that studies on the determinants of the persistence of real exchange rate misalignments are few and far between, with virtually no existing analyses of the global and parametric variety. Conversely, a plethora of papers can be found on the drivers of the level of the real exchange rate, such as those by the IMF.⁵⁶ This is surprising given that the speed of real exchange rate adjustment is particularly relevant for the correction of unsustainable external imbalances when relative price changes are required. Importantly, persistently over or under appreciated real currencies can have significant implications for economic growth. As Feldstein (2011) notes, the fall in risk-aversion by investors in the years after the peak of the recent financial crisis led to a surge in capital inflows in emerging economies, resulting primarily due to favourable interest rate differentials vis-à-vis developed countries like the US. Given open capital markets, these transitional economies become exposed to persistent currency appreciation that may be inconsistent with internal equilibrium. Fearing an adverse impact on growth, some of the nations reintroduced capital controls.⁵⁷

To address the question of how individual structural country characteristics are associated with the rate of real exchange rate mean-reversion, a highly diversified sample of countries is employed that ensures sufficient variation in the data. We conduct a cross-section analysis over the period 1973-2010 using 151 countries and measures of both bilateral and multilateral real exchange rate persistence. The majority

⁵⁶ As we noted in chapter 1, the persistence and level of the real exchange rate may be correlated.

⁵⁷ Brazil is one example of a country that has recently employed capital controls in response to surges in flows. Refer to Bussière et al. (2013) to see how real exchange rate appreciations matter for growth.

of studies on real exchange rate persistence to date have relied on bilateral rates. However, as Black (1986) points out in his comments on the work by Mussa (1986), while bilateral real exchange rate parity with all individual trading partners implies multilateral parity, deviations from bilateral PPP do not necessarily imply deviations from multilateral PPP.

Previewing some of the main empirical results, we find that real exchange rate convergence tends to be typically faster in countries characterised by higher inflation, nominal exchange rate volatility and trade openness. Regarding the second factor, the same outcome holds if one instead uses a discrete nominal exchange rate regime flexibility measure. Although there is a distinction between nominal exchange rate volatility and regime flexibility, like Flood and Rose (1995), we do observe a positive link between the two in the sample. In the case of bilateral real exchange rates, we find that geographical proximity to the reference country (the US) is inversely correlated with persistence. Moreover, we attain some modest evidence that higher productivity growth is associated with slower mean-reversion, although results are more mixed when examining country sub-samples. On the other hand, the degree of de facto international financial openness is found to matter only at the country group level according to our parametric findings, with cross-country discrepancies perhaps obscuring results in full samples. In particular, we obtain a positive correlation between persistence and international financial integration for developing economies, while a negative link for more advanced economies. Further qualitative scrutiny suggests that the debt and reserve components of the financial measure may have relevant roles to play in the result.

Notably, we see that high average inflation and high nominal exchange rate volatility (or flexibility) go in tandem during the sample period. Put differently, it is very difficult to find many economies that decouple this pairing. Both factors contribute positively to real exchange rate volatility, which, interestingly, itself comoves negatively with real exchange rate persistence based on our qualitative assessment. Significantly, the assertion that higher real or nominal exchange rate volatility translates to faster real exchange rate adjustment is a claim that is at variance with the conclusions drawn by traditional studies (e.g. Delgado (1991), Mussa (1986)). As Rogers (1999) and Clarida and Gali (1994), as well as others, have contended in contrast to Mussa (1986), heightened real exchange rate volatility under more flexible nominal exchange rate

regimes might also stem from the greater incidence of nominal and real shocks under such regimes.⁵⁸ Moreover, Taylor (2002) reports that shocks have been much larger during floats than during (credible) pegs. This may offer some insight into why evidence points to lower real exchange rate inertia in regimes that permit greater nominal exchange rate variability. If real exchange rate adjustment is symmetrically non-linear, then larger parity deviations can induce faster convergence.

The remainder of the paper is organised as follows. Section 3.2 provides a review of the literature, highlighting studies that have explored the determinants of real exchange rate persistence. Section 3.3 documents in detail some of the potential drivers of real exchange rate convergence as guided by economic theory and empirical evidence. In section 3.4, we discuss the empirical methodology employed while in section 3.5 we provide a thorough description of the data set. Section 3.6 performs a descriptive cross-sectional analysis of the (structural) country characteristics thought to be playing a role in the degree of inertia in the real exchange rate. In the penultimate part of the paper, section 3.7, we offer a more refined analysis by assessing real exchange rate persistence regression results. Finally, section 3.8 concludes.

3.2 Brief Literature Overview

As far as we are aware, there are very few studies in the literature on parity reversion that attempt to link the cross-country heterogeneity in the real exchange rate half-life to structural country characteristics. For a sample of 94 economies, Cheung and Lai (2000a) analyse whether observed differences in bilateral real exchange rate persistence may be accounted for by discrepancies in national macroeconomic characteristics. Specifically, four determinants are investigated: the inflation rate, productivity growth, trade openness, and government spending. To ascertain the relation between the half-life and each of these factors separately, Cheung and Lai employ the Spearman rank correlation coefficient. The authors find that the inflation rate is negatively correlated with the half-life and that the opposite is true for government expenditure. Conversely,

⁵⁸ Mussa (1986) indicates that this higher volatility in regimes allowing greater currency movement is due to the relatively staggered adjustment of prices. This argument has also found support in other studies, such as those of Baxter and Stockman (1989), Ghosh et al. (1997) and Carrera and Vuletin (2003).

they observe that productivity growth and trade openness are not significantly correlated with real exchange rate persistence.⁵⁹

Achy (2003) examines the drivers of the speed of bilateral real exchange rate parity-reversion in the particular context of 38 middle-income countries. Employing weighted least squares regression techniques, the author finds that inflation, productivity growth, government consumption, exchange rate volatility, and capital account liberalisation all have statistically significant effects on the half-life of parity deviations. Specifically, higher nominal exchange rate volatility, productivity growth, and government spending lead to slower mean-reversion in the real exchange rate. The result pertaining to the first of these three variables runs counter to the finding of Cashin and McDermott (2006) that an inverse relation between nominal exchange rate volatility and the persistence of real exchange rate misalignments exists. Moreover, it opposes the empirical result of Alba and Papell (2007) that countries with moderate nominal exchange rate volatility display stronger evidence of (relative) PPP. On the other hand, higher inflation and capital mobility tend to attenuate the persistence of deviations from parity. Interestingly, trade openness is found to play no significant role. In addition, the black market premium (positive effect), which measures the magnitude of distortions on foreign exchange markets, becomes insignificant when nominal exchange rate volatility is included in the regression. Together, the five significant variables account for 70 percent of the observed variability in the half-life.

Cashin and McDermott (2006) examine the persistence of real effective exchange rate parity deviations across 90 developed and developing countries. Utilising the Spearman rank correlation test, the authors obtain evidence that mean-reversion tends to be faster in high-inflation countries than in low-inflation nations, while higher real exchange rate shock persistence tends to be associated with less nominal exchange rate volatility. Cross-country discrepancies in productivity growth, government expenditure, and trade openness however are not significantly related to the observed heterogeneity in the persistence of parity deviations.

Aside from aggregate-level studies, a couple of papers have also looked at the covariates of sectoral real exchange rate persistence. Cheung et al. (2001) investigate

⁵⁹ A more detailed discussion of the potential drivers of real exchange rate persistence follows in section 3.3.

the empirical link between market structure and the persistence of US dollar-based sectoral real exchange rates for 14 OECD countries and find the relation to be significant. In particular, industries characterised by a larger price-cost margin and a greater degree of intra-industry trade exhibit higher sectoral real exchange rate persistence. Thus, the findings imply that an imperfectly competitive market structure can contribute to persistence in aggregate real exchange rates. Moreover, their maximum likelihood and OLS estimates suggest that trade openness, government spending and nominal exchange rate volatility (although non-robustly) have positive effects on sectoral persistence. In contrast, inflation is reported to have a negative effect while geographical distance to the base country is found to be insignificant.

Mayoral and Gadea (2011) assess the main causes of slow aggregate bilateral real exchange rate parity-reversion through the lens of sectoral data for a group of 10 EU countries. Decomposing aggregate persistence into its subcomponents, they find that it is largely driven by a small number of sectors in the upper quantiles of the distribution of sectoral persistence. To be exact, the authors report that sectors belonging to the durables category are those that display the lowest rates of mean-reversion. Employing a quantile panel regression, they show that the market structure of intermediate inputs and price stickiness of final goods have significant effects on sectoral persistence, with higher price-cost margins, intra-industry trade and lower sectoral inflation volatility leading to higher inertia to be precise. Furthermore, the effect of these variables tends to be larger the higher the quantile considered. All other factors are found not to play a part. For instance sectoral trade openness, proxying the tradability of (final or intermediate input) goods in the analysis (traded vs. nontraded), is thought to be less important given the presence of low trade barriers in the EU.

As a caveat however, it is important to note that none of these studies allow for potential adjustment non-linearities in real exchange rate dynamics when obtaining measures of the rate of PPP convergence. Indeed, chapter 2 has shown that non-linearities in adjustment are empirically an important feature of real exchange rate patterns for many economies.

3.3 Economic Theory and Empirical Evidence: Potential Explanations for the Persistence of Parity Deviations

Productivity growth is a factor that has been well documented in papers seeking to rationalise the real exchange rate speed of convergence to parity.⁶⁰ This supply-side determinant is at the centre of the familiar Harrod (1933), Balassa (1964), and Samuelson (1964) (HBS) story. Their hypothesis indicates that a country's real currency will appreciate as it develops, in turn suggesting that a nation's equilibrium real exchange rate will vary over time. Essentially, by raising the relative price of non-traded goods, this effect may well be unduly intensifying the persistence of real exchange rate shocks if not accounted for adequately in the univariate real exchange rate specification. To see the effects of productivity on the real exchange rate, consider the aggregate price level, P , of a country as a geometrically weighted average of traded and non-traded goods prices, P_T and P_N , respectively:

$$P = P_N^\alpha P_T^{1-\alpha} \quad (3.1)$$

which in logs is:

$$p = \alpha p_N + (1 - \alpha)p_T \quad (3.2)$$

Now if wages are determined by the value of the marginal product of labour and there is free labour mobility between sectors, then the relative price of non-traded goods will be inversely related to relative productivity:

$$p_N - p_T = x_T - x_N \quad (3.3)$$

where x_T and x_N represent the logarithm of traded and non-traded sector productivity levels respectively. Noting that the bilateral real exchange rate can be written as:⁶¹

$$r = p - e - p^* \quad (3.4)$$

and the above equalities, we can rewrite (3.4) as:

⁶⁰ Economic theory often identifies two key sets of determinants of real exchange rates: 1. (real) variables which account for taste and technology trends and affect the long-run equilibrium real exchange rate, and 2. monetary and aggregate demand variables which are thought to account for real exchange rate deviations from PPP. Productivity growth falls into the former group but can also reflect business cycles if it is of the temporary variety.

⁶¹ Starred variables are those of the foreign or reference country e.g. p^* denotes the price level of the foreign country.

$$r = p_T - e - p_T^* + \alpha(x_T - x_T^*) - \alpha(x_N - x_N^*) \quad (3.5)$$

From (3.5) we can see that if the law of one price holds for traded goods, and if technological progress occurs primarily through the traded goods sector, the dynamics of the real exchange rate will be dictated by the evolution of the $x_T - x_T^*$ term. Thus, it becomes apparent that differential traded goods productivity growth influences the path of the real exchange rate.⁶²

Froot and Rogoff (1995) present a two-sector model of the HBS effect and illustrate how trend breaks in the real exchange rate can be associated with changes in the relative price structure between tradable and non-tradable goods. They contend that the rapid income growth frequently associated with low-income countries can stimulate such strong changes in the relative price of tradables and non-tradables that the probability of parity-reversion holding in any given nation will rise with the amount of income. That is, parity-reversion will be much slower in developing countries if one does not allow for structural breaks in the data.

Countries that display a greater degree of openness may exhibit a lower persistence of parity deviations. As a result of higher trade flows (due to a decline in protectionism for instance), arbitrage opportunities will be exploited more frequently in nations thus leading to evidence of faster mean-reversion in the real exchange rate. Faruquee (1995) provides the following reasoning. As the openness of a country rises (imports and exports), nominal depreciations will tend to lead to greater inflation, and consequently real income will be affected more by such exchange rate fluctuations. Given that producers are ultimately also consumers interested in the purchasing power of their own income, heightened concern with the foreign currency value of revenue will attenuate local currency price stickiness. This in turn will result in reduced inertia in the real exchange rate (Faruquee 1995). Lo and Wong (2006) theoretically illustrate that a more open economy is characterised by smaller deviations from parity. The authors attribute this result to the decreasing dominance of monetary factors as openness increases. However, smaller deviations may lead to greater persistence in the real exchange rate if they are relatively more expensive to arbitrage away.

⁶² This traded goods productivity bias is thought to rise with the wealth of the country (Cashin and McDermott 2006). On the basis of the HBS theory, and as Alba and Papell (2007) find, support for relative PPP is more likely to be stronger between similar-growth nations than between high and low-growth countries (implying that mean-reversion should be faster for the former group).

In addition to trade openness, the speed of convergence to parity may also be affected by greater capital mobility through financial integration. Indeed, Rogoff (1992) develops a model that can be used to analyse the effects of capital market liberalisation on the real exchange rate. In his setup, when the stochastic process for traded goods productivity is stationary in levels, the opening of capital markets can lower the variance of real exchange rate changes by allowing agents to smooth their consumption of traded goods intertemporally so that movements in the intra-temporal price of non-traded goods need not to be as large as they otherwise would. The opposite is true if traded goods productivity shocks are stationary in growth rates. Whether, these effects on variance translate into effects on persistence remains to be seen empirically.

Economic intuition would suggest that the inflation experience of a country will determine its speed of real exchange rate mean-reversion. As Cheung and Lai (2000) note, long-run parity may be viewed as an ‘equilibrium condition of money neutrality in an international setting’. If national price fluctuations are dominated by monetary shocks, then one would expect parity reversion to be rather swift. Given the existence of nominal rigidities, a higher inflation rate can induce larger or more regular adjustment of goods prices and therefore reduce the duration of deviations from parity (Cashin and McDermott 2006).

In the case of the euro area, Álvarez et al. (2005) certainly offer evidence that the frequency of price changes at the micro level is significantly influenced, in the expected fashion, by macroeconomic conditions such as inflation. Examining Mexico over the period 1994-2002 and decomposing inflation into its various components, Gagnon (2009) finds that when the annual rate of inflation is below 10-15 percent, the average frequency (size) of price changes comoves weakly (strongly) with inflation due to offsetting movements in the frequency of price increases and decreases. Conversely, when inflation rises beyond 10-15 percent, few price decreases are observed and both the average frequency and size of price changes covary significantly with inflation. As Klenow and Malin (2010) note, the frequency of price changes across products has displayed more meaningful variation in countries characterised by higher and more volatile inflation (i.e. the duration of prices typically falls to levels below 1 year). In addition, during high inflation episodes, demand for foreign currency as an asset grows while that for domestic currency falls. Such substitution according to Bleaney et al.

(1999) is likely to affect both the short-run dynamics and long-run equilibrium of the real exchange rate.

The share of government expenditure in the economy is another potential driver of the rate of parity reversion given that these outlays tend to fall more heavily on non-traded goods. In particular, the persistence of real exchange rate shocks is thought to rise with the proportion of produced goods that are non-traded. In their intertemporal two-country model with monopolistic competition, market segmentation, and staggered price contracts, Bergin and Feenstra (2001) show that the real exchange rate persistence parameter (implied by the model) can be expressed as an increasing function of the share of nontraded goods produced in the economy, or, (equivalently) as a decreasing function of (trade) openness.

Indeed, this demand-side factor has been examined in a number of structural models of PPP deviations.⁶³ Importantly, Rogoff (1992) points out that the effects of government spending may not be long-lived if factors of production are perfectly mobile across sectors in the long-run. Equally however, Alesina and Perotti (1995) demonstrate that when public spending is financed by distortionary taxes, it can induce long-run real effects.

Nominal exchange rate volatility is also expected to influence the rate at which real exchange rate parity deviations peter out. Mussa (1986) studies the dynamics of bilateral real exchange rates under both fixed and floating nominal exchange rate systems. The author finds that for pairs of countries with similar and moderate inflation rates, there are considerable discrepancies in the behaviour of real exchange rates under the two different regimes. Specifically, under a floating exchange rate regime, the real exchange rate generally exhibits greater short-term volatility than under a fixed exchange rate regime. This is mainly due to the greater variability of the nominal exchange rate with little contribution from changes in the variability of the ratio of national price levels. Moreover, Mussa's (1986) thorough investigation reveals that changes in the real exchange rate under a floating regime typically display a high degree of persistence. Conversely, national price levels tend to show similar relatively smooth paths of evolution under both types of regime (with sluggish adjustment). However, as the author notes, the persistence of short-term changes in the real exchange rate is also

⁶³ The factor is studied by Froot & Rogoff (1991a,b) and Rogoff (1992) for example.

an attribute of fixed exchange rate arrangements. This is especially true when changes in official parities occur. The distinction between the two regimes is that large short-term movements in the real exchange rate arise with much greater frequency under a floating nominal exchange rate regime, and these large fluctuations in the real exchange rate tend to display substantial persistence.

Nominal exchange rate variability is sometimes used as a proxy for the exchange rate uncertainty faced by price-setters.⁶⁴ In a dynamic partial equilibrium model of a price-setting firm with menu costs, Delgado (1991) demonstrates that nominal exchange rate variability leads to greater uncertainty and, in turn, price stickiness. That is, firms become more reluctant to alter prices given the likelihood of an exchange rate reversal which would subsequently necessitate another price change, but this time in the opposite direction. Such heightened sluggishness in price adjustment is thought to increase real exchange rate persistence. For a sample of OECD countries, Cheung et al. (2001) report that nominal exchange rate volatility positively affects sectoral real exchange rate persistence and use the former logic to justify their empirical finding.

Engel and Rogers (2001) discuss the implications of nominal exchange rate regime flexibility for PPP deviations and welfare under local versus producer-currency pricing. Under producer-currency pricing and a fluctuating nominal exchange rate, consumers in the export market face prices that change with the exchange rate, meaning that there is complete pass-through of exchange rates to domestic prices. In contrast, under local-currency pricing and a flexible exchange rate regime, prices are set in the currency of the consumer and there is zero pass-through of exchange rates to local prices. Given sticky consumer-currency prices, nominal exchange rate variability in this latter case can lead to large misalignments of goods prices across countries. Consequently, adopting a fixed exchange rate regime under local-currency pricing may reduce parity deviations and the associated inefficiencies. However, as the authors note, fixing the exchange rate (irrevocably in the case of a currency union) does not necessarily improve overall welfare. A fixed exchange rate implies a different monetary policy than under a floating regime, and thus different real outcomes given staggered price adjustment. Specifically, in their example, Engel and Rogers (2001) illustrate that pegging, resulting in perfectly correlated monetary policies at home and abroad, raises

⁶⁴ E.g. Cheung et al. (2001).

aggregate risk by increasing the variance of world income, thus generating welfare losses. Importantly, the underlying inefficiency is due to price stickiness, and the choice of exchange rate system does not necessarily alter that.

Cashin and McDermott (2006) on the other hand argue that greater nominal exchange rate flexibility would be expected to induce faster parity reversion by encouraging more frequent adjustment of goods prices. They further contend that these conclusions are roughly in line with the findings of Goldfajn and Valdes (1999). Their work led them to conclude that overvaluations of real exchange rates were normally corrected for by adjustments in the nominal exchange rate rather than changes in inflation differentials.

In a recent analysis, Engel (2012) shows that there is scope for both price and nominal exchange rate roles in the convergence of real exchange rates. He notes that in this case, both the degree of price stickiness and interest-rate smoothing in the Taylor rule are relevant factors, with higher levels in either capable of leading to slower real exchange rate adjustment. In particular, Engel (2012) asserts that real exchange rate inertia is pinned to the speed of nominal price adjustment only to the extent that monetary policy does not allow the required corrections to occur through the nominal exchange rate channel. If prices do not play a role in adjustment, then, via its link to the nominal exchange rate (uncovered interest rate parity), interest rate persistence determines the rate at which real exchange rate deviations dampen out. With less interest rate smoothing, more of the adjustment can occur through nominal exchange rate changes. Based on numerical exercises, Benigno (2004) also reports that when inflation-targeting in monetary policy is replaced by an interest rate smoothing rule there is endogenous real exchange rate persistence which depends on the sluggishness of price dynamics.

Lastly, it is often argued that transportation costs generate a wedge between prices across countries thus leading to larger real exchange rate parity deviations (Dumas 1992). If transportation costs are proportional to geographical distances, then countries that are further apart will observe larger bilateral or multilateral parity deviations as arbitrage becomes less profitable and the exchange rate fails to adjust (Wei and Parsley 1995). This logic is based in the gravity equation frequently described in trade theory. Alba and Papell (2007) find that PPP holds better and that mean-

reversion is faster for countries located closer to the trading partner of concern. Furthermore, nations that are closer to each other may also be more likely to share the same or similar monetary policies through credible pegs (or currency unions or dollarisation in the extreme cases), thus leading to similar inflation and interest rates across these nations. This in turn could imply smaller real exchange rate misalignments from equilibrium. Indeed, the macroeconomic policies of many of the Caribbean nations are closely tied to that of the US for reasons such as trade.

3.4 Empirical Approach

As a preliminary check on the data, we employ standard differences-in-mean and median hypothesis tests across different country groups for the selected country characteristics. Such inspection provides one with initial evidence as to whether significant variation is present in the data across the cohorts. The specific tests utilised are detailed in the notes of the relevant tables.

Subsequently, using ordinary least squares (OLS) estimation, we run the following cross-section regressions in order to gauge the explanatory power of the country characteristics thought to be influencing real exchange rate persistence:

$$hl_i^{BRED} = \kappa + \omega_1 inf_i + \omega_2 gov_i + \omega_3 to_i + \omega_4 PG_i + \omega_5 nerv_i + \omega_6 ifi_i + \omega_7 dist_i + v_i \quad (3.6)$$

$$hl_i^{REER} = \kappa + \omega_1 inf_i + \omega_2 gov_i + \omega_3 to_i + \omega_4 PG_i + \omega_5 nerv_i + \omega_6 ifi_i + v_i \quad (3.7)$$

where lower case Latin letters are used to denote the natural logarithm of a variable, $hl^{BRED(REER)}$ is the half-life of bilateral real exchange rate (real effective exchange rate) parity deviations, inf is the inflation rate, gov is government expenditure, to is trade openness, PG is productivity growth, $nerv$ is bilateral nominal exchange rate volatility in the case of (3.6) and nominal effective exchange rate volatility in the case of (3.7), ifi is international financial integration, $dist$ is the geographical distance between country i and the US included only in bilateral real exchange rate persistence regressions, and v is the error term. We estimate (3.6) and (3.7) for the overall samples and sub-samples defined by different economic development classification schemes in

order to gain additional insight. Each slope coefficient is an elasticity, except that on productivity growth, ω_4 , which can be interpreted as a semi-elasticity.

In contrast to previous research which only examined gross correlations, our study adopts a parametric approach. Past studies validate their methodology on the grounds that the data are non-normally distributed, and therefore not amenable to regression analysis.⁶⁵ However, we contend that it is only the degree of non-normality that matters and not non-normality per se. This feature of the data will not necessarily invalidate the parametric results (Glass et al. 1972). Moreover, the use of logarithms of variables considerably attenuates any non-normality/skewness issues.⁶⁶

3.5 Data

Our cross-sectional study is executed for the post-Bretton Woods era 1973-2010 and comprises 151 countries in total. The list of countries is the same as in Appendix A of the previous chapter. The measures of real exchange rate persistence are taken for both bilateral (vis-à-vis US) and multilateral CPI-based rates and are adopted from chapter 2.⁶⁷ In particular, the concept of the half-life is employed as the indicator of the rate of mean-reversion, defined as the amount of time required for a unit impulse to dissipate permanently by 50 percent from the time of the initial shock or parity-deviation occurrence. As documented in the previous chapter, these half-lives are obtained from both linear and non-linear models of the real exchange rate. In the linear case, persistence data are acquired from simple and augmented autoregressive (AR) specifications, while in the non-linear case estimates are garnered from the augmented exponential smooth transition autoregressive (ESTAR) model for both maximum and average sized parity deviations as given by the value of the transition function. The half-life data are reported in years but are based on average monthly real exchange rates in

⁶⁵ Such as Cheung and Lai (2000a) and Cashin and McDermott (2006).

⁶⁶ In background checks on the data (continuous variables), we were not able to find significant evidence of severe non-normality for any of the variables used in the regressions on the basis of both qualitative (graphical) and quantitative statistical procedures. In the case of the latter in particular, the null hypothesis of normality across the different variables and samples cannot be rejected at the 10 percent level using the Shapiro-Wilk test. Alternative numerical tests based on skewness and kurtosis also yield consistent results. Note that regression analysis does not require the predictor variables to be normally distributed. Such an assumption would imply that one could not use dummy variables in empirical models.

⁶⁷ This is the unpublished working paper "Mean-Reversion in Real Exchange Rates: A Cross-Country Analysis" by Velic.

order to avoid temporal aggregation bias issues and improve the accuracy of impulse response functions (IRFs) in the linear case.

Data on the potential covariates of real exchange rate persistence are annual, unless stated otherwise, and are obtained from the following databases: World Bank's World Development Indicators (WB's WDI), International Monetary Fund's (IMF's) International Financial Statistics (IFS) and World Economic Outlook (WEO), Penn World Tables (6.1.0) (PWT), updated External Wealth of Nations II (EWN II) of Lane and Milesi-Ferretti (2007), and Centre d'Études Prospectives et d'Informations Internationales's GeoDist (CEPII's GeoDist) developed by Mayer and Zignago (2005). For the purposes of cross-section regressions (3.6) and (3.7), period averages of the variables for each country are taken, except in the cases of volatility measures and geographical distance as explained next.⁶⁸

The utilised variables on country characteristics are defined as follows (with data sources in brackets). The inflation rate is the percentage change in the CPI (IMF's IFS). Government expenditure is defined as general government total spending as a percentage share of GDP (WEO).⁶⁹ Trade openness is the sum of exports and imports of goods and services expressed as a percentage share of GDP (WB's WDI). Productivity growth is proxied by the growth rate of real GDP chain per capita (index, in 2005 constant prices, PWT). Nominal exchange rate volatility is defined as the standard deviation of the monthly change in the logarithm of the nominal exchange rate and is computed for both bilateral and effective rates (IMF's IFS). Two de facto measures of international financial integration (IFI) or capital market openness are considered in the framework. Both measures are constructed using data from EWN II. The first of these is the volume-based measure of IFI:

$$IFI_{1it} = \frac{FA_{it} + FL_{it}}{GDP_{it}} \quad (3.8)$$

⁶⁸ Regressors, where applicable, are not based on data relative to those of the US in equation (3.6) or to those of trading partners (or the sample of countries used) in equation (3.7). That is, regressors are based on country-specific data (the only exception is the nominal effective exchange rate volatility measure in (3.7) – here we note that using the bilateral rate volatility measure instead yields similar estimates). This approach is ultimately consistent with those of past studies. However, in robustness checks, we did employ covariates based on relevant relative data where appropriate and found almost identical results.

⁶⁹ In an unreported robustness check we also use the alternative measure of general government final consumption spending as a percentage share of GDP (WB's WDI) and reached similar conclusions.

where FA and FL are the stocks of aggregate foreign assets and liabilities respectively. This is our primary IFI measure of interest and the one we employ in regression analysis. As international trade in debt instruments may be driven by different factors, Lane and Milesi-Ferretti (2007) also propose an equity-based measure of IFI:

$$IFI_{2it} = \frac{PEQA_{it} + FDIA_{it} + PEQL_{it} + FDIL_{it}}{GDP_{it}} \quad (3.9)$$

where $PEQA(L)$ and $FDIA(L)$ are the stocks of portfolio equity and foreign direct investment assets (liabilities). This is our secondary IFI measure of interest and is only inspected qualitatively through graphical analysis. All data used to construct the IFI indicators are reported in current US dollars. Lastly, geographic distance (in kilometres) in our study is a weighted dyadic measure that uses data on principal cities in each country (CEPII's GeoDist). The fundamental idea is to compute the distance between two countries using bilateral distances between the largest cities of those two countries, with those inter-city distances being weighted by the share of the cities in the countries' respective overall populations. Specifically, the bilateral geographic distance between country i and the US is given by:

$$d_{i,US} = \left(\sum_{k \in i} \left(\frac{pop_k}{pop_i} \right) \sum_{l \in US} \left(\frac{pop_l}{pop_{US}} \right) d_{kl}^\theta \right)^{\frac{1}{\theta}} \quad (3.10)$$

where $d_{x,y}$ is the bilateral distance between two places x and y , pop_k denotes the population of agglomeration k belonging to country i , and θ is the parameter that gauges the sensitivity of trade flows to the bilateral distance d_{kl} . We use the measure that sets $\theta = -1$, consistent with estimates from gravity models of bilateral trade flows.

3.6 Country Characteristics: A Descriptive Cross-Sectional Analysis

Tables 3.1-3.4 present some descriptive statistics on a number of explanatory macroeconomic variables across different country groups defined by stage of economic development and regional location. In particular, tables 3.1-3.2 report the means and medians of these variables in the case of the bilateral real exchange rate sample of countries, while tables 3.3-3.4 provide the same information in the case of real effective

exchange rate samples. Moreover, the tables display the results of differences in mean and median tests for the various categorisations.⁷⁰

The summary statistics on country characteristics are significantly different across sub-samples. The tables indeed suggest that there is plenty of heterogeneity in the data. Firstly, the average and median inflation rate across advanced economies stands at a much lower rate than for either emerging or developing nations, with a similar observation holding for high versus middle and low income countries. More specifically, Latin America and Africa are shown to have the highest inflation rates. Figure 3.1 also shows that the average inflation rate of a country is highly positively correlated with inflation volatility over the period. Indeed, this is consistent with the relatively higher incidence of significant macroeconomic volatility in Latin America and Africa post World War II. As we noted in chapter 2, developed nations display a much slower rate of real exchange rate adjustment than other countries. A plot of bilateral and multilateral real exchange rate persistence levels against the average inflation rate in figure 3.2 illustrates qualitatively the existence of an inverse unconditional relation. The graphic offers support for the conventional claim that PPP holds better for high inflation countries.

Following the literature, we also examine the public sector's involvement in the economy. From our tables, it is clear that government size, as measured by the state expenditure to GDP ratio, is largest for industrial countries (over 40 percent of GDP), followed by emerging and developing nations. The trend is identical across income groups. In fact, these advanced economies had higher government spending shares than the US. Regionally, European nations are characterised by much larger shares of public spending. As discussed, the outlays may be contributing positively to these countries' real exchange rate half-lives.

Average trade openness differences also tend to be statistically significant, although less so along the regional level. Tables 3.1-3.4 indicate that emerging and high-income country groups exhibit the highest levels of trade openness. In particular, Asia boasts high levels of openness, a reflection of their trade-driven economies. At the same time however, such openness can expose a country to larger and more frequent

⁷⁰ In appendix A, these tables are reproduced for the sub-sample of countries common to both bilateral and multilateral real exchange rate samples. The reproduced tables in the appendix are A3.1-A3.4.

macroeconomic shocks, such as terms of trade shocks (Clower and Ito 2012). In line with Romer (1993) and Cheung et al. (2001), figure 3.3 reveals a negative gross correlation between inflation and trade openness. Cheung et al. (2001) argue that the inflation effect on real exchange rate inertia arising from increased openness or trade liberalisation can be so strong that it may dominate the trade openness effect itself, thus resulting in a non-negative link between openness and persistence.

International financial openness or integration decreases as we move from the industrial (high income) country group to the developing (low income) country group.⁷¹ This is true for both volume and equity-based measures, with the former reported on the left and the latter reported on the right in each of the international financial integration columns of the tables. Moreover, the quantitative difference between these two variables (across all samples) suggests that debt (and reserves) plays a major part in international capital flows. The composition of international balance sheets is important in understanding sensitivity to external shocks and the extent of international risk sharing. Notably, excessive reliance on debt finance can increase macroeconomic vulnerability, while equity-based finance is thought to enhance international risk sharing.⁷² Lane and Milesi-Ferretti (2001a, 2007) document the rapid rise in international financial integration since the early 1970s. As illustrated by this research, the growth of product trade across the world, and particularly the industrialised world, has been outstripped by the growth of asset trade.

Figures 3.4 and 3.5 show that real exchange rate persistence is positively associated with IFI and that Luxembourg is an extreme outlier.⁷³ One potential interpretation is that with more internationally open capital markets, a country can actively pursue (foreign and domestic) asset buying and selling strategies that keep the currency persistently undervalued (misaligned) vis-à-vis trading partners, thus sustaining the competitiveness position (e.g. China vs. US). Figures 3.6 and 3.7 provide the plots separately for industrial, emerging and developing country groups. In all cases the correlations are now weak and statistically insignificant, although they remain mostly positive. Based on the insignificant correlation coefficients, advanced economies exhibit

⁷¹ Note that IFI and domestic financial development are positively correlated – both gross foreign assets and liabilities are positively associated with such development (Lane and Milesi-Ferretti 2003, 2008). However, in the presence of binding capital controls domestic financial development may not lead to higher international financial integration (Lane and Milesi-Ferretti 2008).

⁷² See Rogoff (1999), Lane and Milesi-Ferretti (2001b).

⁷³ The positive correlation is still maintained when Luxembourg is removed from the overall samples.

some evidence of a negative comovement between persistence and IFI (with Luxembourg being a significant driver). Interestingly, in the case of the bilateral real exchange rate sample of developing countries in figure 3.6, a negative correlation coefficient is found when using the equity-based IFI measure. Taken seriously for developing countries, it broadly implies that higher international trade in debt instruments or lower trade in equity instruments increases the persistence of bilateral real exchange rate parity deviations. On the other hand, the inverse relation may also be due to the removal of international reserves (although they carry a much lower weight in the overall position) from the equation, which are generally thought to increase persistence. However, in all other sub-sample cases across figures 3.6 and 3.7, the insignificant correlation coefficients actually increase when the equity-based IFI measure is employed. This may suggest that the debt component hastens real exchange rate adjustment. Indeed, for emerging markets, historical evidence indicates that external debt levels close to the default threshold are typically accompanied by significant real depreciations as locals and foreign investors flee the currency.

Productivity growth figures, as proxied by per capita GDP growth, also vary significantly across groups with emerging market and high income economies having the highest growth rates. Along the regional level, Asia and Europe experienced the highest average levels of growth. It is interesting to note that, unlike emerging markets which are catching up or converging, developing countries on average observed lower productivity growth than industrial countries.⁷⁴ Cheung and Lai (2000a) explain that such a result is possible according to endogenous growth theory. The theory implies that productivity growth in advanced economies may still remain high in steady state. Figure 3.8 points to a positive connection between real exchange rate persistence and productivity growth, although the link is significantly weaker in the bilateral case.

Lastly, the statistics indicate greater nominal exchange rate volatility for the non-industrialised world along all country classification schemes. In particular, developing and emerging economies, low and middle income countries, and Latin America and Africa are characterised by the highest exchange rate variability levels. Certainly, over the past 40 years, these economies have observed sizable nominal exchange rate movements due to the liberalisation of capital flows and the tremendous rise in the scale

⁷⁴ From tables 3.1-3.4 we can see that there is no evidence of catching-up or convergence for groupings by income.

and type of cross-border financial transactions. The currency crises in emerging markets that occurred during our sample period were also notable instances of large exchange rate volatility. Moreover, the phases of transition to a market-based system in CEE economies often entailed major adjustments in the international value of these countries' currencies. For both bilateral and multilateral cases, figure 3.9 yields some preliminary evidence of a relatively strong inverse relation between real exchange rate persistence and nominal exchange rate volatility. Using the average de jure IMF exchange rate regime classification for each country over the sample period, the graphs also show that fixers generally observe higher real exchange rate persistence and lower nominal exchange rate volatility than intermediate and flexible exchange rate regime countries. Figures 3.10 and 3.11 graph average inflation and real exchange rate volatility respectively against nominal exchange rate volatility and report statistically significant large positive correlation coefficients, with countries that were peggers on average normally displaying lower inflation and real/nominal exchange rate volatility.

3.7 Regression Analysis

Table 3.5 presents the results of cross-section bilateral and multilateral real exchange rate persistence regressions (3.6) and (3.7) respectively. The findings in the table are given for full samples of countries and the different sets of half-life estimates attained from chapter 2.^{75,76} Investigating further, tables 3.6-3.9 provide these regression results for different country groups defined by stage of economic development. Overall, the collective explanatory power of the country characteristics appears to be reasonably good on the basis of R-squared values which generally tend to improve with half-lives from more elaborate real exchange rate specifications. In the case of full samples, these variables can account for up to a maximum of 46 percent of the variation in cross-country real exchange rate inertia levels. As indicated in the notes of the respective

⁷⁵ Table A3.5 in appendix A tenders results for the sample of countries that is common across both bilateral and multilateral rates of persistence. These findings are very similar to those obtained with the respective full samples in table 3.5.

⁷⁶ Our regression results are robust to truncating the sample along the time dimension in two respects (this entails re-estimation of the real exchange rate half-lives and statistics pertaining to country characteristics). Specifically, when the data is based on the sample period that excludes the recent global crisis phase, which was characterised by a relative increase in international macroeconomic volatility, or on sample periods that are the same as those employed by past studies (such as those of Cheung and Lai (2000a) and Cashin and McDermott (2006)), our regression results remain broadly intact. In addition, when making comparisons to past analyses, we observe that our findings are not driven by country sample differences.

tables, we also perform diagnostic checks on the residuals from each regression. In particular, tests of normality of the residuals are conducted given the importance of this assumption for the validity of the relevant test statistics in inference (particularly in smaller samples).⁷⁷ Ultimately, across all specifications, we retrieve no significant evidence of non-normality.

Our results offer considerable support for the proposition that a higher inflation rate enhances the speed of mean-reversion in the real exchange rate. For the full bilateral real exchange rate sample of countries, this result seems to be robust across different specifications and consistent with the findings of Bleaney et al. (1999). As columns (4), (8) and (9) show, the point estimate in the case of large parity deviations is around -0.40 suggesting that a 10 percent increase (percentage change) in the growth rate of prices is associated with a 4 percent decline in the bilateral real exchange rate half-life.⁷⁸ In all other cases, including smaller parity deviations in columns (5), (6) and (7), the estimate lies around -0.18. The result implies that larger percentage changes in inflation are required in order to more significantly influence the persistence of smaller real exchange rate misalignments. Concerning the multilateral real exchange rate sample in table 3.5, the inflation coefficients are mostly negative and statistically insignificant, with a similar pattern holding for smaller and larger parity deviation half-lives. Returning to figure 3.2, in the lower panel we can observe how the outlying observations of Ukraine and Brazil are obscuring our estimates. If one drops these two cases of very high average inflation, significant negative estimates are once again attained throughout.

Across the sub-samples shown in tables 3.6-3.9, the evidence on the whole again indicates a negative comovement between real exchange rate inertia and inflation. However, there are some groups with insufficient cross-country variation and thus insignificant coefficients. In the bilateral case, there appears to be sufficient variation in the developing and middle income country cohorts to engender significant negative estimates. On the other hand, in the multilateral case, the coefficients are significant and negative primarily in the industrial and high income groups, with the US, New Zealand

⁷⁷ More generally, asymptotic theory suggests that this is less of an issue in larger samples.

⁷⁸ If originally the inflation rate or growth rate of prices is x percent, then a 10 percent increase in the rate of inflation results in a new inflation rate of $x + 0.1x$ percent. This is the implied interpretation of our result. This percentage change interpretation should be differentiated from a percentage point change interpretation, that is, an increase from x percent to $x + 10$ percent.

and Australia being the notable advanced economy additions to the sample. For the other groups in the multilateral case, observation numbers are substantially reduced.⁷⁹ In contrast to Alba and Papell (2007), we do not find any support in the bilateral sample for the notion that countries with low inflation rates, similar to that of the US, are more likely to be characterised by faster real exchange rate convergence. The authors argue that countries with notably different inflation rates and fixed exchange rates can intervene in the foreign exchange market to suppress adjustment so that PPP may not hold. As table 3.10 shows, low-inflation fixed exchange rate economies in fact observed the highest levels of bilateral real exchange rate persistence. In such economies, the deviations from parity may have been relatively small but highly persistent.

Our parametric analysis corroborates the earlier observation of an inverse relation between real exchange rate persistence and nominal exchange rate volatility. Indeed, the slope coefficient of concern is consistently significant across virtually all specifications given in tables 3.5-3.9. The average point estimate for the overall samples in table 3.5 is around -0.63 indicating that a 10 percent rise in nominal exchange rate volatility is tied to a 6.3 percent decline in the real exchange rate half-life. Moreover, the volatility effect on the different selected model half-lives (columns (5)-(9)) displays little variation. Table 3.10 also confirms that countries which were typically characterised by a fixed exchange rate regime had much lower nominal exchange rate volatility. Certainly, if exchange rate arrangement instead of volatility was used in the regressions, one would observe that more flexible regimes are associated with lower real exchange rate inertia.⁸⁰ In line with Cheung et al. (2004), our empirical findings suggest that nominal exchange rate adjustment is more important than price adjustment in governing the speed of parity convergence.

The coefficient for trade openness is around -0.45 on average when we consider the entire samples, with the usual interpretation applying. Apart from middle income countries, trade openness does not appear to be a significant factor across sub-samples due to the homogeneity within country groups. For instance, industrial countries have low average levels of trade openness and exhibit slow real exchange rate convergence.

⁷⁹ As alluded to, the outlier of Ukraine is driving the positive coefficients for the developing group in the reduced multilateral sample.

⁸⁰ This was checked using the data and verified to be the case.

Overall, we find sufficient evidence in favour of the theoretical arguments of Faruquee (1995) and Bergin and Feenstra (2001).

Focusing on distance in the bilateral real exchange rate persistence case in table 3.5, we obtain unequivocal support for the notion that countries geographically closer to the US observe faster mean-reversion, despite controlling for a number of other macroeconomic factors. Except for industrial and high income groups, the same conclusion can be reached in sub-samples (tables 3.6-3.9) as indicated by the statistically significant positive coefficients. This result is consistent with that of Campa and Wolf (1997), although their study was conducted for G7 countries, but in opposition to that of Cheung et al. (2001) who state that the distance effect is absorbed by other determinants, such as nominal exchange rate volatility which happens to be positively correlated with the variable. Distance may be representing transportation costs and/or monetary policy similarities. However, these factors to some extent may already be accounted for by the non-linear estimation of real exchange rate dynamics and the inclusion of inflation and nominal exchange rate flexibility/volatility variables in the cross-section regressions.⁸¹

Although we recognise that our measure of productivity growth is not ideal, we still note that there is some evidence of higher growth leading to higher persistence of smaller real effective exchange rate parity deviations for the full sample. Specifically, a 1 percentage point rise in productivity growth is correlated with a +10 percent change in persistence. In the bilateral case however, the results are insignificant. Tables 3.6-3.9 show mixed results, with significantly negative slope coefficients in a couple of country groups. Whether or not productivity growth strenghtens the persistence of real exchange rate disequilibria may depend on the magnitude of its potential demand and supply-side effects. On the one hand, productivity growth induces a positive income effect and subsequently raises the demand for non-tradables. On the other hand, it can be factor augmenting, engendering positive supply effects. If supply-side effects dominate demand-side effects, a real currency depreciation occurs. Conceivably, this could act in the opposite direction to the traditional Balassa-Samuelson effect. Of course, if the

⁸¹ Another potential factor that could be associated with distance, but that is not considered in the analysis, is pricing-to-market or price discrimination. In particular, it would be interesting to investigate whether countries further away from the US are more likely to be exposed to price discrimination and thus characterized by higher (bilateral) real exchange rate persistence.

effects just offset each other, then the rate of real exchange rate convergence may not be influenced at all by productivity growth changes.⁸²

Table 3.5 reveals almost no evidence in full samples of higher government spending leading to slower parity reversion.⁸³ As Galstyan and Lane (2009) demonstrate, while government consumption unambiguously leads to a real exchange rate appreciation, government investment may potentially depreciate a country's real currency if it disproportionately affects the respective productivity levels of traded and non-traded sectors (in favour of the latter sector). If these dynamics offset each other, then we may observe no effect on real exchange rate persistence. Tables 3.6-3.9 overall display mixed results regarding government spending in sub-samples, with most estimates yet again being insignificant.⁸⁴

The effect of international financial integration or capital market liberalisation on the persistence of real exchange rate parity deviations is virtually non-existent for overall samples.⁸⁵ However, some support in favour of a relation between the two variables is found at sub-sample level. In particular, the sign of the correlation changes across country groups which may obscure results at the aggregate level. As reported in tables 3.6-3.9, there is a positive link between financial integration and the real exchange rate half-life for developing countries. Conversely, high income, industrial and emerging economies display some evidence of a negative link.

As mentioned in section 3.6, it appears that the debt component of the volume-based measure of IFI may be driving upward the partial effect in the wider bilateral exchange rate persistence sample of developing economies. Nevertheless, the effect of debt for developing (and emerging) countries might have diminished in recent decades given the decline in the relative weight of debt (liabilities) in these economies' external portfolios since the mid-1980s.⁸⁶ Indeed, an excessive reliance on debt finance is often associated with greater vulnerability. More generally, Devereux and Lane (2003) find

⁸² See Cheung and Lai (2000a).

⁸³ Qualitatively, most coefficients are of positive sign.

⁸⁴ Interestingly, Engel (1999) finds that relative prices of non-tradables account for very little of the movement in dollar real exchange rates vis-à-vis a number of other high income countries. Based on Engel's work, Sarno (2005) contends that non-tradable prices are not likely to explain much of the dynamics of parity deviations.

⁸⁵ The results do not change if one uses the Chinn and Ito index of financial openness (*de jure* measure) instead of the Lane and Milesi-Ferretti measure of international financial integration (*de facto* measure).

⁸⁶ See Lane and Milesi-Ferretti (2007).

that nominal exchange rate volatility in developing countries is reduced by external financial liabilities via its impact on the choice of exchange rate regime (a factor we control for). Specifically, external debt tightens financial constraints and attenuates the efficiency of the exchange rate in responding to external shocks. Furthermore, the build up of international reserves in non-industrialised economies may have contributed towards higher real exchange rate inertia by affording such economies the ability to defend or maintain currency pegs.⁸⁷ While figure 3.12 displays virtually a zero correlation between real exchange rate persistence and reserves in full samples, figure 3.13 shows that a significant positive link between the two variables holds for developing and emerging nations collectively.^{88,89}

3.8 Conclusion

The objective of this paper was to empirically examine the main determinants or correlates of the persistence of real exchange rate parity deviations. Employing bilateral and multilateral real exchange rate persistence data over the period 1973-2010 for a group of 151 nations, our cross-sectional parametric investigation identifies a number of important country characteristics. The results indicate that higher inflation, nominal exchange rate volatility and trade openness are associated with faster real exchange rate mean-reversion. On the other hand, in the bilateral case, it is found that countries located further away from the reference country (the US) are characterised by greater real exchange rate inertia. We also attain some modest evidence of a positive relation between productivity growth and persistence at the aggregate level. The degree of international financial openness a country is exposed to does not appear to matter in overall samples. However, closer scrutiny reveals that it plays somewhat of a role at country group level, with differences across cohorts perhaps cancelling each other in full samples. In particular, developing economies tend to display a positive link between the two variables, while more advanced economies show signs of a negative link. Thus,

⁸⁷ Lane and Milesi-Ferretti (2007) document the rise in official reserves on the asset side of the balance sheet (in particular since the mid-1990s) that has accompanied the fall in external debt in the non-industrialised world.

⁸⁸ If we look at the two groups separately, developing countries display a stronger and more significant positive correlation than emerging countries. International reserves exclude gold holdings.

⁸⁹ Out of curiosity, we also inspected the connection between the net foreign asset position (in absolute and non-absolute form) and real exchange rate persistence both graphically and in regressions. Overall, the results indicated no significant link. Studies similar to the one that we produce have generally not considered this variable.

the findings indicate that the extent of an economy's (financial and trade) openness is important. Intuitively, one would expect openness to influence the scope for financial asset price (e.g. nominal exchange rates reflect prices of currencies) and goods price arbitrage.

3.9 References

Achy, L. 2003. Parity Reversion Persistence in Real Exchange Rates: Middle Income Country Case. *Applied Economics*, Vol.35, No.5, pp541-553.

Alba, J.D. and Papell, D.H. 2007. Purchasing Power Parity and Country Characteristics: Evidence from Panel Data Sets. *Journal of Development Economics*, Vol.83, No.1, pp240-251.

Alesina, A. and Perotti, R. 1995. Fiscal Expansions and Fiscal Adjustments in OECD Countries. *Economic Policy*, Vol.10, No.21, pp205-248.

Álvarez, L.J., Dhyne, E., Hoeberichts, M.M., Kwapil, C., Le Bihan, H., Lünnemann, P., Martins, F., Sabbatini, R., Stahl, H., Vermeulen, P. and Vilmunen, J. 2005. Sticky Prices in the Euro Area: A Summary of New Micro Evidence. European Central Bank Working Paper No.563.

Balassa, B. 1964. The Purchasing-Power Parity Doctrine: A Reappraisal. *Journal of Political Economy*, Vol.72, No.6, pp584-596.

Baxter, M. and Stockman, A. 1989. Business cycles and the exchange-rate regime: Some international evidence. *Journal of Monetary Economics*, Vol.23, No.3, pp377-400.

Benigno, G. 2004. Real exchange rate persistence and monetary policy rules. *Journal of Monetary Economics*, Vol.51, No.3, pp473-502.

Bergin, P.R. and Feenstra, R.C. 2001. Pricing-to-Market, Staggered Contracts, and Real Exchange Rate Persistence. *Journal of International Economics*, Vol.54, No.2, pp333-359.

Black, S. 1986. Real Exchange Rates and Deviations from Purchasing Power Parity Under Floating Exchange Rates. A Comment. *Carnegie-Rochester Conference Series on Public Policy*, Vol.25, No.1, pp215-220.

Bleaney, M.F., Leybourne, S.J., and Mizen, P. 1999. Mean Reversion of Real Exchange Rates in High-Inflation Countries. *Southern Economic Journal*, Vol.65, No.4, pp839-854.

Bussière, M., Lopez, C. and Tille, C. 2013. Currency Crises in Reverse: Do Large Real Exchange Rate Appreciations Matter for Growth? MPRA Paper No. 44096.

Campa, J.M. and Wolf, H.C. 1997. Is real exchange rate mean reversion caused by arbitrage? National Bureau of Economic Research Working Paper No.6162.

Carrera, J. and Vuletin, G. 2003. The effects of exchange rate regimes on real exchange rate volatility: a dynamic panel data approach. Brazilian Association of Graduate Programs in Economics Working Paper No.c67.

Cheung, Y.-W., Chinn, M. and Fujii, E. 2001. Market Structure and the Persistence of Sectoral Real Exchange Rates. *International Journal of Finance and Economics*, Vol.6, No.2, pp95-114.

Cheung, Y.-W., Lai, K.S. and Bergman, M. 2004. Dissecting the PPP puzzle: the unconventional roles of nominal exchange rate and price adjustments. *Journal of International Economics*, Vol.64, No.1, pp135-150.

Clower, E. and Ito, H. 2012. The Persistence and Determinants of Current Account Balances: The Implications for Global Rebalancing. Asian Development Bank Institute Working Paper Series, Working Paper No.400.

Delgado, F.A. 1991. Hysteresis, menu costs, and pricing with random exchange rates. *Journal of Monetary Economics*, Vol.28, No.3, pp461-484.

Devereux, M.B. and Lane, P.R. 2003. Understanding real exchange rate volatility. *Journal of International Economics*, Vol.60, No.1, pp109-132.

Dumas, B. 1992. Dynamic Equilibrium and the Real Exchange Rate in a Spatially Separated World. *The Review of Financial Studies*, Vol.5, No.2, pp153-180.

Engel, C. 1999. Accounting for U.S. Real Exchange Rate Changes. *Journal of Political Economy*, Vol.107, No.3, pp507-538.

Engel, C. 2012. Real Exchange Rate Convergence: The Roles of Price Stickiness and Monetary Policy. Working Paper, University of Wisconsin.

Engel, C. and Rogers, J.H. 2001. Deviations from purchasing power parity: causes and welfare costs. *Journal of International Economics*, Vol.55, No.1, pp29-57.

Faruquee, H. 1995. Pricing to Market and the Real Exchange Rate. *IMF Staff Papers*, Vol.42, No.4, pp855-881.

Feldstein, M. 2011. The role of currency realignments in eliminating the US and China current account imbalances. *Journal of Policy Modeling*, Vol.33, No.5, pp731-736.

Flood, R.P. and Rose, A.K. 1995. Fixing exchange rates: A virtual quest for fundamentals. *Journal of Monetary Economics*, Vol.36, No.1, pp3-37.

Froot, K.A. and Rogoff, K.S. 1991a. The EMS, the EMU, and the Transition to a Common Currency. In *National Bureau of Economic Research Macroeconomics Annual*, ed. by Fisher, S. and Blanchard, O., (Cambridge: MIT Press), pp269-317.

Froot, K.A. and Rogoff, K.S. 1991b. Government Consumption and the Real Exchange Rate: The Empirical Evidence. Mimeo, Harvard Business School.

Froot, K.A. and Rogoff, K.S. 1995. Perspectives on PPP and Long-Run Real Exchange Rates. In *Handbook of International Economics*, Vol.3, ed. by Grossman, G. and Rogoff, K., (Amsterdam: Elsevier Press), pp1647-1688.

Gagnon, E. 2009. Price Setting during Low and High Inflation: Evidence from Mexico. *Quarterly Journal of Economics*, Vol.124, No.3, pp1221-1263.

Galstyan, V. and Lane, P.R. 2009. The Composition of Government Spending and the Real Exchange Rate. *Journal of Money, Credit and Banking*, Vol.41, No.6, pp1233-1249.

Ghosh, A., Gulde, A., Ostry, J., and Wolf, H. 1997. Does the nominal exchange rate regime matter? National Bureau of Economic Research Working Paper No.5874.

Glass, G.V., Peckham, P.D. and Sanders, J.R. 1972. Consequences of failure to meet the assumptions underlying the fixed effects analysis of variance and covariance. *Review of Educational Research*, Vol.42, No.3, pp237-288.

Goldfajn, I. and Valdés, R.O. 1999. The Aftermath of Appreciations. *The Quarterly Journal of Economics*, Vol.114, No.1, pp229-262.

Harrod, R. 1933. *International Economics*. London: Nisbet and Cambridge University Press.

- Klenow, P.J. and Malin, B.A. 2010. Microeconomic Evidence on Price-Setting. National Bureau of Economic Research Working Paper No.15826.
- Lane, P.R. and Milesi-Ferretti, G.M. 2001a. The External Wealth of Nations: Measures of Foreign Assets and Liabilities for Industrial and Developing Countries. *Journal of International Economics*, Vol.55, No.2, pp263-294.
- Lane, P.R. and Milesi-Ferretti, G.M. 2001b. External Capital Structure: Theory and Evidence. In *The World's New Financial Landscape: Challenges for Economic Policy*, ed. by Siebert, H., (Berlin: Springer-Verlag), pp247-284.
- Lane, P.R. and Milesi-Ferretti, G.M. 2003. International Financial Integration. *IMF Staff Papers*, Vol.50, Special Issue, pp82-113.
- Lane, P.R. and Milesi-Ferretti, G.M. 2007. The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004. *Journal of International Economics*, Vol.73, No.2, pp223-250.
- Lane, P.R. and Milesi-Ferretti, G.M. 2008. The Drivers of Financial Globalisation. *American Economic Review*, Vol.98, No.2, pp327-332.
- Lo, M. and Wong, M.C.S. 2006. What Explains the Deviations of Purchasing Power Parity Across Countries? International Evidence from Macro Data. *Economics Letters*, Vol.91, No.2, pp229-235.
- Mayer, T. and Zignago, S. 2005. Market Access in Global and Regional Trade. Centre d'Études Prospectives et d'Informations Internationales Working Paper No.2.
- Mayoral, L. and Gadea, M.D. 2011. Aggregate real exchange rate persistence through the lens of sectoral data. *Journal of Monetary Economics*, Vol.58, No.3, pp290-304.
- Mussa, M. 1986. Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications. *Carnegie-Rochester Series on Public Policy*, Vol.25, No.1, pp117-214.
- Rogers, J.H. 1999. Monetary shocks and real exchange rates. *Journal of International Economics*, Vol.49, No.2, pp269-288.

Rogoff, K. 1992. Traded Goods Consumption Smoothing and the Random Walk Behavior of the Real Exchange Rate. *Bank of Japan Monetary and Economic Studies*, Vol.10, No.2, pp1-29.

Rogoff, K. 1999. International Institutions for Reducing Global Financial Instability. *Journal of Economic Perspectives*, Vol.13, No.4, pp21-42.

Romer, D. 1993. Openness and Inflation: Theory and Evidence. *The Quarterly Journal of Economics*, Vol.108, No.4, pp869-903.

Sarno, L. 2005. Towards a Solution to the Puzzles in Exchange Rate Economics: Where Do We Stand? Warwick Business School, Financial Econometrics Research Centre Working Paper No.wp05-11.

Samuelson, P.A. 1964. Theoretical Notes on Trade Problems. *Review of Economics and Statistics*, Vol.46, No.2, pp145-154.

Taylor, A.M. 2002. A century of purchasing-power parity. *Review of Economics and Statistics*, Vol.84, No.1, pp139-150.

Wei, S.-J. and Parsley, D. 1995. Purchasing power dis-parity during the floating rate period: Exchange rate volatility, trade barriers, and other culprits. National Bureau of Economic Research Working Paper No.5032.

Table 3.1: Means of Macroeconomic Variables for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	141	37.04	31.44	83.05	280.75, 98.27	1.98	0.05
United States	1	4.48	37.44	21.54	110.26, 42.74	2.05	(0.03)
Industrial	20	5.96	45.88	77.17	1019.36, 466.55	2.30	0.03
Emerging	45	41.67	32.70	98.46	222.27, 54.05	2.72	0.05
Developing	76	42.48	26.90	75.67	119.47, 26.38	1.47	0.06
Test of Equal Sub-Group Means		1.69 [0.19]	42.99*** [0.00]	3.22** [0.05]	1.35, 1.26 [0.28], [0.31]	9.67*** [0.00]	3.21** [0.05]
High Income	42	11.87	41.10	102.99	680.28, 275.01	2.69	0.04
Middle Income	74	46.93	29.35	80.81	123.39, 30.64	2.11	0.06
Low Income	25	50.08	21.40	56.95	107.32, 15.68	0.42	0.05
Test of Equal Sub-Group Means		1.09 [0.35]	54.09*** [0.00]	9.08*** [0.00]	2.22, 1.67 [0.12], [0.20]	14.18*** [0.00]	2.48* [0.09]
Africa	41	48.22	27.14	71.69	123.10, 27.70	1.12	0.06
Asia	32	23.34	27.98	94.00	218.54, 46.33	2.77	0.05
Europe	35	21.01	43.21	90.60	661.56, 289.64	2.56	0.05
Latin America	28	61.67	26.63	77.34	146.92, 37.74	1.72	0.06
Oceania	4	8.15	30.65	93.09	93.85, 26.27	1.28	0.02
Test of Equal Sub-Group Means		1.17 [0.33]	29.88*** [0.00]	1.82 [0.13]	1.31, 1.25 [0.29], [0.31]	5.86*** [0.00]	0.64 [0.64]

* significant at 10%; ** significant at 5%; *** significant at 1%

‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 3.2: Medians of Macroeconomic Variables for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	141	8.90	31.20	74.08	123.32, 26.28	1.78	0.03
Industrial	20	4.88	44.69	67.06	209.57, 63.59	2.15	0.03
Emerging	45	9.62	34.83	94.85	135.60, 30.92	2.44	0.03
Developing	76	10.20	26.28	71.60	114.05, 20.28	1.02	0.04
Test of Equal Sub-Group Medians		11.71*** [0.00]	33.64*** [0.00]	4.29* [0.10]	14.3***, 18.3*** [0.00], [0.00]	28.79*** [0.00]	26.89*** [0.00]
High Income	42	4.73	42.04	87.23	191.51, 53.34	2.29	0.03
Middle Income	74	10.95	28.94	76.30	103.78, 22.32	1.72	0.04
Low Income	25	10.18	19.79	50.81	99.86, 10.95	0.70	0.04
Test of Equal Sub-Group Medians		19.47*** [0.00]	40.41*** [0.00]	9.77*** [0.01]	32.3***, 33.1*** [0.00], [0.00]	33.10*** [0.00]	29.61*** [0.00]
Africa	41	9.28	25.58	59.85	115.29, 18.44	0.87	0.04
Asia	32	8.05	25.37	80.70	103.78, 19.75	2.18	0.03
Europe	35	7.51	42.13	77.42	170.87, 44.64	2.31	0.03
Latin America	28	14.04	28.03	68.89	112.33, 21.74	1.45	0.04
Oceania	4	8.25	30.19	91.03	95.19, 23.86	1.10	0.02
Test of Equal Sub-Group Medians		6.63 [0.16]	42.01*** [0.00]	9.85** [0.04]	21.8***, 23.0*** [0.00], [0.00]	31.44*** [0.00]	24.47*** [0.00]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 3.3: Means of Macroeconomic Variables for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	93	39.61	33.49	83.23	343.48, 132.75	2.09	0.07
Industrial	23	5.94	44.50	72.04	902.20, 412.49	2.25	0.02
Emerging	28	37.23	32.49	93.08	159.36, 49.10	2.53	0.06
Developing	42	59.64	28.12	82.80	155.89, 33.34	1.71	0.11
Test of Equal Sub-Group Means		2.22* [0.10]	29.05*** [0.00]	1.16 [0.32]	1.30, 1.25 [0.29], [0.31]	1.84 [0.17]	5.06*** [0.01]
High Income	38	12.38	41.66	93.52	675.76, 281.82	2.59	0.02
Middle Income	47	45.75	28.60	79.57	120.22, 35.25	2.13	0.09
Low Income	8	132.89	23.37	55.90	118.40, 16.10	-0.57	0.20
Test of Equal Sub-Group Means		0.93 [0.43]	35.99*** [0.00]	3.38** [0.04]	1.87, 1.44 [0.17], [0.25]	10.42*** [0.00]	1.92 [0.21]
Africa	20	61.67	26.15	69.20	121.31, 30.06	0.88	0.13
Asia	13	31.42	28.04	100.56	252.10, 47.38	3.66	0.05
Europe	30	32.54	44.23	87.79	732.43, 322.92	2.25	0.04
Latin America	22	45.97	28.26	83.94	142.18, 44.77	2.23	0.10
Oceania	6	7.53	32.72	81.07	113.22, 42.68	1.35	0.02
Test of Equal Sub-Group Means		0.37 [0.83]	28.56*** [0.00]	0.82 [0.52]	1.32, 1.21 [0.28], [0.33]	3.82*** [0.01]	1.75 [0.16]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table 3.4: Medians of Macroeconomic Variables for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	93	7.51	32.49	73.70	136.64, 39.25	1.92	0.03
Industrial	23	4.94	43.59	60.90	193.77, 57.64	2.13	0.01
Emerging	28	9.95	33.75	88.86	139.81, 38.98	2.22	0.03
Developing	42	10.15	29.15	78.19	118.54, 26.90	1.23	0.05
Test of Equal		13.34***	36.71***	4.46*	10.3***, 18.7***	10.06***	28.73***
Sub-Group Medians		[0.00]	[0.00]	[0.10]	[0.01], [0.00]	[0.01]	[0.00]
High Income	38	4.83	42.26	77.42	186.22, 55.59	2.18	0.02
Middle Income	47	10.28	28.85	73.70	111.43, 27.70	1.65	0.04
Low Income	8	12.27	19.78	49.97	122.84, 14.06	-0.57	0.08
Test of Equal		17.30***	35.92***	2.43	20.1***, 31.0***	16.45***	32.83***
Sub-Group Medians		[0.00]	[0.00]	[0.30]	[0.00], [0.00]	[0.00]	[0.00]
Africa	20	10.23	26.02	59.44	118.70, 20.71	0.39	0.05
Asia	13	5.98	24.21	79.55	107.88, 26.28	2.59	0.03
Europe	30	6.46	43.31	76.42	174.50, 45.55	2.23	0.02
Latin America	22	8.72	29.15	75.54	121.85, 27.51	1.94	0.04
Oceania	6	7.35	32.86	91.03	113.41, 47.45	1.41	0.02
Test of Equal		2.25	48.26***	4.68	12.5***, 12.8***	19.68***	21.39***
Sub-Group Medians		[0.69]	[0.00]	[0.32]	[0.01], [0.01]	[0.00]	[0.00]

* significant at 10%; ** significant at 5%; *** significant at 1%
‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table 3.5: Cross-section regression results for full BRER and REER samples

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR model TF max. half-life	augmented ESTAR model TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
<i>BRER-based</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.283**	-0.093	-0.183	-0.406***	-0.169*	-0.183*	-0.178*	-0.408***	-0.403***
(inf)	(0.131)	(0.112)	(0.115)	(0.127)	(0.099)	(0.096)	(0.097)	(0.127)	(0.127)
govt. exp.	-0.395	-0.205	-0.222	0.076	-0.002	0.078	0.020	0.215	0.157
(gov)	(0.299)	(0.271)	(0.269)	(0.318)	(0.255)	(0.258)	(0.257)	(0.331)	(0.331)
trade open.	0.175	-0.617***	-0.668***	-0.326	-0.352	-0.398*	-0.421*	-0.428	-0.451
(to)	(0.239)	(0.237)	(0.238)	(0.290)	(0.227)	(0.222)	(0.223)	(0.288)	(0.290)
prod. growth	-0.106**	0.026	0.032	-0.061	0.003	0.021	0.020	-0.029	-0.029
(PG)	(0.049)	(0.041)	(0.044)	(0.060)	(0.045)	(0.043)	(0.043)	(0.059)	(0.059)
ner volatility	-0.555**	-0.735***	-0.826***	-0.508**	-0.651***	-0.689***	-0.682***	-0.666***	-0.659***
(nerv)	(0.254)	(0.194)	(0.186)	(0.227)	(0.206)	(0.198)	(0.200)	(0.222)	(0.223)
financial int.	-0.051	0.244*	0.206	-0.029	0.025	0.035	0.058	-0.024	-0.001
(ifi)	(0.246)	(0.135)	(0.134)	(0.170)	(0.149)	(0.143)	(0.140)	(0.169)	(0.168)
geo. distance	0.367**	0.572***	0.477**	0.540**	0.438**	0.363*	0.381*	0.462*	0.480*
(dist)	(0.175)	(0.209)	(0.196)	(0.259)	(0.209)	(0.199)	(0.202)	(0.246)	(0.248)
Observations	138	138	138	138	138	138	138	138	138
R ²	0.34	0.38	0.46	0.34	0.36	0.39	0.39	0.39	0.38
<i>REER-based</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.304***	0.006	-0.031	-0.115	0.095	0.009	0.023	-0.132	-0.118
(inf)	(0.104)	(0.110)	(0.105)	(0.137)	(0.112)	(0.102)	(0.101)	(0.132)	(0.133)
govt. exp.	-0.102	-0.288	-0.212	0.422	0.004	0.085	0.067	0.523	0.505
(gov)	(0.355)	(0.389)	(0.378)	(0.473)	(0.436)	(0.329)	(0.340)	(0.448)	(0.452)
trade open.	-0.198	-0.723***	-0.720***	-0.437	-0.506*	-0.580**	-0.596**	-0.393	-0.409
(to)	(0.226)	(0.289)	(0.277)	(0.329)	(0.312)	(0.258)	(0.258)	(0.315)	(0.315)
prod. growth	-0.038	0.063	0.055	0.054	0.108***	0.092***	0.097**	0.030	0.035
(PG)	(0.038)	(0.049)	(0.047)	(0.057)	(0.040)	(0.037)	(0.039)	(0.053)	(0.054)
ner volatility	-0.028	-0.760***	-0.715***	-0.608***	-0.707***	-0.636***	-0.651***	-0.640***	-0.655***
(nerv)	(0.148)	(0.153)	(0.144)	(0.147)	(0.135)	(0.130)	(0.133)	(0.146)	(0.147)
financial int.	-0.016	0.135	0.122	-0.048	0.086	0.053	0.060	-0.136	-0.129
(ifi)	(0.190)	(0.159)	(0.157)	(0.199)	(0.201)	(0.171)	(0.173)	(0.181)	(0.182)
Observations	90	91	91	91	91	91	91	91	91
R ²	0.18	0.39	0.39	0.38	0.40	0.42	0.42	0.40	0.40

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The dependent variable is the natural logarithm of the bilateral real exchange rate (BRER) half-life for BRER-based regression results and the natural logarithm of the real effective exchange rate (REER) half-life for REER-based regression results. The half-life is our measure of persistence. All regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

Table 3.6: BRER-based cross-section regression results by economic development group

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR model TF max. half-life	augmented ESTAR model TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
<i>Industrial Countries</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	0.353**	0.208	0.263	-0.055	0.363	0.364	0.349	0.127	0.112
(inf)	(0.153)	(0.179)	(0.170)	(0.404)	(0.269)	(0.269)	(0.267)	(0.418)	(0.409)
govt. exp.	0.018	-0.515	-0.410	-0.741	-0.207	0.024	-0.136	-0.077	-0.237
(gov)	(0.551)	(0.589)	(0.539)	(1.545)	(1.062)	(1.049)	(1.021)	(1.584)	(1.524)
trade open.	0.266	0.302	0.230	0.084	-0.334	-0.264	-0.243	-0.123	-0.102
(to)	(0.442)	(0.429)	(0.451)	(0.823)	(0.668)	(0.714)	(0.698)	(0.965)	(0.938)
prod. growth	-0.031	0.031	-0.026	-0.151	-0.110	0.065	0.061	0.191	0.187
(PG)	(0.140)	(0.143)	(0.139)	(0.241)	(0.220)	(0.270)	(0.259)	(0.397)	(0.380)
ner volatility	-1.932***	-1.956**	-1.657**	-2.218**	-2.080**	-2.233**	-2.183**	-3.039	-2.988
(nerv)	(0.527)	(0.784)	(0.645)	(1.040)	(0.756)	(0.959)	(0.922)	(1.915)	(1.857)
financial int.	-0.015	-0.097	-0.043	0.039	0.209	0.151	0.144	0.011	0.004
(ifi)	(0.189)	(0.184)	(0.194)	(0.327)	(0.286)	(0.327)	(0.318)	(0.421)	(0.410)
geo. distance	0.285	0.338	0.322	0.069	0.126	0.227	0.200	0.468	0.441
(dist)	(0.207)	(0.288)	(0.244)	(0.381)	(0.280)	(0.356)	(0.342)	(0.696)	(0.674)
Observations	20	20	20	20	20	20	20	20	20
R ²	0.48	0.38	0.31	0.23	0.32	0.33	0.33	0.25	0.26
<i>Emerging Countries</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.768***	0.119	0.088	-0.038	0.236	0.126	0.153	-0.162	-0.134
(inf)	(0.218)	(0.264)	(0.259)	(0.311)	(0.190)	(0.182)	(0.177)	(0.301)	(0.297)
govt. exp.	-0.338	-0.197	-0.243	-0.207	-0.293	-0.005	-0.077	0.335	0.263
(gov)	(0.612)	(0.434)	(0.446)	(0.676)	(0.435)	(0.443)	(0.443)	(0.666)	(0.666)
trade open.	-0.916	-0.858*	-0.812*	0.118	0.232	-0.190	-0.153	-0.495	-0.458
(to)	(0.671)	(0.499)	(0.464)	(0.665)	(0.393)	(0.374)	(0.372)	(0.636)	(0.629)
prod. growth	-0.121	0.151*	0.161**	0.022	0.003	0.115	0.104	0.166	0.155
(PG)	(0.132)	(0.078)	(0.073)	(0.149)	(0.096)	(0.094)	(0.093)	(0.138)	(0.136)
ner volatility	-0.028	-1.091***	-1.166***	-1.053***	-1.157***	-1.127***	-1.170***	-1.200***	-1.242***
(nerv)	(0.342)	(0.283)	(0.249)	(0.322)	(0.259)	(0.254)	(0.246)	(0.328)	(0.321)
financial int.	0.751	-0.129	-0.128	-0.946**	-0.866***	-0.593**	-0.640***	-0.652	-0.700*
(ifi)	(0.742)	(0.322)	(0.299)	(0.398)	(0.267)	(0.251)	(0.243)	(0.416)	(0.404)
geo. distance	0.521	0.731***	0.571**	0.707	0.703***	0.408	0.433*	0.333	0.359
(dist)	(0.338)	(0.280)	(0.242)	(0.462)	(0.268)	(0.259)	(0.264)	(0.409)	(0.414)
Observations	42	42	42	42	42	42	42	42	42
R ²	0.41	0.58	0.64	0.44	0.58	0.59	0.60	0.50	0.51
<i>Developing Countries</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.354***	-0.162	-0.272	-0.504***	-0.286**	-0.280*	-0.290**	-0.500***	-0.509***
(inf)	(0.124)	(0.168)	(0.174)	(0.148)	(0.141)	(0.144)	(0.143)	(0.151)	(0.149)
govt. exp.	-0.079	-1.328***	-1.189**	-0.197	-0.676	-0.539	-0.619	-0.217	-0.297
(gov)	(0.532)	(0.511)	(0.492)	(0.540)	(0.459)	(0.474)	(0.463)	(0.542)	(0.535)
trade open.	0.283	-0.009	-0.110	-0.398	-0.132	-0.096	-0.145	-0.277	-0.326
(to)	(0.379)	(0.421)	(0.458)	(0.448)	(0.417)	(0.437)	(0.413)	(0.479)	(0.462)
prod. growth	-0.104**	-0.006	-0.003	-0.077*	0.005	-0.007	-0.005	-0.077*	-0.074*
(PG)	(0.053)	(0.049)	(0.057)	(0.043)	(0.039)	(0.041)	(0.040)	(0.041)	(0.040)
ner volatility	-0.485***	-0.713***	-0.818***	-0.489**	-0.619***	-0.653***	-0.618***	-0.596***	-0.561**
(nerv)	(0.182)	(0.226)	(0.235)	(0.237)	(0.223)	(0.233)	(0.232)	(0.231)	(0.228)
financial int.	-0.314	1.061***	0.813*	0.995**	0.881**	0.718*	0.819**	0.893**	0.994**
(ifi)	(0.286)	(0.402)	(0.429)	(0.406)	(0.383)	(0.431)	(0.397)	(0.427)	(0.404)
geo. distance	0.237	0.979***	0.861***	0.889***	0.756***	0.732***	0.764***	0.900***	0.932***
(dist)	(0.201)	(0.257)	(0.262)	(0.298)	(0.252)	(0.254)	(0.250)	(0.301)	(0.296)
Observations	76	76	76	76	76	76	76	76	76
R ²	0.40	0.45	0.48	0.48	0.46	0.44	0.45	0.49	0.49

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
The dependent variable is the natural logarithm of the bilateral real exchange rate (BRER) half-life. The half-life is our measure of persistence. All regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

Table 3.7: BRER-based cross-section regression results by income group

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR TF max. half-life	augmented ESTAR TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
<i>High Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.259	-0.297	-0.309	-0.522*	-0.078	-0.037	-0.030	-0.345	-0.337
(inf)	(0.380)	(0.187)	(0.208)	(0.278)	(0.150)	(0.136)	(0.136)	(0.303)	(0.307)
govt. exp.	-0.558	0.807	0.747	0.526	0.454	0.967	0.899	1.506*	1.438*
(gov)	(0.780)	(0.544)	(0.580)	(0.875)	(0.668)	(0.620)	(0.616)	(0.822)	(0.816)
trade open.	1.100*	-0.530	-0.640*	-0.411	-0.620	-0.631	-0.631	-0.588	-0.588
(to)	(0.635)	(0.328)	(0.356)	(0.495)	(0.389)	(0.392)	(0.388)	(0.557)	(0.552)
prod. growth	-0.248*	0.182*	0.167*	0.065	0.127	0.238**	0.230**	0.256**	0.248**
(PG)	(0.141)	(0.094)	(0.101)	(0.163)	(0.122)	(0.097)	(0.094)	(0.108)	(0.105)
ner volatility	-0.494	-1.061***	-1.078***	-0.567	-0.884**	-1.051***	-1.044***	-1.069***	-1.062***
(nerv)	(0.618)	(0.240)	(0.241)	(0.448)	(0.416)	(0.298)	(0.298)	(0.259)	(0.258)
financial int.	-0.163	0.047	0.103	-0.011	0.075	0.101	0.103	-0.005	-0.003
(ifi)	(0.345)	(0.169)	(0.175)	(0.254)	(0.238)	(0.194)	(0.194)	(0.252)	(0.251)
geo. distance	-0.130	-0.004	0.018	-0.033	-0.034	-0.195	-0.206	-0.187	-0.198
(dist)	(0.330)	(0.282)	(0.287)	(0.587)	(0.415)	(0.287)	(0.286)	(0.352)	(0.351)
Observations	40	40	40	40	40	40	40	40	40
R ²	0.30	0.65	0.65	0.32	0.40	0.53	0.53	0.46	0.46
<i>Middle Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.588***	-0.008	-0.167	-0.497**	-0.231	-0.240	-0.228	-0.518**	-0.506**
(inf)	(0.143)	(0.194)	(0.207)	(0.215)	(0.194)	(0.186)	(0.191)	(0.211)	(0.214)
govt. exp.	0.068	-0.473	-0.485	0.483	-0.098	-0.010	-0.114	0.311	0.206
(gov)	(0.460)	(0.432)	(0.463)	(0.647)	(0.492)	(0.477)	(0.487)	(0.646)	(0.653)
trade open.	-0.646**	-1.015**	-1.197**	-1.024*	-0.853*	-0.972**	-0.955**	-1.183**	-1.166**
(to)	(0.316)	(0.491)	(0.497)	(0.598)	(0.498)	(0.462)	(0.474)	(0.570)	(0.580)
prod. growth	-0.049	0.004	0.042	-0.045	0.007	0.010	0.000	-0.039	-0.048
(PG)	(0.060)	(0.057)	(0.063)	(0.064)	(0.057)	(0.056)	(0.056)	(0.061)	(0.061)
ner volatility	-0.270	-0.824***	-0.910***	-0.648**	-0.728***	-0.767***	-0.771***	-0.774***	-0.778***
(nerv)	(0.187)	(0.272)	(0.258)	(0.298)	(0.262)	(0.255)	(0.263)	(0.287)	(0.294)
financial int.	-0.104	0.837	0.893*	0.767	0.673	0.739	0.726	0.916	0.904
(ifi)	(0.303)	(0.575)	(0.541)	(0.637)	(0.554)	(0.532)	(0.542)	(0.600)	(0.608)
geo. distance	0.454**	0.924***	0.752***	0.749***	0.727***	0.684***	0.735***	0.803***	0.853***
(dist)	(0.196)	(0.233)	(0.224)	(0.290)	(0.232)	(0.223)	(0.230)	(0.282)	(0.288)
Observations	73	73	73	73	73	73	73	73	73
R ²	0.47	0.43	0.51	0.46	0.46	0.49	0.48	0.50	0.50
<i>Low Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	0.011	-0.024	-0.010	-0.175	-0.133	-0.131	-0.121	-0.151	-0.140
(inf)	(0.198)	(0.279)	(0.286)	(0.239)	(0.236)	(0.258)	(0.246)	(0.266)	(0.251)
govt. exp.	-0.171	-1.203	-0.517	-0.068	-0.245	-0.031	-0.204	-0.004	-0.177
(gov)	(0.834)	(1.136)	(1.081)	(0.985)	(0.944)	(1.028)	(0.976)	(1.060)	(1.005)
trade open.	1.053**	0.637	0.944	0.429	0.429	0.722	0.506	0.586	0.370
(to)	(0.463)	(0.709)	(0.696)	(0.660)	(0.638)	(0.716)	(0.656)	(0.725)	(0.658)
prod. growth	-0.023	0.115	0.081	0.139	0.116	0.015	0.094	0.097	0.176
(PG)	(0.135)	(0.169)	(0.191)	(0.137)	(0.113)	(0.153)	(0.123)	(0.165)	(0.134)
ner volatility	-1.205***	-1.139*	-1.090*	-0.406	-0.481	-0.640	-0.573	-0.567	-0.500
(nerv)	(0.265)	(0.625)	(0.584)	(0.565)	(0.554)	(0.630)	(0.592)	(0.648)	(0.609)
financial int.	-0.483	0.795	-0.086	0.261	0.304	-0.233	0.120	-0.072	0.280
(ifi)	(0.453)	(0.788)	(0.796)	(0.652)	(0.625)	(0.778)	(0.656)	(0.773)	(0.631)
geo. distance	0.225	0.864*	0.707	0.298	0.283	0.460	0.341	0.410	0.291
(dist)	(0.496)	(0.509)	(0.571)	(0.512)	(0.423)	(0.495)	(0.433)	(0.537)	(0.472)
Observations	25	25	25	25	25	25	25	25	25
R ²	0.55	0.42	0.38	0.30	0.29	0.30	0.30	0.29	0.31

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The dependent variable is the natural logarithm of the bilateral real exchange rate (BRER) half-life. The half-life is our measure of persistence. All other regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

Table 3.8: REER-based cross-section regression results by economic development group

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR model TF max. half-life	augmented ESTAR model TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
<i>Industrial</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	0.255	-0.727**	-0.694**	-1.138***	-0.781**	-0.822**	-0.829***	-1.138***	-1.144***
(inf)	(0.266)	(0.276)	(0.295)	(0.292)	(0.314)	(0.313)	(0.297)	(0.339)	(0.322)
govt. exp.	0.119	-3.562***	-3.227***	-1.322	-1.890*	-2.214**	-2.173**	-2.027	-1.986
(gov)	(0.770)	(0.764)	(0.707)	(1.456)	(0.968)	(0.921)	(0.870)	(1.618)	(1.559)
trade open.	-0.387	-0.563	-0.588	-1.186*	-0.544	-0.408	-0.418	-1.013	-1.023
(to)	(0.449)	(0.536)	(0.497)	(0.710)	(0.503)	(0.495)	(0.476)	(0.724)	(0.701)
prod. growth	0.171	0.656***	0.685***	0.254	0.257	0.331	0.336	0.402	0.408
(PG)	(0.248)	(0.215)	(0.222)	(0.207)	(0.224)	(0.234)	(0.226)	(0.326)	(0.314)
ner volatility	-0.080	-1.174***	-1.186***	-1.256**	-0.720*	-0.649*	-0.589*	-1.389**	-1.328**
(nerv)	(0.352)	(0.285)	(0.287)	(0.575)	(0.399)	(0.366)	(0.340)	(0.616)	(0.584)
financial int.	-0.016	-0.367**	-0.383*	-0.261	-0.246	-0.307	-0.285	-0.455*	-0.433*
(ifi)	(0.227)	(0.177)	(0.192)	(0.251)	(0.221)	(0.209)	(0.198)	(0.266)	(0.250)
Observations	23	23	23	23	23	23	23	23	23
R ²	0.27	0.65	0.65	0.73	0.57	0.56	0.59	0.63	0.65
<i>Emerging</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.272	-0.210	-0.210	-0.157	0.048	-0.094	-0.082	-0.149	-0.137
(inf)	(0.293)	(0.257)	(0.239)	(0.254)	(0.270)	(0.211)	(0.210)	(0.254)	(0.254)
govt. exp.	0.727	-1.381*	-1.637*	-1.265	-1.176	-0.617	-0.631	-1.204	-1.219
(gov)	(0.905)	(0.824)	(0.824)	(0.848)	(0.915)	(0.638)	(0.627)	(0.791)	(0.782)
trade open.	-0.679	-0.393	-0.421	0.211	0.498	-0.140	-0.127	0.049	0.063
(to)	(0.794)	(0.752)	(0.738)	(0.752)	(0.739)	(0.643)	(0.640)	(0.722)	(0.720)
prod. growth	0.061	-0.088	-0.119	0.000	0.021	0.007	0.009	-0.003	-0.001
(PG)	(0.107)	(0.159)	(0.162)	(0.137)	(0.138)	(0.129)	(0.130)	(0.137)	(0.138)
ner volatility	-0.334	-0.224	-0.195	-0.170	-0.211	-0.282	-0.286	-0.198	-0.202
(nerv)	(0.524)	(0.560)	(0.551)	(0.501)	(0.512)	(0.445)	(0.442)	(0.492)	(0.490)
financial int.	-0.256	0.221	0.253	-0.031	0.080	0.039	0.037	0.001	-0.001
(ifi)	(0.698)	(0.696)	(0.673)	(0.771)	(0.708)	(0.609)	(0.607)	(0.730)	(0.728)
Observations	25	26	26	26	26	26	26	26	26
R ²	0.23	0.27	0.29	0.29	0.26	0.22	0.22	0.28	0.28
<i>Developing</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.347**	0.225*	0.172	0.121	0.278**	0.218*	0.232*	0.102	0.116
(inf)	(0.140)	(0.132)	(0.125)	(0.160)	(0.127)	(0.122)	(0.123)	(0.149)	(0.153)
govt. exp.	-0.041	0.348	0.487	1.478***	0.594	0.462	0.483	1.641***	1.663***
(gov)	(0.602)	(0.596)	(0.559)	(0.548)	(0.429)	(0.464)	(0.514)	(0.494)	(0.525)
trade open.	-0.429	-0.683	-0.553	-0.584	-1.182***	-0.611	-0.719	-0.143	-0.251
(to)	(0.386)	(0.608)	(0.594)	(0.506)	(0.399)	(0.597)	(0.578)	(0.573)	(0.553)
prod. growth	-0.055	0.058	0.049	0.018	0.129***	0.097**	0.105**	-0.028	-0.020
(PG)	(0.041)	(0.049)	(0.046)	(0.071)	(0.042)	(0.043)	(0.046)	(0.067)	(0.070)
ner volatility	-0.129	-1.048***	-0.966***	-0.844***	-0.984***	-0.890***	-0.930***	-0.856***	-0.895***
(nerv)	(0.221)	(0.181)	(0.169)	(0.164)	(0.149)	(0.169)	(0.175)	(0.166)	(0.169)
financial int.	0.446	0.508*	0.447	0.485**	0.665***	0.413*	0.466*	0.198	0.252
(ifi)	(0.500)	(0.299)	(0.297)	(0.219)	(0.185)	(0.248)	(0.251)	(0.233)	(0.229)
Observations	42	42	42	42	42	42	42	42	42
R ²	0.33	0.52	0.53	0.57	0.58	0.51	0.51	0.61	0.61

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
The dependent variable is the natural logarithm of the real effective exchange rate (REER) half-life. The half-life is our measure of persistence. All regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

Table 3.9: REER-based cross-section regression results by income group

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR model TF max. half-life	augmented ESTAR model TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
<i>High Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.588**	-0.532*	-0.560*	-0.776*	-0.408	-0.509**	-0.499**	-0.700	-0.690
(ifi)	(0.262)	(0.291)	(0.300)	(0.464)	(0.348)	(0.249)	(0.248)	(0.460)	(0.462)
govt. exp.	0.066	-1.544*	-1.430*	-1.142	-1.712*	-0.968	-1.016	-1.101	-1.149
(gov)	(0.738)	(0.825)	(0.846)	(1.005)	(1.042)	(0.744)	(0.727)	(1.022)	(1.005)
trade open.	0.525	-0.187	-0.243	0.180	0.177	-0.255	-0.251	-0.090	-0.087
(to)	(0.418)	(0.348)	(0.346)	(0.456)	(0.388)	(0.322)	(0.310)	(0.464)	(0.453)
prod. growth	-0.248**	-0.269**	-0.281**	-0.182**	-0.203***	-0.179***	-0.179***	-0.156*	-0.156*
(PG)	(0.123)	(0.117)	(0.129)	(0.075)	(0.063)	(0.058)	(0.056)	(0.088)	(0.086)
ner volatility	0.570	-0.037	-0.067	-0.189	-0.193	-0.074	-0.060	-0.279	-0.264
(nerv)	(0.340)	(0.454)	(0.469)	(0.446)	(0.386)	(0.342)	(0.335)	(0.479)	(0.472)
financial int.	-0.066	0.096	0.100	-0.325**	-0.187	0.005	0.012	-0.275**	-0.268**
(ifi)	(0.190)	(0.148)	(0.165)	(0.139)	(0.172)	(0.148)	(0.146)	(0.132)	(0.130)
Observations	36	37	37	37	37	37	37	37	37
R ²	0.23	0.44	0.44	0.44	0.38	0.47	0.48	0.40	0.41
<i>Middle Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.400***	-0.073	-0.092	-0.136	0.114	0.039	0.058	-0.176	-0.157
(inf)	(0.152)	(0.145)	(0.139)	(0.160)	(0.154)	(0.143)	(0.145)	(0.150)	(0.151)
govt. exp.	0.326	0.862	0.910	1.836**	0.782	0.795	0.735	2.208***	2.148***
(gov)	(0.623)	(0.733)	(0.696)	(0.730)	(0.697)	(0.766)	(0.784)	(0.706)	(0.714)
trade open.	-0.549	-1.366**	-1.244**	-1.391***	-1.012**	-0.625	-0.703	-1.138**	-1.215**
(to)	(0.471)	(0.606)	(0.591)	(0.450)	(0.504)	(0.561)	(0.570)	(0.486)	(0.492)
prod. growth	0.010	0.128**	0.134**	0.093	0.171***	0.161***	0.157***	0.070	0.066
(PG)	(0.056)	(0.058)	(0.055)	(0.066)	(0.056)	(0.052)	(0.053)	(0.058)	(0.057)
ner volatility	-0.003	-0.932***	-0.864***	-0.830***	-0.854***	-0.745***	-0.800***	-0.835***	-0.890***
(nerv)	(0.265)	(0.234)	(0.211)	(0.206)	(0.208)	(0.210)	(0.227)	(0.203)	(0.211)
financial int.	-0.260	0.171	0.074	0.284	0.394	0.027	0.133	-0.095	0.010
(ifi)	(0.515)	(0.494)	(0.489)	(0.356)	(0.399)	(0.445)	(0.461)	(0.388)	(0.391)
Observations	46	46	46	46	46	46	46	46	46
R ²	0.25	0.50	0.50	0.50	0.49	0.45	0.45	0.54	0.55
<i>Low Income</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	0.400	1.292	0.956	1.390	0.918	0.899*	0.934	1.343	1.378
(inf)	(0.450)	(0.697)	(0.566)	(0.702)	(0.168)	(0.077)	(0.252)	(0.469)	(0.643)
govt. exp.	-2.925	-1.190	-0.770	2.900	-2.466	-2.150	-2.757	3.713	3.106
(gov)	(2.988)	(4.633)	(3.758)	(4.667)	(1.117)	(0.515)	(1.672)	(3.117)	(4.275)
trade open.	-2.486	-2.241	-2.035	0.349	-3.820	-3.464*	-4.149	1.267	0.581
(to)	(2.347)	(3.640)	(2.952)	(3.666)	(0.877)	(0.404)	(1.314)	(2.449)	(3.358)
prod. growth	0.576	0.537	0.554	-0.290	0.854	0.763*	0.938	-0.524	-0.349
(PG)	(0.780)	(1.210)	(0.981)	(1.218)	(0.292)	(0.134)	(0.437)	(0.814)	(1.116)
ner volatility	-1.047	-2.105	-1.670	-2.459	-1.555*	-1.580**	-1.533*	-2.522*	-2.475
(nerv)	(0.424)	(0.657)	(0.533)	(0.662)	(0.158)	(0.073)	(0.237)	(0.442)	(0.606)
financial int.	3.777	2.663	3.156	-1.062	3.829	3.515*	4.119	-1.870	-1.267
(ifi)	(3.463)	(5.370)	(4.355)	(5.409)	(1.294)	(0.596)	(1.938)	(3.613)	(4.954)
Observations	8	8	8	8	8	8	8	8	8
R ²	0.82	0.79	0.84	0.82	0.98	0.99	0.97	0.91	0.85

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The dependent variable is the natural logarithm of the real effective exchange rate (REER) half-life. The half-life is our measure of persistence. All regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

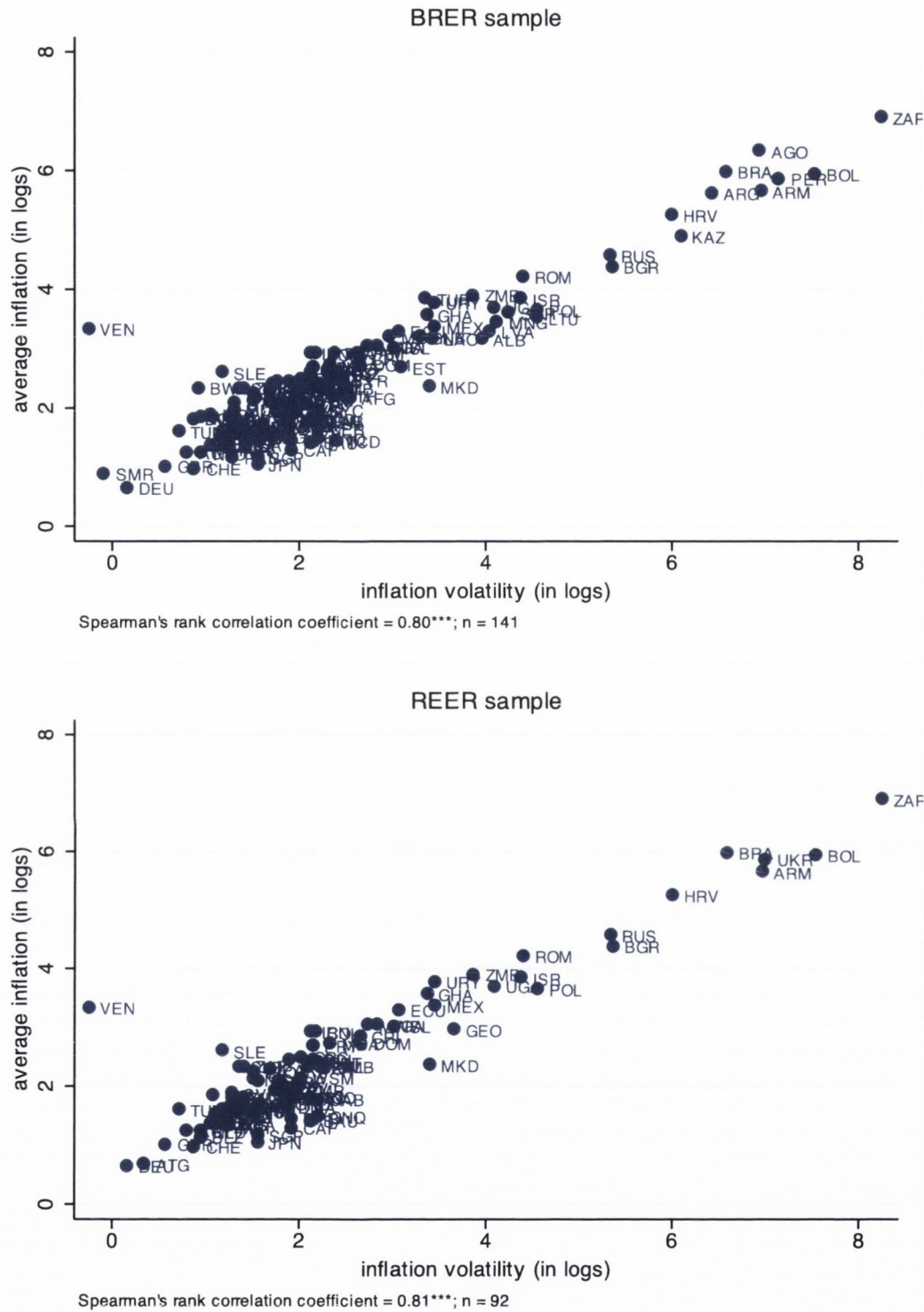
Table 3.10: Nominal exchange rate volatility, inflation, and real exchange rate persistence by nominal exchange rate regime

Nominal Exchange Rate Regime Classification (IMF, de jure)	Size	Average Nominal Exchange Rate Volatility	Median Nominal Exchange Rate Volatility	Average Inflation Rate	Median Inflation Rate	Average Selected Model II Half-Life	Median Selected Model II Half-Life
<i>BRER sample</i>							
Fixed	80	0.03	0.03	10.26	6.27	3.30	2.20
Intermediate	47	0.07	0.05	63.71	15.12	2.37	0.98
Flexible	14	0.09	0.04	100.55	11.69	2.37	1.55
Test of Equal Sub-Group Means/Medians		3.73** [0.04]	16.02*** [0.00]	2.13 [0.15]	25.07*** [0.00]	1.38 [0.25]	8.27*** [0.01]
<i>REER sample</i>							
Fixed	50	0.05	0.02	9.75	5.87	1.26	0.91
Intermediate	26	0.09	0.05	68.71	18.60	0.83	0.64
Flexible	17	0.11	0.04	82.93	10.18	1.45	0.90
Test of Equal Sub-Group Means/Medians		0.88 [0.43]	10.66*** [0.01]	1.79 [0.19]	18.37*** [0.00]	1.93 [0.16]	1.75 [0.42]
<i>Common Group: BRER sample</i>							
Fixed	47	0.03	0.03	10.14	5.89	2.92	2.52
Intermediate	23	0.06	0.05	61.63	18.32	2.66	0.98
Flexible	13	0.09	0.04	106.51	10.28	2.46	1.59
Test of Equal Sub-Group Means/Medians		2.60* [0.10]	10.22*** [0.01]	1.61 [0.23]	21.08*** [0.00]	0.11 [0.90]	7.90** [0.02]
<i>Common Group: REER sample</i>							
Fixed	47	0.05	0.02	10.14	5.89	1.26	0.81
Intermediate	23	0.09	0.05	61.63	18.32	0.81	0.53
Flexible	13	0.14	0.04	106.51	10.28	1.32	0.68
Test of Equal Sub-Group Means/Medians		0.99 [0.39]	7.18** [0.03]	1.61 [0.23]	21.08*** [0.00]	1.60 [0.22]	1.68 [0.43]

* significant at 10%; ** significant at 5%; *** significant at 1%

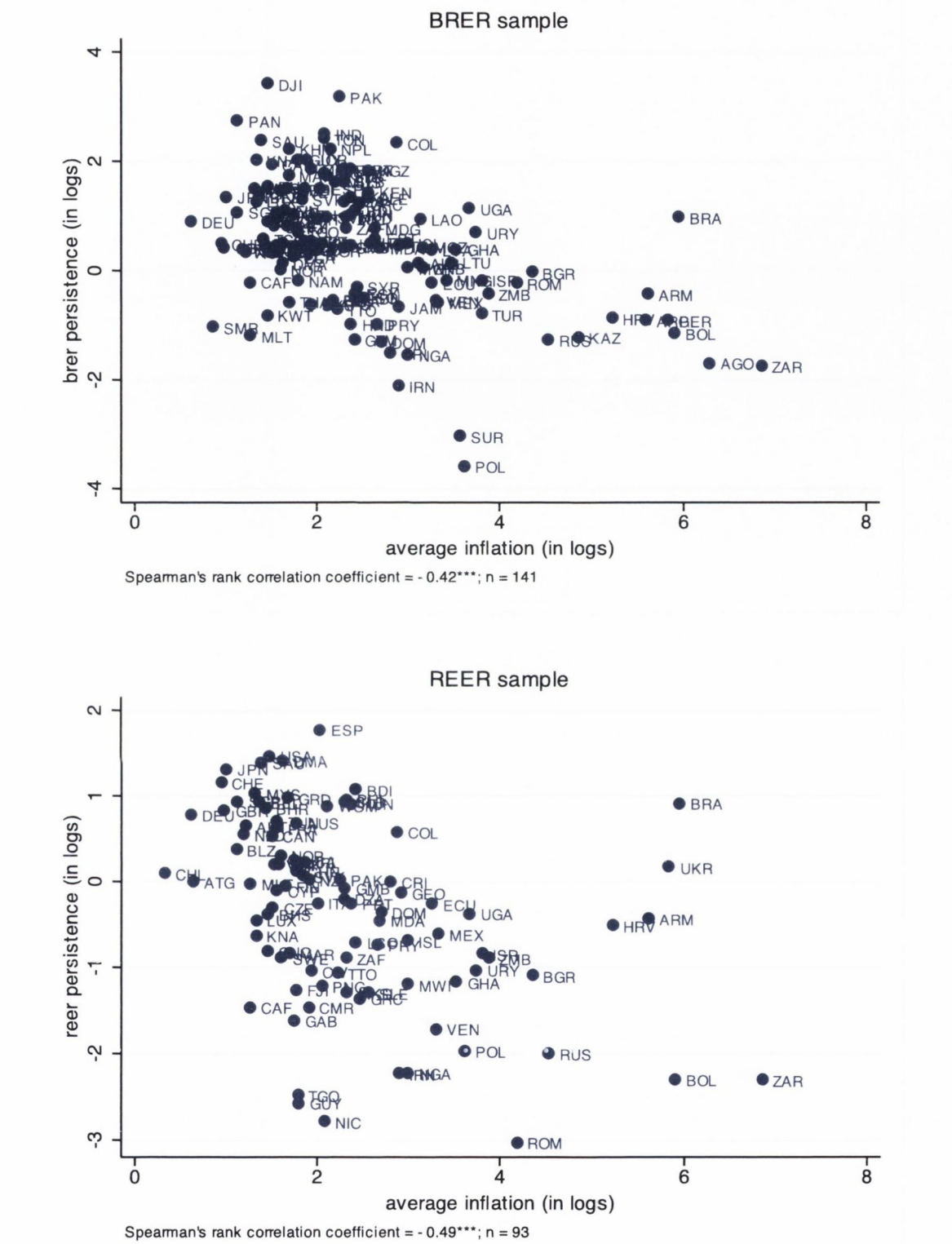
‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means. ‘Test of equal sub-group medians’ tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood’s median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood’s median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples. ‘Common group’ results refer to the sample of countries common to both bilateral real exchange rate (BRER) and real effective exchange rate (REER) series. A country is characterised by the nominal exchange rate regime that accounts for more than 50 percent of its total number of arrangement observations over the period, or alternatively by the typical type of regime prevailing over the period if the former rule does not apply. Selected Model II half-life (adopted from chapter 2): whenever nonlinear real exchange rate specification is chosen, monotonic half-life is based on mean of transition function (TF); and whenever linear real exchange rate specification is chosen, monotonic half-life is reported. Half-life is given in years.

Figure 3.1: Inflation Rate vs. Inflation Volatility



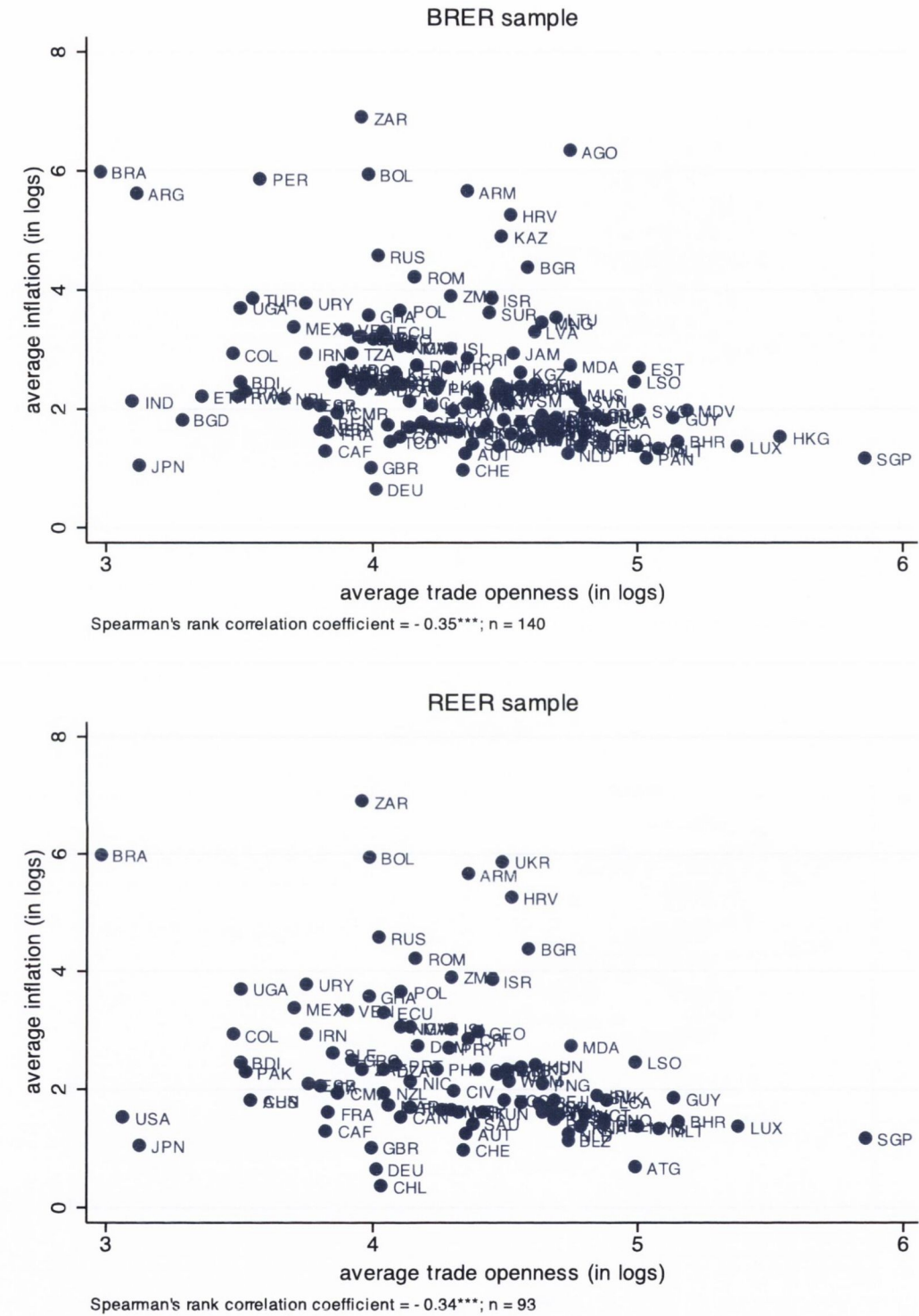
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973-2010. CPI-based inflation (%) is used. Inflation volatility is defined as the standard deviation of the annual inflation rate (by the definition employed for nominal exchange rate volatility, this is effectively CPI volatility). Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: 0 = “1”, 1 = “2.72” ($1 \times e$), 2 = “7.39” ($2.72 \times e$), 3 = “20.09” ($7.39 \times e$), 4 = “54.60” ($20.09 \times e$), 5 = “148.41” ($54.60 \times e$), 6 = “403.43” ($148.41 \times e$), 7 = “1096.63” ($403.43 \times e$), 8 = “2980.96” ($1096.63 \times e$).

Figure 3.2: Real Exchange Rate Persistence vs. Inflation Rate



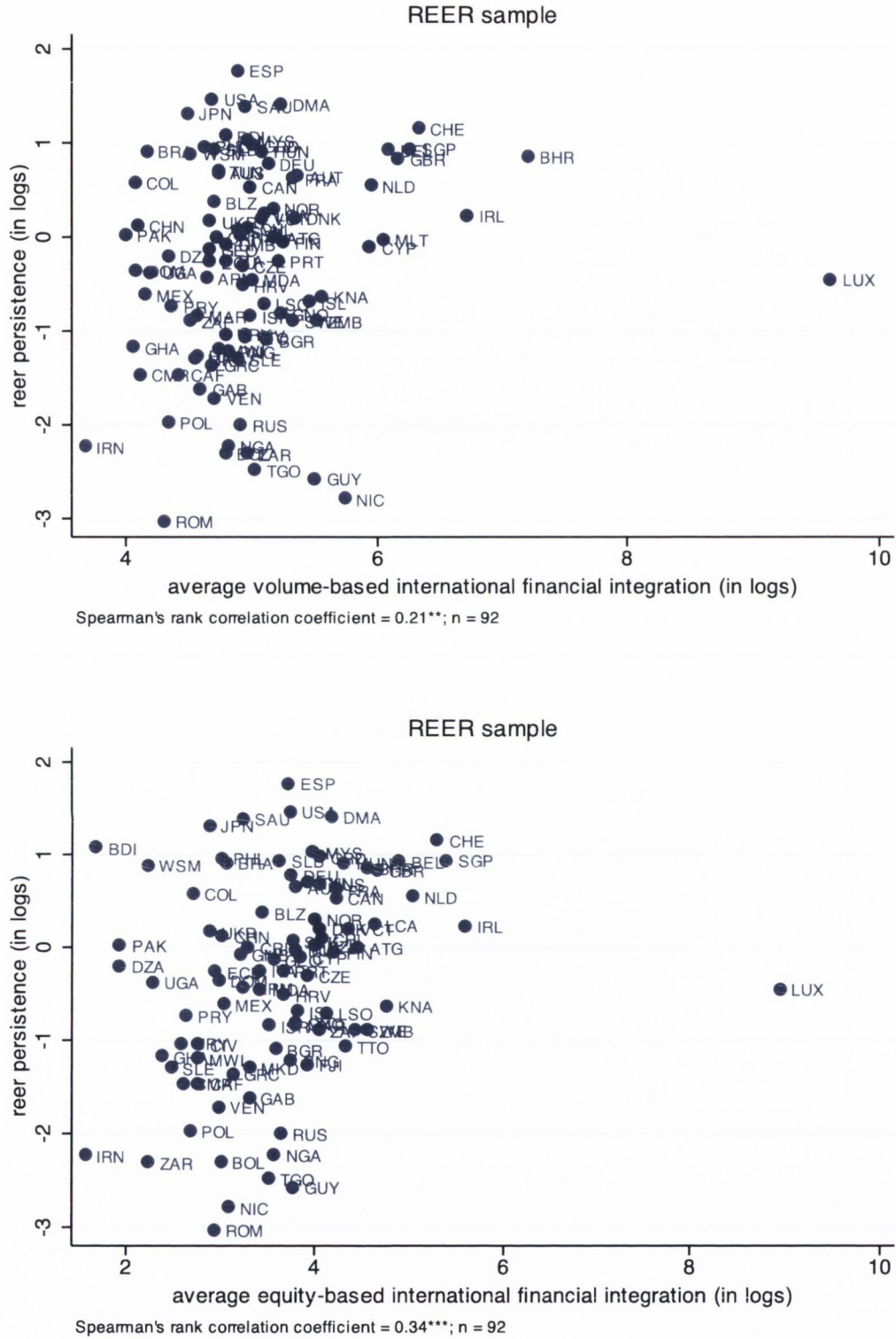
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973-2010. CPI-based inflation (%) is used. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = "0.02", -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e), 4 = "54.60" (20.09 x e), 5 = "148.41" (54.60 x e), 6 = "403.43" (148.41 x e), 7 = "1096.63" (403.43 x e).

Figure 3.3: Inflation Rate vs. Trade Openness



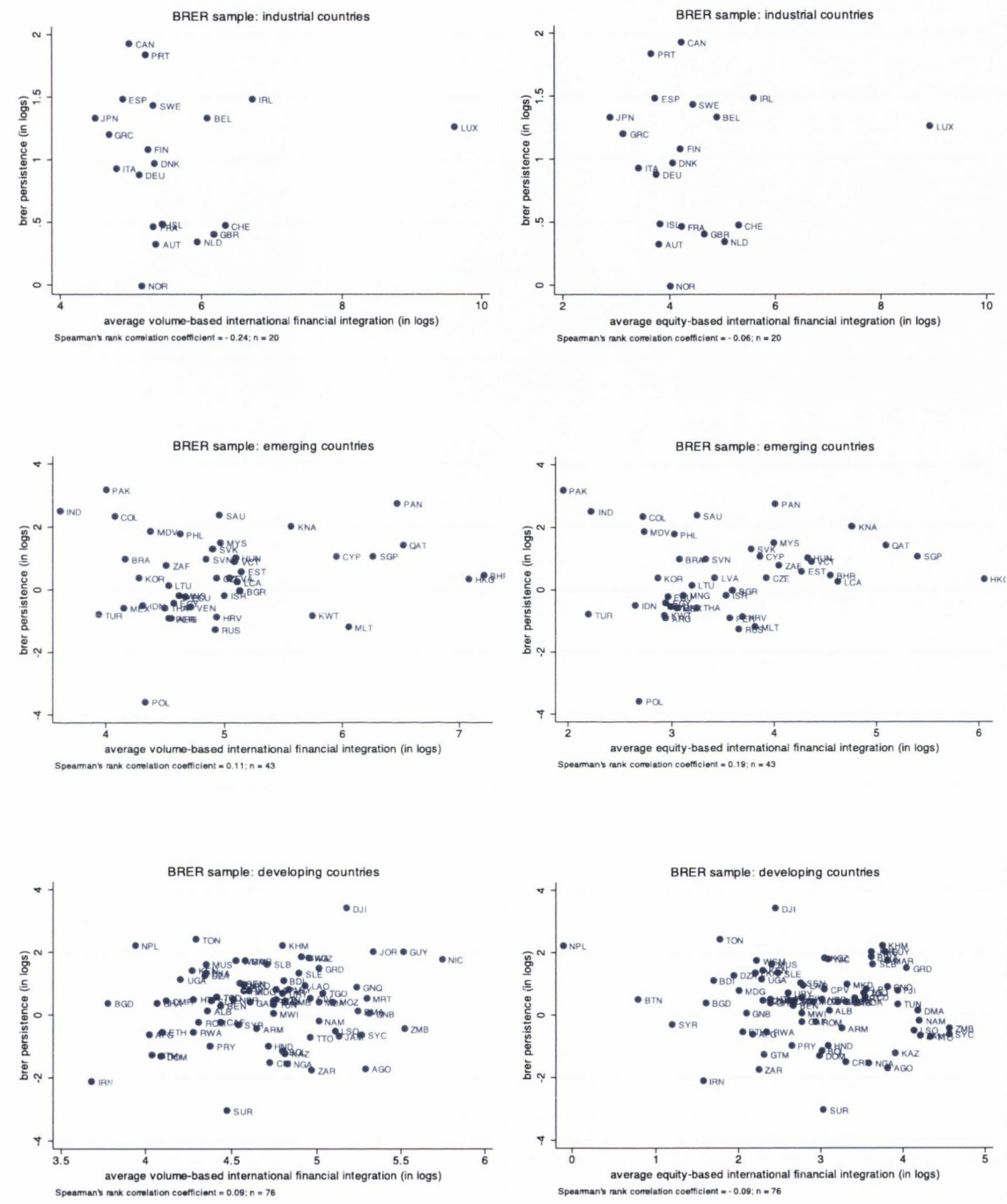
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973-2010. CPI-based inflation (%) is used. Trade openness is defined as exports plus imports expressed as a percentage share of GDP. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: 0 = “1”, 1 = “2.72” ($1 \times e$), 2 = “7.39” ($2.72 \times e$), 3 = “20.09” ($7.39 \times e$), 4 = “54.60” ($20.09 \times e$), 5 = “148.41” ($54.60 \times e$), 6 = “403.43” ($148.41 \times e$), 7 = “1096.63” ($403.43 \times e$), 8 = “2980.96” ($1096.63 \times e$).

Figure 3.5: Multilateral Real Exchange Rate Persistence vs. International Financial Integration



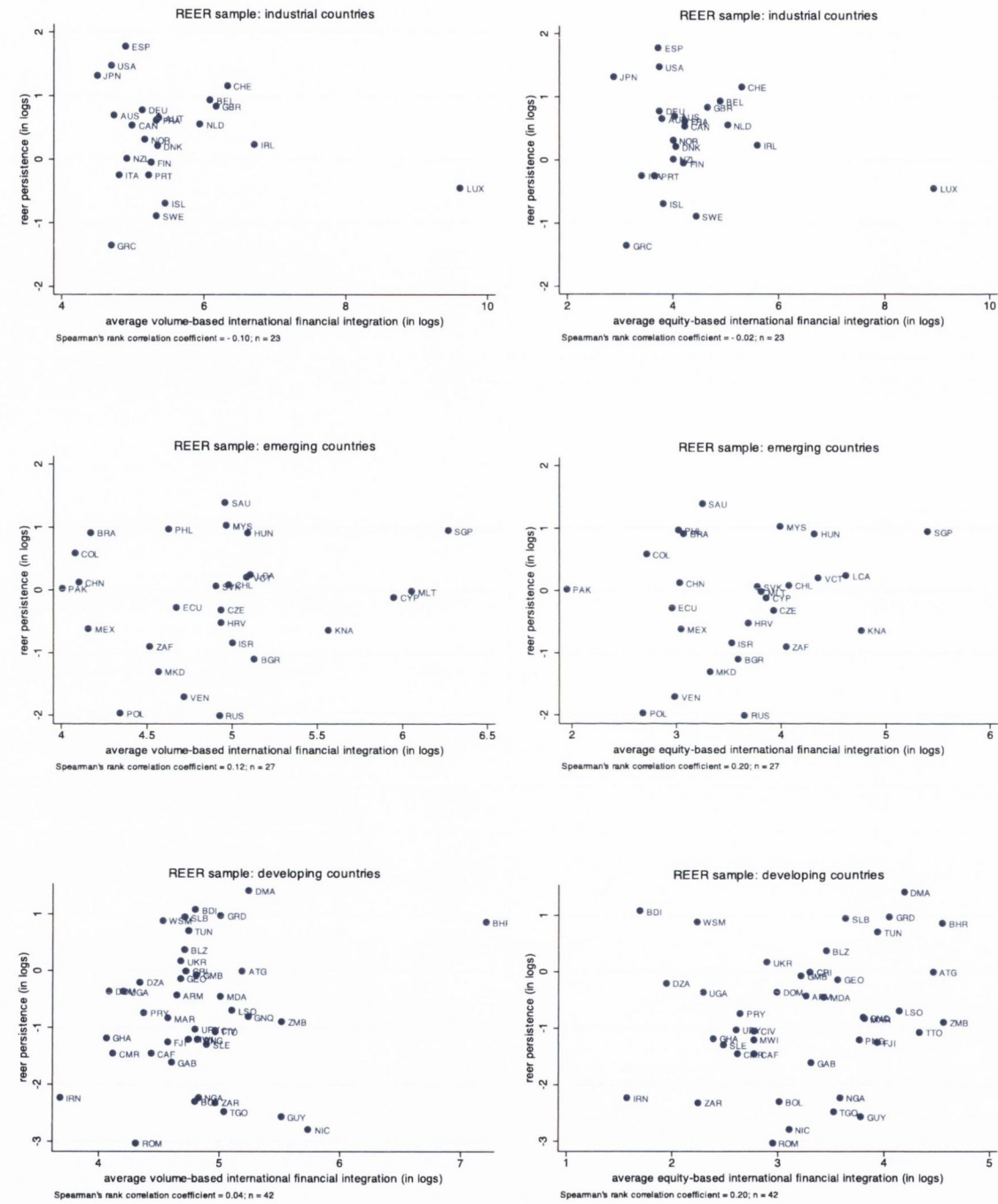
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function reported in non-linear case; monotonic half-life reported in linear case; half-life is given in years) of chapter 2. Volume (equity)-based integration is defined as total external assets (portfolio equity and FDI assets) plus total external liabilities (portfolio equity and FDI liabilities) expressed as a percentage of GDP. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -3 = “0.05”, -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e), 6 = “403.43” (148.41 x e), 7 = “1096.63” (403.43 x e), 8 = “2980.96” (1096.63 x e).

Figure 3.6: Bilateral Real Exchange Rate Persistence vs. International Financial Integration by stage of economic development



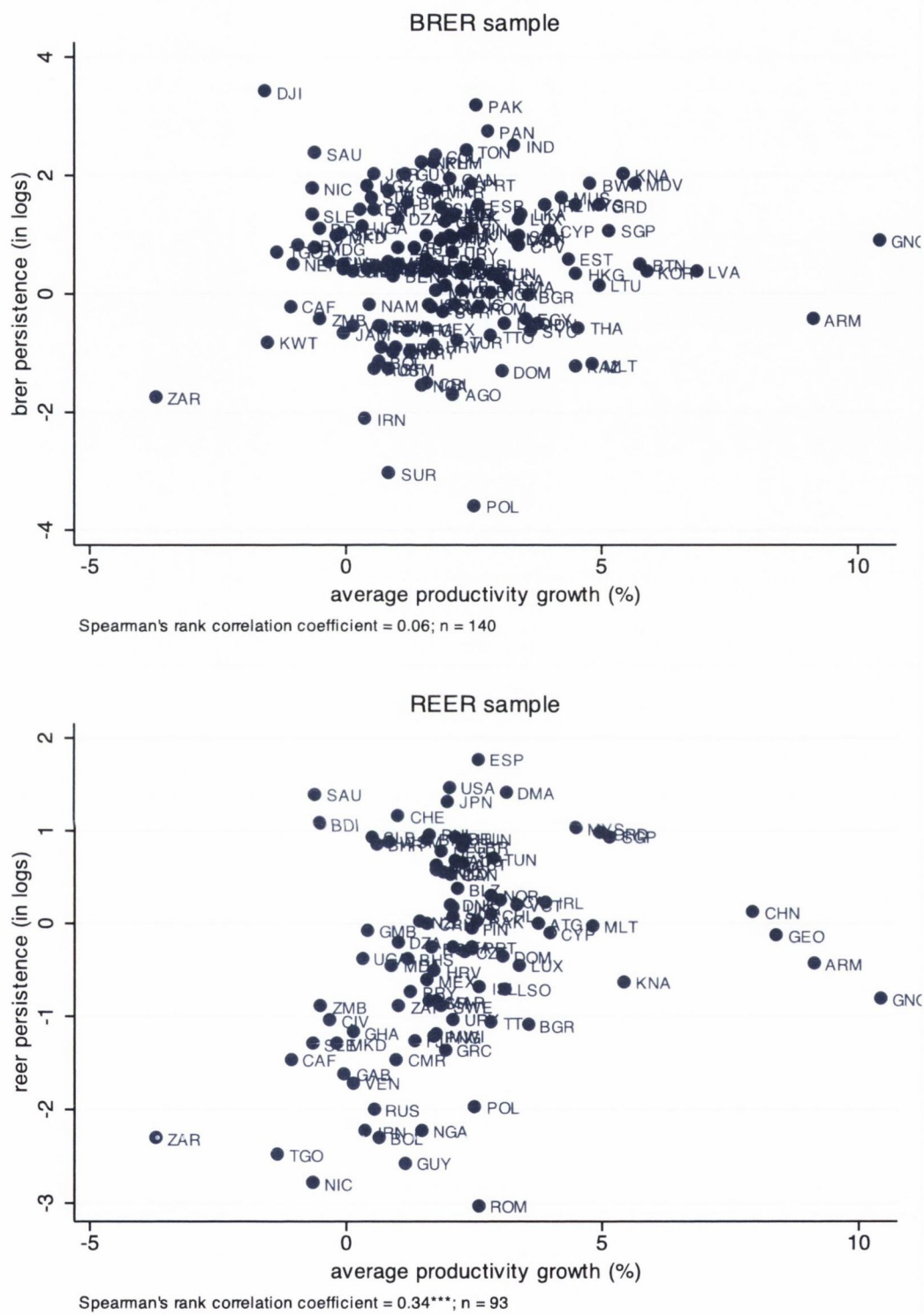
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. Volume (equity)-based integration is defined as total external assets (portfolio equity and FDI assets) plus total external liabilities (portfolio equity and FDI liabilities) expressed as a percentage of GDP. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e), 6 = “403.43” (148.41 x e), 7 = “1096.63” (403.43 x e), 8 = “2980.96” (1096.63 x e).

Figure 3.7: Multilateral Real Exchange Rate Persistence vs. International Financial Integration by stage of economic development



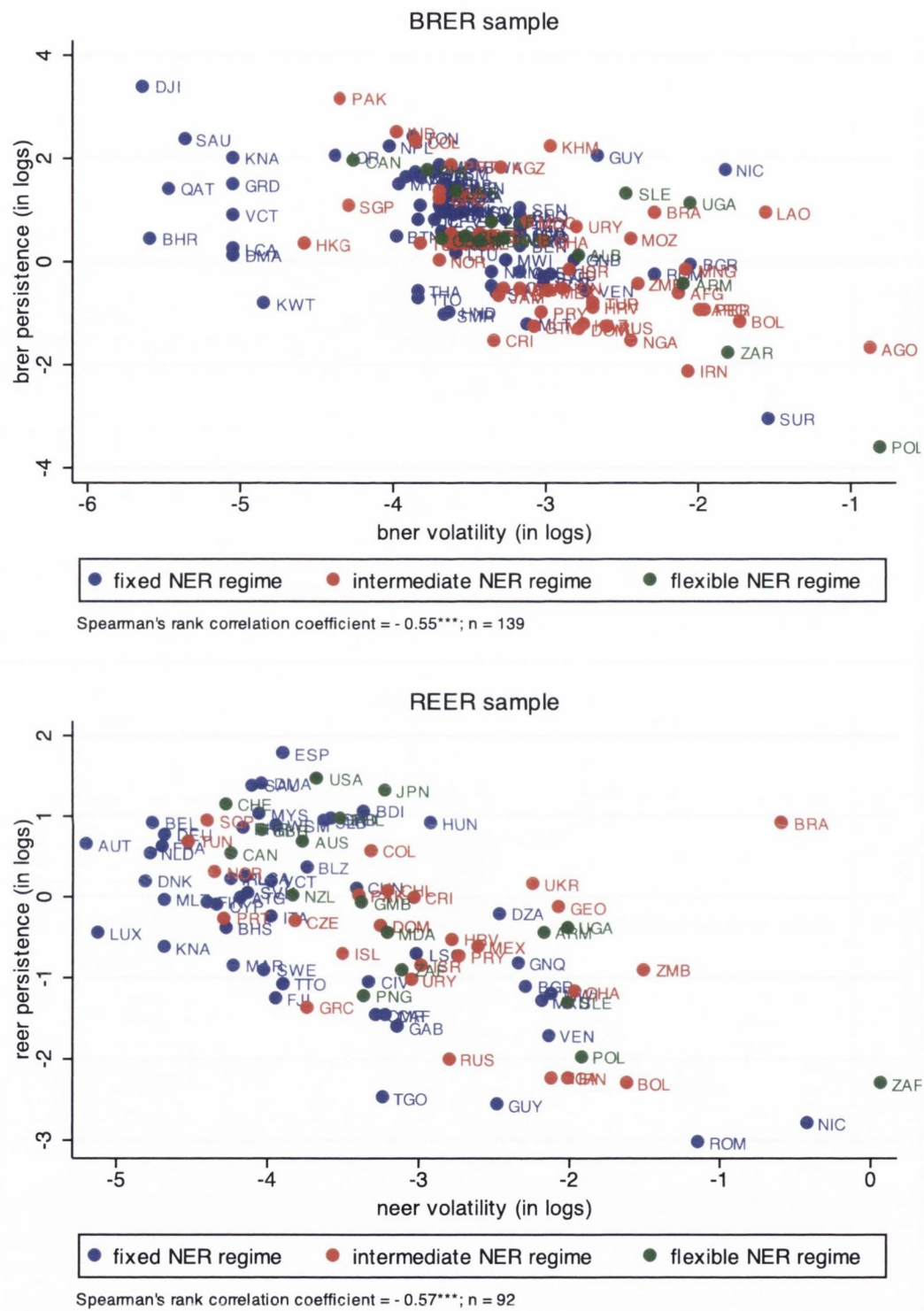
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973–2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. Volume (equity)-based integration is defined as total external assets (portfolio equity and FDI assets) plus total external liabilities (portfolio equity and FDI liabilities) expressed as a percentage of GDP. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -3 = “0.05”, -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e), 6 = “403.43” (148.41 x e), 7 = “1096.63” (403.43 x e), 8 = “2980.96” (1096.63 x e).

Figure 3.8: Real Exchange Rate Persistence vs. Productivity Growth



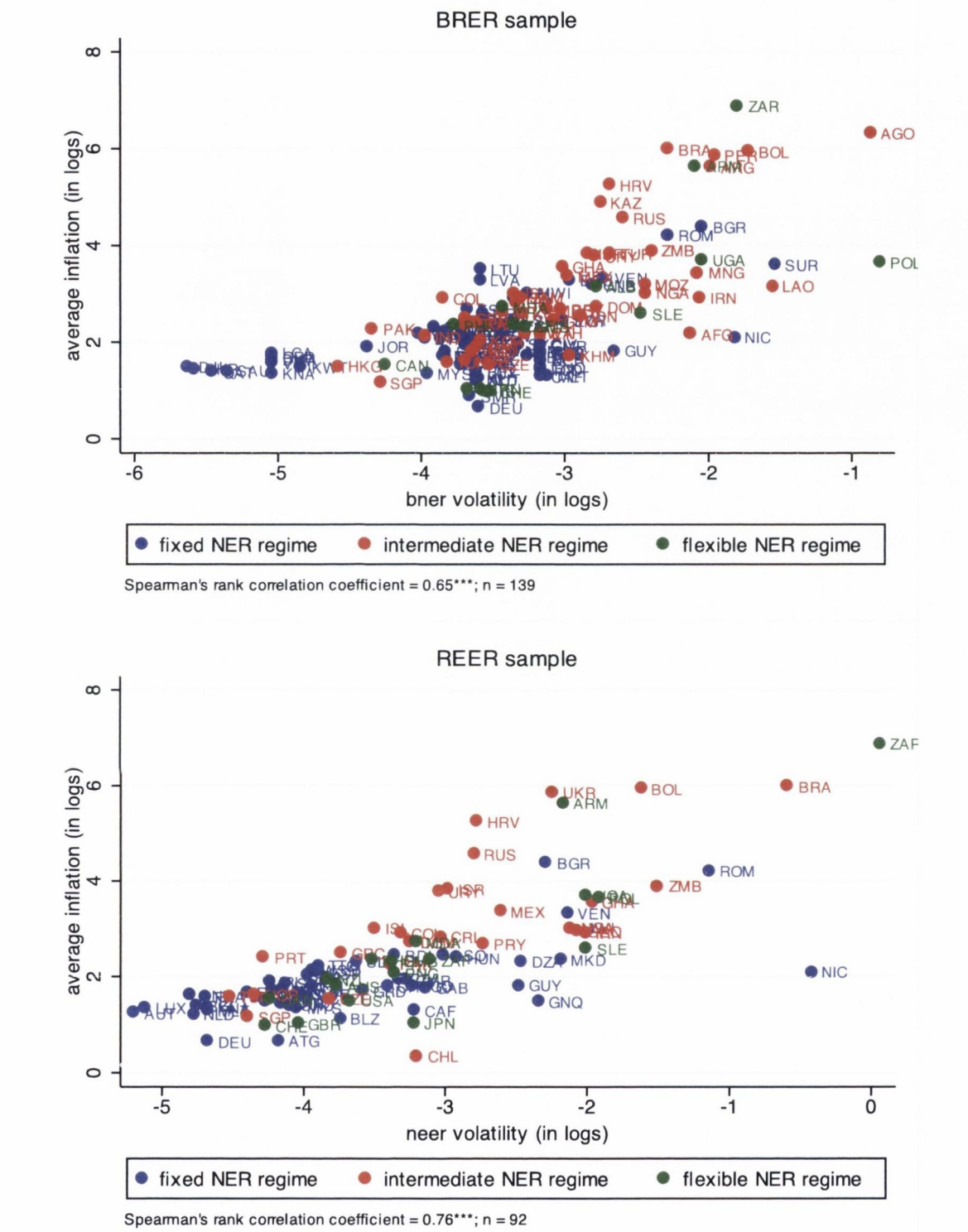
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. BRER denotes bilateral real exchange rate. REER denotes real effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. Productivity growth is proxied by per capita GDP growth. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e).

Figure 3.9: Real Exchange Rate Persistence vs. Nominal Exchange Rate Volatility



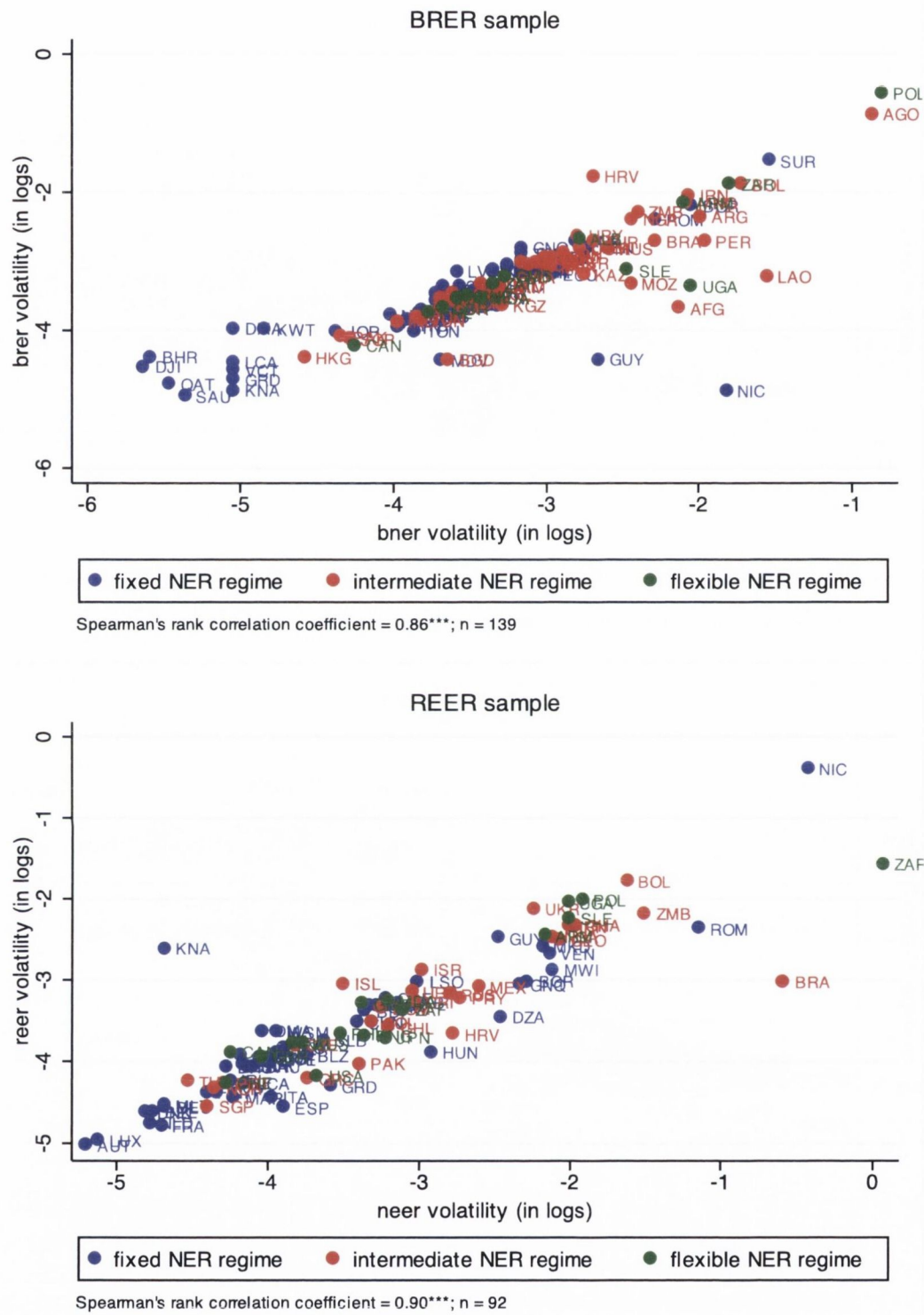
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. brer (bner) denotes bilateral real (nominal) exchange rate. reer (neer) denotes real (nominal) effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. Nominal exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -6 = “0.00”, -5 = “0.01” (0.00 x e), -4 = “0.02” (0.01 x e), -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e).

Figure 3.10: Inflation Rate vs. Nominal Exchange Rate Volatility



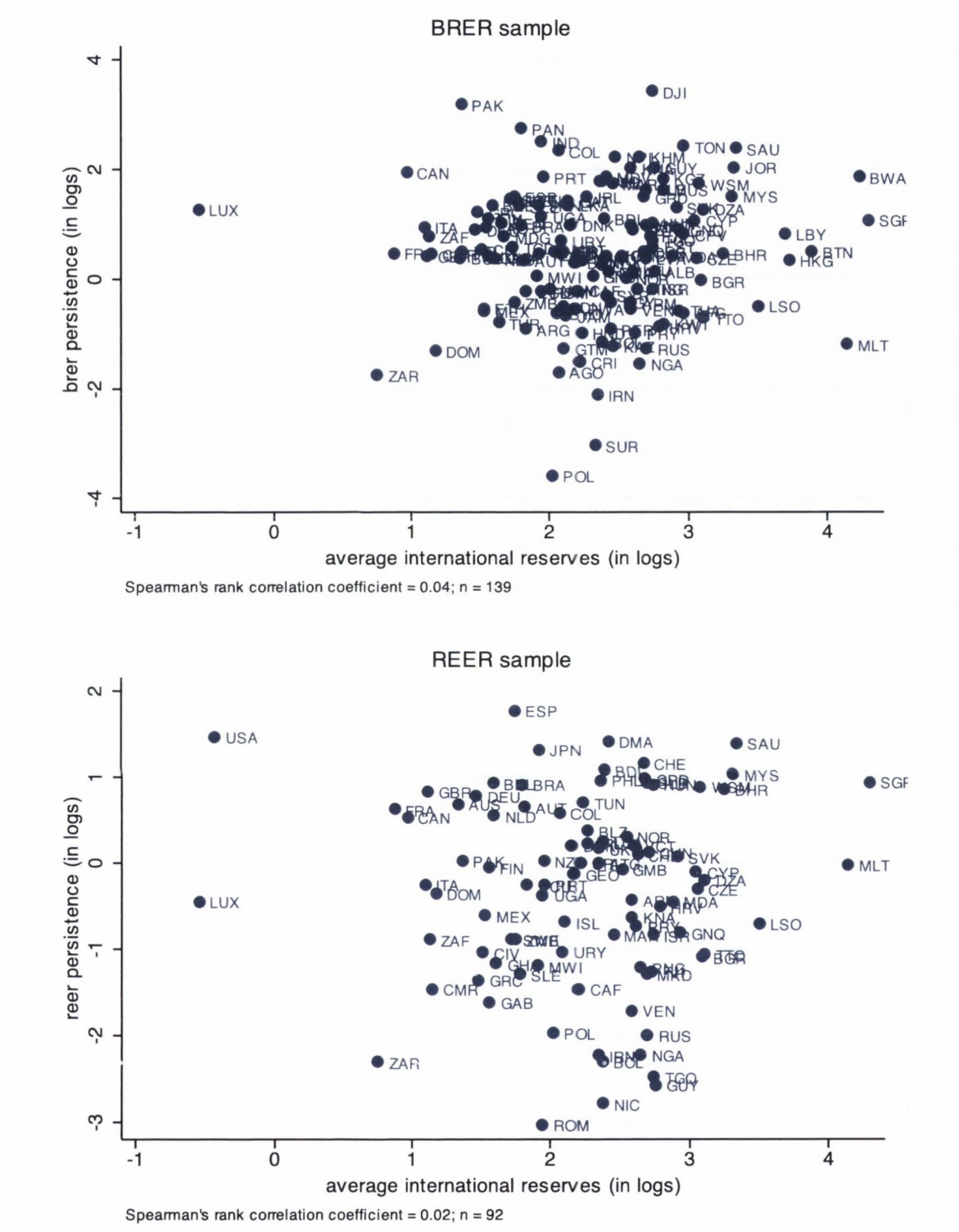
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. brer (bner) denotes bilateral real (nominal) exchange rate. reer (neer) denotes real (nominal) effective exchange rate. n is the country sample size. Time period: 1973-2010. CPI-based inflation (%) is used. Nominal exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -6 = "0.00", -5 = "0.01" (0.00 x e), -4 = "0.02" (0.01 x e), -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e), 4 = "54.60" (20.09 x e), 5 = "148.41" (54.60 x e), 6 = "403.43" (148.41 x e), 7 = "1096.63" (403.43 x e), 8 = "2980.96" (1096.63 x e).

Figure 3.11: Real Exchange Rate Volatility vs. Nominal Exchange Rate Volatility



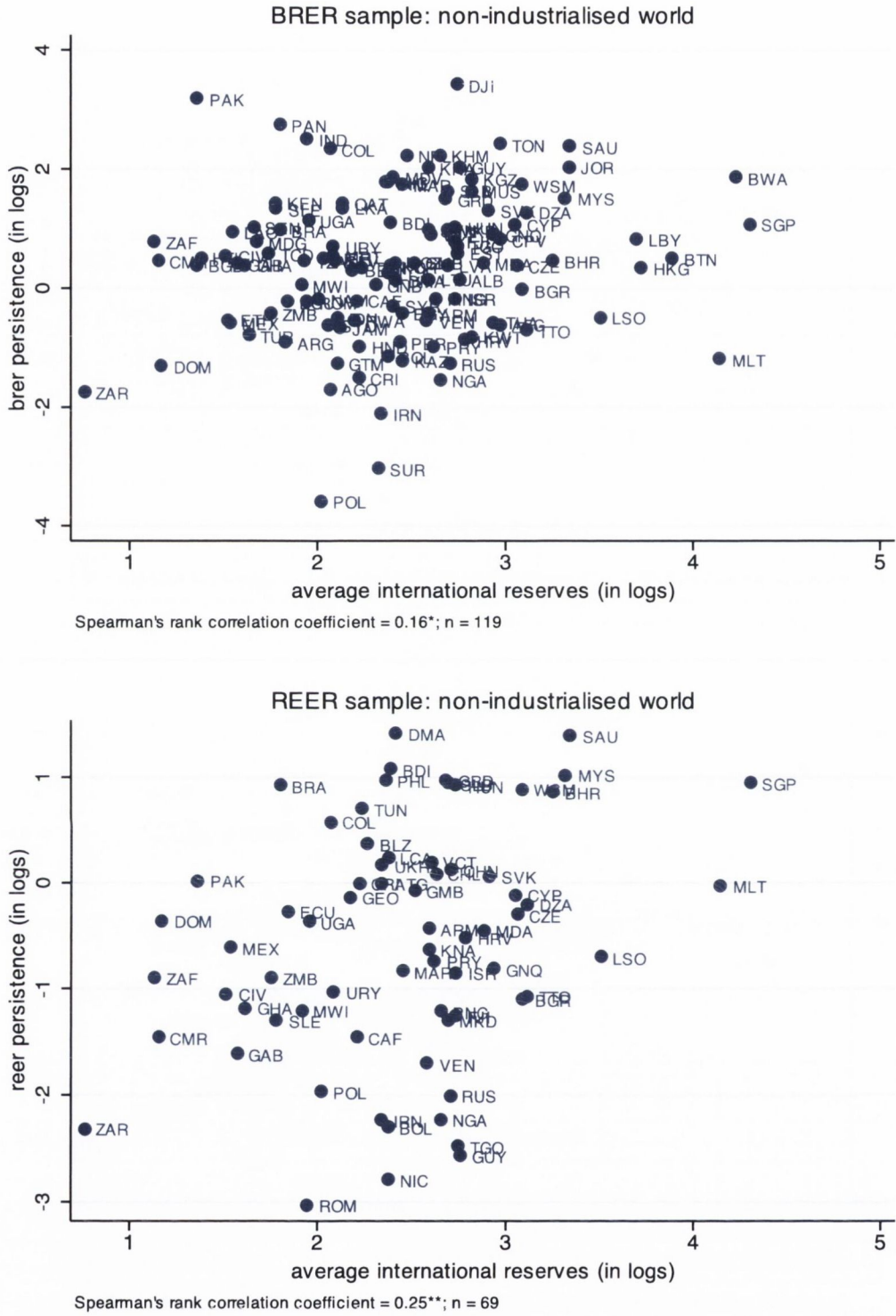
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. brer (bner) denotes bilateral real (nominal) exchange rate. reer (neer) denotes real (nominal) effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the monthly real exchange rate. Nominal exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -6 = “0.00”, -5 = “0.01” (0.00 x e), -4 = “0.02” (0.01 x e), -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e).

Figure 3.12: Real Exchange Rate Persistence vs. International Reserves



Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. brer (bner) denotes bilateral real (nominal) exchange rate. reer (neer) denotes real (nominal) effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. International reserves exclude gold holdings and are expressed as a percentage of GDP (source: EWN II). Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e).

Figure 3.13: Real Exchange Rate Persistence vs. International Reserves; non-industrialised world



Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. brer (bner) denotes bilateral real (nominal) exchange rate. reer (neer) denotes real (nominal) effective exchange rate. n is the country sample size. Time period: 1973-2010. Real exchange rate persistence is gauged by the selected model II half-life (monotonic half-life based on mean of transition function is reported in non-linear case; monotonic half-life is reported in linear case; half-life is given in years) of chapter 2. International reserves exclude gold holdings and are expressed as a percentage of GDP (source: EWN II). Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = “0.02”, -3 = “0.05” (0.02 x e), -2 = “0.14” (0.05 x e), -1 = “0.37” (0.14 x e), 0 = “1” (0.37 x e), 1 = “2.72” (1 x e), 2 = “7.39” (2.72 x e), 3 = “20.09” (7.39 x e), 4 = “54.60” (20.09 x e), 5 = “148.41” (54.60 x e).

3.10 Appendix A: Summary Statistics and Regressions for countries common to both BRER and REER series

Table A3.1: Means of Macroeconomic Variables for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	83	39.50	33.86	84.34	3.71, 1.43	1.92	0.05
Industrial	20	5.96	45.88	77.17	1019.36, 466.55	2.30	0.03
Emerging	26	39.57	33.20	99.75	214.45, 52.53	2.33	0.05
Developing	37	57.58	27.83	77.38	125.63, 30.16	1.42	0.06
Test of Equal Sub-Group Means		1.69 [0.19]	32.22*** [0.00]	1.82 [0.17]	1.32, 1.24 [0.29], [0.31]	2.94* [0.06]	2.31* [0.10]
High Income	35	12.95	42.21	98.29	724.70, 302.09	2.65	0.04
Middle Income	40	44.06	28.66	77.82	120.24, 34.00	1.78	0.05
Low Income	8	132.89	23.37	55.90	118.40, 16.10	-0.57	0.07
Test of Equal Sub-Group Means		0.90 [0.44]	34.83*** [0.00]	4.82*** [0.01]	1.87, 1.44 [0.17], [0.25]	11.81*** [0.00]	1.40 [0.26]
Africa	20	61.67	26.15	69.20	121.31, 30.06	0.88	0.06
Asia	11	34.87	29.18	108.31	282.61, 50.85	2.84	0.04
Europe	29	21.65	44.33	87.74	753.95, 333.42	2.25	0.05
Latin America	19	52.89	28.45	80.43	141.48, 42.31	2.12	0.05
Oceania	3	8.17	32.01	96.91	100.60, 33.04	0.91	0.02
Test of Equal Sub-Group Means		0.50 [0.73]	24.80*** [0.00]	1.15 [0.36]	1.31, 1.23 [0.29], [0.32]	2.57** [0.05]	0.46 [0.76]

* significant at 10%; ** significant at 5%; *** significant at 1%

‘Test of equal sub-group means’ tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table A3.2: Medians of Macroeconomic Variables for BRER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	83	8.13	33.38	73.70	139.91, 38.66	1.81	0.03
Industrial	20	4.88	44.69	67.06	209.57, 63.59	2.15	0.03
Emerging	26	9.95	33.95	95.43	140.01, 40.17	1.94	0.03
Developing	37	10.40	28.37	73.70	115.29, 25.21	1.01	0.04
Test of Equal Sub-Group Medians		13.21*** [0.00]	31.91*** [0.00]	3.20 [0.20]	11.8***, 18.0*** [0.00], [0.00]	20.60*** [0.00]	20.76*** [0.00]
High Income	35	4.82	43.02	79.55	191.51, 53.34	2.28	0.03
Middle Income	40	10.96	28.61	71.22	109.55, 26.90	1.55	0.04
Low Income	8	12.27	19.78	49.97	122.84, 14.06	-0.57	0.04
Test of Equal Sub-Group Medians		17.20*** [0.00]	32.35*** [0.00]	3.79 [0.15]	20.2***, 27.1*** [0.00], [0.00]	25.49*** [0.00]	18.40*** [0.00]
Africa	20	10.23	26.02	59.44	118.70, 20.71	0.39	0.04
Asia	11	4.83	28.85	79.55	143.52, 26.28	2.03	0.02
Europe	29	6.38	43.59	75.77	177.79, 45.72	2.28	0.03
Latin America	19	14.49	29.03	72.85	121.82, 22.10	1.68	0.05
Oceania	3	8.42	32.02	91.31	97.24, 38.35	0.85	0.02
Test of Equal Sub-Group Medians		3.39 [0.50]	46.32*** [0.00]	5.71 [0.22]	10.7**, 13.0*** [0.03], [0.01]	20.73*** [0.00]	14.64*** [0.01]

* significant at 10%; ** significant at 5%; *** significant at 1%

'Test of equal sub-group medians' tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood's median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood's median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table A3.3: Means of Macroeconomic Variables for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	83	39.50	33.86	84.34	370.69, 143.41	1.92	0.08
Industrial	20	5.96	45.88	77.17	1019.36, 466.55	2.30	0.02
Emerging	26	39.81	33.36	96.73	163.82, 49.82	2.30	0.07
Developing	37	57.42	27.72	79.50	159.84, 31.99	1.44	0.12
Test of Equal		1.68	32.74***	1.20	1.30, 1.24	2.67*	4.68***
Sub-Group Means		[0.20]	[0.00]	[0.31]	[0.29], [0.31]	[0.08]	[0.01]
High Income	35	12.95	42.21	98.29	724.70, 302.09	2.65	0.02
Middle Income	40	44.06	28.66	77.82	120.24, 34.00	1.78	0.10
Low Income	8	132.89	23.37	55.90	118.40, 16.10	-0.57	0.20
Test of Equal		0.90	34.83***	4.82***	1.87, 1.44	11.81***	1.92
Sub-Group Means		[0.44]	[0.00]	[0.01]	[0.17], [0.25]	[0.00]	[0.21]
Africa	20	61.67	26.15	69.20	121.31, 30.06	0.88	0.13
Asia	11	34.87	29.18	108.31	282.61, 50.85	2.84	0.04
Europe	29	21.65	44.33	87.74	753.95, 333.42	2.25	0.04
Latin America	19	52.89	28.45	80.43	141.48, 42.31	2.12	0.11
Oceania	3	8.17	32.01	96.91	100.60, 33.04	0.91	0.02
Test of Equal		0.50	24.80***	1.15	1.31, 1.23	2.57**	1.84
Sub-Group Means		[0.73]	[0.00]	[0.36]	[0.29], [0.32]	[0.05]	[0.14]

* significant at 10%; ** significant at 5%; *** significant at 1%
'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means.

Table A3.4: Medians of Macroeconomic Variables for REER Country Samples

<i>Sample</i>	<i>Size</i>	<i>Inflation Rate</i>	<i>Government Expenditure</i>	<i>Trade Openness</i>	<i>International Financial Integration</i>	<i>Productivity Growth</i>	<i>Nominal Exchange Rate Volatility</i>
Whole	83	8.13	33.38	73.70	139.91, 38.66	1.81	0.03
Industrial	20	4.88	44.69	67.06	209.57, 63.59	2.15	0.01
Emerging	26	10.28	35.21	93.94	139.81, 38.98	1.94	0.03
Developing	37	10.18	28.37	73.70	121.79, 25.21	1.01	0.05
Test of Equal Sub-Group Medians		12.59*** [0.00]	34.44*** [0.00]	3.20 [0.20]	10.5***, 15.9*** [0.01], [0.00]	20.60*** [0.00]	26.00*** [0.00]
High Income	35	4.82	43.02	79.55	191.51, 53.34	2.28	0.01
Middle Income	40	10.96	28.61	71.22	109.55, 26.90	1.55	0.05
Low Income	8	12.27	19.78	49.97	122.84, 14.06	-0.57	0.08
Test of Equal Sub-Group Medians		17.20*** [0.00]	32.35*** [0.00]	3.79 [0.15]	20.2***, 27.1*** [0.00], [0.00]	25.49*** [0.00]	28.88*** [0.00]
Africa	20	10.23	26.02	59.44	118.70, 20.71	0.39	0.05
Asia	11	4.83	28.85	79.55	143.52, 26.28	2.03	0.03
Europe	29	6.38	43.59	75.77	177.79, 45.72	2.28	0.02
Latin America	19	14.49	29.03	72.85	121.82, 22.10	1.68	0.04
Oceania	3	8.42	32.02	91.31	97.24, 38.35	0.85	0.02
Test of Equal Sub-Group Medians		3.39 [0.50]	46.32*** [0.00]	5.71 [0.22]	10.7**, 13.0*** [0.03], [0.01]	20.73*** [0.00]	20.33*** [0.00]

* significant at 10%; ** significant at 5%; *** significant at 1%

'Test of equal sub-group medians' tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood's median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood's median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples.

Table A3.5: Cross-section regression results for sample common across BRER and REER series

	simple AR model half-life	augmented AR model monotonic half-life	augmented AR model IRF half-life	augmented ESTAR model TF max. half-life	augmented ESTAR model TF mean half-life	selected model I half-life	selected model II half-life	selected model III half-life	selected model IV half-life
BRER-based									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.202	-0.205	-0.230*	-0.394**	-0.172	-0.174	-0.174	-0.382**	-0.382**
(inf)	(0.193)	(0.141)	(0.143)	(0.167)	(0.133)	(0.127)	(0.128)	(0.170)	(0.170)
govt. exp.	-0.112	-0.193	-0.103	0.191	-0.050	-0.024	-0.081	0.258	0.201
(gov)	(0.457)	(0.309)	(0.298)	(0.406)	(0.308)	(0.304)	(0.311)	(0.398)	(0.406)
trade open.	0.374	-0.850**	-0.836**	-0.676*	-0.693**	-0.718**	-0.754**	-0.803**	-0.839**
(to)	(0.385)	(0.351)	(0.338)	(0.384)	(0.309)	(0.319)	(0.329)	(0.410)	(0.420)
prod. growth	-0.125*	0.025	0.023	-0.104	-0.012	0.023	0.026	-0.054	-0.051
(PG)	(0.073)	(0.054)	(0.058)	(0.079)	(0.057)	(0.048)	(0.049)	(0.072)	(0.073)
ner volatility	-0.523	-0.649**	-0.709***	-0.425	-0.674**	-0.705***	-0.701**	-0.621**	-0.618**
(nerv)	(0.427)	(0.271)	(0.255)	(0.306)	(0.288)	(0.276)	(0.282)	(0.305)	(0.310)
financial int.	-0.009	0.288*	0.279*	0.143	0.181	0.204	0.209	0.144	0.149
(ifi)	(0.349)	(0.157)	(0.150)	(0.173)	(0.166)	(0.165)	(0.166)	(0.188)	(0.188)
geo. distance	0.372	0.343	0.301	0.425	0.308	0.216	0.249	0.364	0.397
(dist)	(0.276)	(0.273)	(0.243)	(0.342)	(0.285)	(0.275)	(0.283)	(0.325)	(0.333)
Observations	82	82	82	82	82	82	82	82	82
R ²	0.27	0.40	0.47	0.32	0.38	0.41	0.40	0.38	0.37
BRER-based (no distance)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.203	-0.205	-0.231*	-0.395**	-0.173	-0.175	-0.175	-0.383**	-0.383**
(inf)	(0.194)	(0.136)	(0.138)	(0.161)	(0.127)	(0.122)	(0.123)	(0.163)	(0.163)
govt. exp.	-0.139	-0.219	-0.126	0.159	-0.073	-0.040	-0.099	0.231	0.171
(gov)	(0.462)	(0.325)	(0.310)	(0.419)	(0.319)	(0.310)	(0.320)	(0.412)	(0.422)
trade open.	0.440	-0.789**	-0.782**	-0.601*	-0.638**	-0.680**	-0.709**	-0.739*	-0.768*
(to)	(0.369)	(0.328)	(0.317)	(0.368)	(0.290)	(0.299)	(0.308)	(0.387)	(0.396)
prod. growth	-0.136*	0.015	0.014	-0.116	-0.021	0.017	0.019	-0.065	-0.063
(PG)	(0.076)	(0.054)	(0.058)	(0.081)	(0.058)	(0.047)	(0.048)	(0.070)	(0.072)
ner volatility	-0.491	-0.619**	-0.683***	-0.389	-0.647**	-0.686***	-0.680***	-0.590**	-0.584**
(nerv)	(0.422)	(0.256)	(0.239)	(0.295)	(0.272)	(0.259)	(0.264)	(0.288)	(0.292)
financial int.	-0.021	0.277*	0.270*	0.130	0.172	0.197	0.202	0.133	0.137
(ifi)	(0.350)	(0.149)	(0.143)	(0.166)	(0.159)	(0.159)	(0.159)	(0.180)	(0.180)
Observations	82	82	82	82	82	82	82	82	82
R ²	0.26	0.38	0.45	0.30	0.36	0.40	0.39	0.36	0.35
REER-based									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
inflation	-0.272***	0.063	0.014	-0.133	0.083	-0.010	0.004	-0.143	-0.129
(inf)	(0.108)	(0.119)	(0.111)	(0.151)	(0.130)	(0.110)	(0.109)	(0.146)	(0.147)
govt. exp.	-0.080	-0.286	-0.211	0.397	-0.052	0.027	0.009	0.511	0.493
(gov)	(0.370)	(0.396)	(0.393)	(0.486)	(0.449)	(0.339)	(0.348)	(0.461)	(0.464)
trade open.	-0.141	-0.585	-0.615*	-0.292	-0.414	-0.561*	-0.573*	-0.291	-0.303
(to)	(0.287)	(0.370)	(0.356)	(0.398)	(0.381)	(0.318)	(0.320)	(0.388)	(0.389)
prod. growth	-0.025	0.065	0.049	0.047	0.103**	0.087*	0.092*	0.021	0.026
(PG)	(0.049)	(0.065)	(0.064)	(0.074)	(0.053)	(0.047)	(0.050)	(0.069)	(0.071)
ner volatility	-0.021	-0.783***	-0.744***	-0.587***	-0.709***	-0.638***	-0.653***	-0.629***	-0.643***
(nerv)	(0.151)	(0.149)	(0.138)	(0.150)	(0.140)	(0.133)	(0.136)	(0.150)	(0.150)
financial int.	-0.042	0.110	0.109	-0.071	0.061	0.058	0.063	-0.142	-0.137
(ifi)	(0.194)	(0.165)	(0.164)	(0.206)	(0.205)	(0.179)	(0.181)	(0.188)	(0.189)
Observations	82	82	82	82	82	82	82	82	82
R ²	0.12	0.37	0.38	0.38	0.40	0.43	0.42	0.41	0.41

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The dependent variable is the natural logarithm of the bilateral real exchange rate (BRER) half-life for BRER-based regression results and the natural logarithm of the real effective exchange rate (REER) half-life for REER-based regression results. The half-life is our measure of persistence. All regressors except for productivity growth (PG) are also expressed in logarithms. A test of normality of residuals is also performed for every specification using the Shapiro-Wilk test, and in each case the null hypothesis of normality cannot be rejected at the 10 percent level (all p-values are found to be notably larger than 0.10). Alternative numerical normality tests based on skewness and kurtosis yield consistent results.

Chapter 4

On the Relation between the Current Account and Real Exchange Rate: A Role for Nominal Exchange Rate Variability?

4.1 Introduction

The emergence of large external imbalances across the globe in relatively recent times has renewed interest in the sources of such imbalances and their dynamics. In particular, certain studies have concluded that the nominal exchange rate regime is a redundant factor in the adjustment process of current account positions, thereby directly calling into question the arguments of Friedman (1953).⁹⁰ Indeed, the notion advocated by Friedman is that nominal exchange rate flexibility will accommodate optimal corrections in the terms of trade or real exchange rate on a continuing basis even in the case of nominal goods price stickiness. Therefore, a more flexible exchange rate regime would allow for smoother and less protracted adjustment of external imbalances. On these grounds, it would appear that the choice of exchange rate regime is quite a pertinent factor for the relation between the current account and real exchange rate. This provides the motivation for the current study. In this paper, we are principally concerned with empirically examining the implications of greater nominal exchange rate flexibility for the bivariate relation between large current account imbalances and the real exchange rate, and moreover, the persistence of the current account itself. To the best of our knowledge, no research conducted to date has systematically scrutinised the former, while very limited research exists on the latter. Throughout the paper, we use the terms ‘flexibility’ and ‘volatility’ interchangeably (for reasons discussed later) though we do recognise the difference between the two.

In their analysis across a panel of 70 countries, Clower and Ito (2012) report that the exchange rate arrangement is not a robust determinant of current account inertia. Chinn and Wei (2013) obtain a similar result but over a much larger number of countries. Furthermore, they hypothesise that the current account responds to the real

⁹⁰ See Chinn and Wei (2013) or Clower and Ito (2012) for example.

exchange rate, not the nominal exchange rate. Elaborating on this point, they explain that if real exchange rate adjustment, in the form of mean-reversion, is not influenced by the choice of exchange rate regime, then one should not expect current account adjustment to be affected by it either. However, intuitively one would think that nominal variables can have an impact on (relevant) real variables in the short run. After all, persistence is a short run issue in the context of stationary variables. If the exchange rate regime does not matter, the task of adjustment for both fixed and flexible regime countries would be left up to either relative national price levels and/or domestic economic activity levels. In practice though, both nominal prices and wages move quite sluggishly, implying that any adjustment will have to be borne primarily by economic activity. Furthermore, as Lane and Milesi-Ferretti (2011) note, to the extent that current account corrections are engendered by a deviation of output and demand from ‘potential’, adjustments may prove to be temporary unless more meaningful expenditure switching occurs through exchange rate changes. Interestingly, Edwards (2007) notes that realignments of global growth rates would have only a modest impact on external imbalances and that significant real exchange rate movements are likely to be needed. In a series of papers on the US current account position, Obstfeld and Rogoff (2001, 2005, 2007) conclude that a narrowing of the US external deficit is likely to entail a large real domestic currency depreciation, as well as a sharp decline in the nation’s consumption and welfare levels. Nam (2011) studies the contribution of the nominal exchange rate and relative price levels respectively to real exchange rate convergence. Significantly, he finds that when the real exchange rate is sufficiently far away from its unconditional mean that adjustment is almost entirely driven by nominal exchange rate movements.⁹¹ According to Engel (2012), the intuition drawn from theoretical models is that both price changes and nominal exchange rate determination play roles in the adjustment of real exchange rates, and therefore both price stickiness and the degree of interest rate smoothing (under monetary independence).

The importance of the relation between the current account and real exchange rate not only in traditional models but also in new open economy macroeconomics and the theory of optimum currency areas provides a further reason to study the strength of

⁹¹ In the previous chapter we examined the durability of real exchange rate parity deviations and found an inverse relation between persistence and nominal exchange rate volatility. Moreover, Goldfajn and Valdés (1999) conclude that overvaluations of real exchange rates have been typically corrected for by adjustments in the nominal exchange rate rather than changes in inflation differentials.

this relation in disparate settings. According to the Mundell-Fleming and Obstfeld-Rogoff style models, the link between the two variables is given by changes in the composition of the demand side. The expenditure-switching effect is often cited as the key mechanism through which changes in the real exchange rate can engender movements in the current account in these models, though we do recognise that reverse causality is also possible.⁹² In the case of a home real currency depreciation for example, expenditure-switching would entail the shifting of domestic and foreign residents' spending towards the home country's goods.⁹³ However, as Engel (2002) notes, the expenditure-switching effect is eradicated in the Redux model (or Obstfeld and Rogoff-style models more generally) in the presence of market segmentation in home and foreign countries and pricing-to-market by monopolistically competitive firms.⁹⁴

Given free international capital flows, it is also important to note that more flexible exchange rate arrangements provide scope for larger and more frequent independent interest rate changes at home.⁹⁵ By uncovered interest rate parity (for which violations can and do occur), the rate of currency depreciation will be tied to the domestic interest rate.⁹⁶ Thus, under autonomous monetary policy, there is added potential for output-shifting arising from the impact of domestic interest rate changes on aggregate expenditure, including that on imports. That is, interest rate-induced output-shifting effects can also act as another outlet for current account adjustment, or alternatively be of the variety that act in the offsetting direction to a correction. Importantly, the persistence of the interest rate will depend on the extent to which the

⁹² For instance, under a fixed exchange rate regime, a large current account deficit may prompt the national authorities to devalue their currency/revise their parity.

⁹³ In the Redux model of Obstfeld and Rogoff (1995) for example, the expenditure-switching mechanism is valid provided that nominal prices are fixed in the producers' currencies and exchange rate pass-through is complete. That is, with respect to the latter, prices for consumers change one for one in the short run with changes in the nominal exchange rate. Also see Obstfeld and Rogoff (1998, 2000a). The principal role of nominal exchange rate flexibility in these models is that it allows for expenditure switching. This is precisely the line of thinking evoked by Friedman (1953). Friedman assumes sufficient, rather than complete, exchange rate pass-through (and substitutability across foreign and domestic goods) and also notes that the choice of exchange rate regime would matter little if nominal prices could adjust quickly.

⁹⁴ Further discussion on the implications of producer versus local-currency pricing for expenditure switching in the context of new open economy macroeconomic models (e.g. Redux) is indeed provided in Engel (2002).

⁹⁵ Lane and Milesi-Ferretti (2013) obtain evidence that non-peggers observed larger changes in policy interest rates than peggers did during the global crisis (from 2008).

⁹⁶ To illustrate, according to uncovered interest rate parity, an expected home currency devaluation will be associated with a domestic interest rate rise, controlling for all other factors.

national authorities engage in interest rate smoothing as reflected in the policy rule (Engel 2012).

Cuestas and Regis (2013) note that present changes in the real exchange rate may engender expectations of future exchange rate movements in the opposite direction. Further elaborating, they explain that a sudden and unanticipated appreciation of the currency today might signal a depreciation in the future. In such an environment, financial investments abroad will become more attractive, not only because of the currency appreciation today, but also because a depreciation may occur at the maturity of the investment.⁹⁷ The authors emphasise that this type of expenditure-switching mechanism of the exchange rate provides the link to movements in the current account. They contend that large and persistent changes in the current account balance may then be connected to the long-run behaviour of the real exchange rate. At the same time, it is also important to point out that high exchange rate volatility may be an indication of greater uncertainty, or economic instability, and therefore may lead to heavier private capital outflows (or sudden stops) that can be associated with sharp current account deficit reversals if they are not replaced by public or official flows.⁹⁸

Previewing our central results, for large external imbalances, we typically find that relaxing the nominal exchange rate regime towards greater flexibility is associated with an increasingly stabilising current account-real exchange rate relation. The link becomes stabilising as exchange rate flexibility rises in the sense that an inverse relation between the two variables develops. Moreover, this result holds regardless of the regime flexibility measure employed. This in turn implies that under less rigid regimes the real exchange rate is able to absorb some of the pressure by engendering expenditure-switching effects that allow the current account to adjust. However, allowing for asymmetric adjustment in the current account reveals that the bivariate relation becomes destabilising at high nominal exchange rate flexibility levels when the real exchange rate is highly appreciated. Further scrutiny reveals that this result in the non-linear setup is predominantly driven by high-income nations.

⁹⁷ According to the authors, this can result in an equivocal sign for the current account-real exchange rate relation.

⁹⁸ Target 2 funding (ECB liquidity) and official external assistance from the EU and IMF for example cushioned the exit of private capital flows for some euro zone countries after 2007. The added ECB liquidity buffer may have resulted in weaker pressure for current account adjustment in the euro area periphery than in the Baltics and Bulgaria which did not have access to it.

On the other hand, controlling for the real exchange rate, the current account itself always observes faster convergence under greater flexibility. In particular, one might interpret the current account coefficients as a proxy for output shifting-based adjustment. In that case, the result suggests that further adjustment also occurs through domestic economic activity in the presence of lower nominal exchange rate rigidity. The empirical finding is consistent with the notion that there may be greater scope for interest rate-based output-shifting effects under more flexible exchange rate arrangements.

We also obtain a cross-section of country-specific measures of current account and real exchange rate persistence over the sample period and find a statistically significant positive correlation between the two, yielding a new result in the field. Interestingly, we consistently retrieve evidence of a negative link between persistence in either the current account or real exchange rate and nominal exchange rate variability.

The remainder of the paper is structured as follows. Section 4.2 provides an overview of the empirical methodology employed. Section 4.3 offers a brief description of the data set used. In section 4.4, we present linear panel specification results, while in section 4.5 we report findings when asymmetric current account movement is permitted across relatively appreciated and depreciated real exchange rate scenarios. Section 4.6 covers the analysis on country-specific current account persistence. Finally, Section 4.7 concludes.

4.2 Analytical Framework

4.2.1 Linear Dynamic Panel Approach

In order to study the empirical relation between the current account and real exchange rate, we employ a single equation dynamic panel model. The longitudinal setup is preferred to the country-by-country time series approach in our analysis for two reasons. Firstly, the cross-sectional dimension is particularly interesting given the greater variation in nominal exchange rate volatility across countries than over time for a single country. For instance, member nations of the African currency unions observe virtually zero nominal exchange rate volatility over time. Thus, panel techniques may provide an advantage in discerning whether more flexible exchange rate regimes facilitate greater

adjustment between external imbalances and the real exchange rate. Second, unlike Lee and Chinn (2006) for example, our focus is on lower frequency data. Although such data may be more relevant for the analysis of external adjustment and can allow for superior country coverage, they engender degrees of freedom issues in time series studies thus impeding meaningful statistical inference. This would be highly problematic in a regime-switching (non-linear) framework, a setting we also consider later. On the issue of a single equation versus system of equations approach such as a panel VAR, the latter method would not be feasible yet again due to the degrees of freedom problem and moreover because we incorporate interaction terms between endogenous variables into the analysis.⁹⁹

Tables 4.1-4.3 present the results of panel unit root tests for the main two variables in the cases of both cross-sectional independence and dependence respectively. An overwhelming majority of the tests appear to strongly reject the null of non-stationary panels. As we will see later, the current account tends to display relatively fast mean-reversion for most individual country cases even under a pure AR(1) specification (and annual data). Although it is interesting to find that one can reject the unit root hypothesis for both real effective exchange rates (REERs) and US-based bilateral real exchange rates (BRERs) at the annual frequency, it should be noted that these series exhibit higher levels of persistence than the current account.¹⁰⁰ Given these results, we consequently conclude that cointegration methods are not appropriate.¹⁰¹

Having conducted preliminary checks on the data, we first estimate the following linear baseline level-log specification via pooled OLS, fixed effects, the difference

⁹⁹ Degrees of freedom would become an even greater concern in this alternative framework when analysing interesting single country or small sub-sample cases.

¹⁰⁰ This may suggest that the current account is quite sensitive to small real exchange rate changes (or vice versa i.e. real exchange rate is relatively insensitive to larger current account movements). Regarding the real exchange rate measure, multilateral and US-based bilateral rates are highly correlated and we employ both since the former is theoretically the correct measure for our purposes while the latter provides greater country coverage. Schmitz et al. (2012) note that the US dollar, an anchor currency for a number of large emerging markets (by the IMF's last count, 66 countries across the globe other than America either adopt the dollar as legal tender, peg their currency to it, or manage their exchange rate against it), continues to play a highly significant role for the effective exchange rate of the euro and euro zone competitiveness. Lane and Milesi-Ferretti (2011) also illustrate that changes in the euro-US dollar exchange rate have been very influential in shaping the pattern of the respective trade-weighted real exchange rates of euro area economies.

¹⁰¹ Furthermore, even with near-unit root variables, Hjälmarsson and Österholm (2007) show that the risk of erroneously finding cointegration is substantially higher. They contend that standard inferential procedures based on the assumption of unit root data are generally not robust to even small deviations from this assumption.

generalised method of moments (GMM) à la Arellano and Bond (1991), and system GMM à la Blundell and Bond (1998):¹⁰²

$$ca_{i,t} = \alpha_{i,t} + \sum_{j=1}^p \beta_j ca_{i,t-j} + \sum_{k=0}^q \gamma_k rer_{i,t-k} + \varepsilon_{i,t} \quad (4.1)$$

where ca is the current account to GDP ratio, rer is the natural logarithm of either the REER or the BRER against the US, and $p \geq 1, q \geq 0$. Alternatively, one can re-parameterise (4.1) as:

$$\Delta ca_{i,t} = \alpha_{i,t} + \tau_1 ca_{i,t-1} + \sum_{j=1}^{p-1} \tau_{2j} \Delta ca_{i,t-j} + \tau_3 rer_{i,t} + \sum_{k=0}^{q-1} \tau_{4k} \Delta rer_{i,t-k} + \varepsilon_{i,t} \quad (4.2)$$

where;

$$\tau_1 = - \left(1 - \sum_{j=1}^p \beta_j \right) \quad (4.3)$$

$$\tau_{2j} = - \sum_{l=j+1}^p \beta_l \quad (4.4)$$

$$\tau_3 = \sum_{k=0}^q \gamma_k \quad (4.5)$$

$$\tau_{4k} = - \sum_{m=k+1}^q \gamma_m \quad (4.6)$$

¹⁰² As we allude to, it has been well documented that dynamic panel regressions with a lagged dependent variable and fixed effects can result in inconsistent estimates (often referred to as dynamic panel bias or Nickell bias). This problem typically erodes away as T increases. However, simulation studies have shown that the bias in the coefficient estimate of interest can be as large as 20 percent even when $T=30$. The GMM approach helps to gauge the extent of this problem. To execute the GMM regressions, we employ the downloadable 'xtabond2' routine designed for STATA, as opposed to the less flexible inbuilt STATA 'xtdpdys' command. David Roodman (2009b) provides further information on 'xtabond2'. Difference GMM uses additional lags of the dependent variable as instruments in the differenced equation. The results are always reported for the original levels model even though mechanically the first difference model is fitted. According to the Monte Carlo simulations of Judson and Owen (1999), differences in efficiency and bias across the Anderson and Hsiao (1981) and Arellano and Bond (1991) estimators (the former of which uses only one further lag of the dependent variable as an instrument) become quite small for larger N and T . System GMM employs additional moment conditions to obtain an estimator with improved precision and better finite-sample properties. Moreover, Blundell and Bond (1998) demonstrate that if the dependent variable is close to a random walk, past changes (as instruments) may be more predictive of current levels. The method estimates a two-equation system of regressions in first differences and levels, using lags of levels as instruments for the first differences and first differences as well as further lags of first differences as instruments for the levels. Given model overidentification, more efficient two-step estimation is used for both difference and system GMM. Good GMM estimates should lie in the range of the pooled OLS and fixed effects estimates, or at least lie close to this interval.

The parameters in (4.3) and (4.5) are of particular interest as the figure $-(\tau_3/\tau_1)$ gives the long-run or cumulative impact of a change in the real exchange rate provided that the stability condition $\sum_j \beta_j < 1$ holds.^{103,104} Moreover, a standard error for the long-run coefficient can be obtained via the delta method.

Studies of a similar flavour by Debelle and Faruquee (1996), Chinn and Prasad (2003), Lee et al. (2008) and Auer (2013) examine the current account in a panel setting but do so using only pooled OLS and fixed effects estimation. However, as is well known, dynamic panel bias and endogeneity of regressors can invalidate such estimation procedures. We recognise this to be a pertinent argument in analyses of this variety and therefore supplement the standard methodology with the GMM-based approach. To assess the effect of nominal exchange rate flexibility on the strength of the relation between the current account and real exchange rate, we augment (4.1) with nominal exchange rate volatility (continuous measure), or regime (discrete measure) interaction terms and estimate:

$$\begin{aligned}
 ca_{i,t} = & \alpha_{i,t} + \sum_{j=1}^p \beta_j ca_{i,t-j} + \sum_{j=1}^p \phi_j (ca_{i,t-j} \times nervol_{i,t-j}) + \sum_{k=0}^q \gamma_k rer_{i,t-k} + \\
 & + \sum_{k=0}^q \psi_k (rer_{i,t-k} \times nervol_{i,t-k}) + \sum_{k=0}^r \theta_k nervol_{i,t-k} + \varepsilon_{i,t} \quad (4.7)
 \end{aligned}$$

and

$$\begin{aligned}
 ca_{i,t} = & \alpha_{i,t} + \sum_{j=1}^p \beta_j ca_{i,t-j} + \sum_{j=1}^p \delta_j (ca_{i,t-j} \times ierr_{i,t-j}) + \sum_{j=1}^p \rho_j (ca_{i,t-j} \times flerr_{i,t-j}) + \\
 & + \sum_{k=0}^q \gamma_k rer_{i,t-k} + \sum_{k=0}^q \lambda_k (rer_{i,t-k} \times ierr_{i,t-k}) + \sum_{k=0}^q \pi_k (rer_{i,t-k} \times flerr_{i,t-k}) + \\
 & + \sum_{k=0}^r \varphi_k ierr_{i,t-k} + \sum_{k=0}^r \omega_k flerr_{i,t-k} + \varepsilon_{it} \quad (4.8)
 \end{aligned}$$

¹⁰³ The long-run effect is often referred to as the long-run or equilibrium multiplier.

¹⁰⁴ Strictly speaking, this is not the sole stationarity condition since one cannot expect ca_t to be stationary without imposing further conditions on rer_t . Nevertheless, it is apparent that if this condition is violated, ca_t becomes characterised by martingale or explosive behavior. As a result, in order for the long-run multiplier definition to make sense, the convergence requirement must be satisfied.

where *nervol* is the natural logarithm of either effective or bilateral nominal exchange rate volatility, *ierr* is a dummy variable that takes the value of 1 whenever a country is characterised by an intermediate exchange rate regime and zero otherwise, *flerr* is a binary variable that takes the value of 1 whenever a country is characterised by a flexible exchange rate regime and zero otherwise, and $r = \max(p, q)$. In our context, the effect of the exchange rate volatility or regime measure on its own is not meaningful and is only included in the specifications for econometric reasons.

4.2.2 Incorporating non-linear transitional dynamics

There are few reasons a priori to believe that the dynamics of the current account should be symmetric across real exchange rate appreciation and depreciation episodes respectively. For instance, if the current account is initially in deficit and the real exchange rate overvalued (like was the situation in the peripheral euro zone countries), then under a fixed exchange rate regime, barring an adjustment through output compression, an improvement in the external balance will necessitate a fall in the price level. However, this may be more difficult to achieve if prices or wages are less flexible downward, in turn implying a more persistent deficit. Consequently, nominal exchange rate flexibility may impart a differential effect in such cases than in the opposite scenario in which upward price adjustment is relatively easier. Specifically, we examine whether non-linear adjustment in the current account can be attributed to asymmetries in the relation between the current account and the real exchange rate by estimating the following dynamic panel smooth transition regression (DPSTR) model with non-linear least squares (NLS):^{105,106}

¹⁰⁵ Studies that look at current account non-linearities/asymmetries include those by Freund (2005) and Ghosh et al. (2010) for example.

¹⁰⁶ Hansen (1999) introduced the panel threshold regression model that over time allows discrete shifts in coefficients across regimes. Building on this work, González et al. (2005) developed the panel smooth transition regression model which instead facilitates a smooth and gradual transition of coefficients between regimes. We adopt the latter more general smooth transition approach since we are analysing a wide range of countries with different historical experiences. With aggregated series and heterogeneous agents there is also a good chance that responses will not be simultaneous, thus resulting in a smoother change in the adjustment coefficients.

$$\begin{aligned}
 ca_{i,t} = & \alpha_{i,t} + \sum_{j=1}^p \beta_j ca_{i,t-j} + \sum_{j=1}^p \phi_j (ca_{i,t-j} \times nervol_{i,t-j}) + \sum_{k=0}^q \gamma_k rer_{i,t-k} + \\
 & + \sum_{k=0}^q \psi_k (rer_{i,t-k} \times nervol_{i,t-k}) + \sum_{k=0}^r \theta_k nervol_{i,t-k} + \\
 & + \left(\alpha_{i,t}^* + \sum_{j=1}^p \beta_j^* ca_{i,t-j} + \sum_{j=1}^p \phi_j^* (ca_{i,t-j} \times nervol_{i,t-j}) + \sum_{k=0}^q \gamma_k^* rer_{i,t-k} + \right. \\
 & \left. + \sum_{k=0}^q \psi_k^* (rer_{i,t-k} \times nervol_{i,t-k}) + \sum_{k=0}^r \theta_k^* nervol_{i,t-k} \right) G(rer_{i,t-d}; \sigma, c) + \varepsilon_{i,t}
 \end{aligned}$$

$$\text{where } G(rer_{i,t-d}; \sigma, c) = \left[1 + \exp \left(-\sigma \prod_{s=1}^m (rer_{i,t-d} - c_s) \right) \right]^{-1} \quad (4.9)$$

Prior to estimating this equation, the nominal exchange rate volatility augmented DPSTR, we also inspect its baseline version. That is, (4.9) is first estimated without the volatility and interaction terms.^{107, 108} Taking a closer look at (4.9), $G(\cdot)$ is a (continuous) transition function of the logistic variety that governs the non-linear behaviour of the current account. The slope/smoothness parameter $\sigma > 0$ determines the speed of transition between regimes, with higher values of σ indicating faster transition. $rer_{i,t-d}$ is the transition variable with delay parameter d , while the c_s are threshold parameters with $c_1 \leq c_2 \leq \dots \leq c_m$. For the purposes of discussion, we denote the coefficients in the linear and non-linear components of the DPSTR by the vectors μ and μ^* respectively. Given the annual frequency of the data, the only plausible value for d is 1, with $d = 2$ inspected only out of curiosity. From an empirical perspective, González et al. (2005) note that considering $m = 1, 2$ is generally sufficient for capturing non-linearities arising from regime switching. In our analysis, tests

¹⁰⁷ GMM-style estimation in our non-linear setting would be too computationally intensive. Moreover, it would be exposed to severe instrument proliferation with the number of instruments exceeding the number of observations. Nevertheless, as a robustness check, we do re-execute the regressions with/without fixed effects and using lagged changes in variables instead and find qualitatively similar results.

¹⁰⁸ We also conduct the analysis with the (discrete) nominal exchange rate regime variables. However, we find that most of the parameter estimates for these binary regressors and their interactions are unstable. This is particularly true in sub-sample cases. Consequently, we do not report the results of these specifications.

suggest that $m = 1$ is appropriate resulting in $G(.) \in [0, 1]$.¹⁰⁹ Such a restriction implies that the two extreme lower and upper regimes are associated with low and high values of $rer_{i,t-d}$ respectively, with a single monotonic transition of coefficients from μ to $\mu + \mu^*$ as $rer_{i,t-d}$ rises where the change is centered around c_1 . More generally, an observation has effective regression coefficients $\mu + \mu^* G(.)$ and is assigned to the low (high) regime when $G(.) < (>) 0.5$. Furthermore, as $\sigma \rightarrow \infty$ in the limit, $G(.)$ becomes an indicator function and the DPSTR reduces to a dynamic panel threshold model. Conversely, as $\sigma \rightarrow 0$, $G(.)$ tends to a constant (0.5) and the DPSTR specification dwindles down to a homogeneous or linear dynamic panel regression model with fixed effects.¹¹⁰ As suggested by Teräsvirta (1994), when necessary, we re-parameterise the transition function as:

$$G(rer_{i,t-d}; \sigma, c) = \left[1 + \exp \left(\frac{-\sigma(rer_{i,t-d} - c_1)}{\hat{s}(rer_{i,t-d})} \right) \right]^{-1} \quad (4.10)$$

where $\hat{s}(rer_{i,t-d})$ is the sample standard deviation of the transition variable. Such an adjustment speeds the convergence and improves the stability of parameter estimates.¹¹¹

4.2.3 Cross-Sectional Approach

This sub-section takes a different perspective and turns attention to obtaining country-specific scalar measures of current account inertia, which are subsequently related to individual country levels of real exchange rate persistence, available from chapter 2, and nominal exchange rate variability over the time period of study. The intertemporal approach can be employed to formalise the trajectory of the current account. Within this framework, it can be shown that current account stationarity is a sufficient, but not necessary, condition for compliance with the open economy long-run budget constraint. In this case, the current account is said to be ‘strongly sustainable’. However, these are

¹⁰⁹ Setting $m = 2$ yields a logistic quadratic panel smooth transition model in which the minimum value of $G(.)$ is $(c_1 + c_2)/2$ and $G(.) = 1$ is attained at both low and high values of $rer_{i,t-d}$. This model nests the three-regime threshold model whose outer regimes are symmetric and different from the middle one.

¹¹⁰ This particular property applies to any value of m .

¹¹¹ Naturally, this is done when the convergence of estimates is difficult to achieve, or is not achievable at all, and when parameter estimates are sensitive to the choice of initial values (i.e. are unstable). Some studies have also argued that such an adjustment makes σ approximately scale-free and therefore comparable across specifications or samples. However, since the real exchange rate (our transition variable) has been rescaled and rebased in the same fashion for each country prior to estimation, the transition parameters are already comparable. Consequently, one would have to re-adjust σ by the standard deviation after estimation to achieve comparability again.

not the only dynamics of the current account that will avoid violation of the intertemporal budget constraint. As Bohn (2007) demonstrates, theoretically the budget constraint can be met even if the current account is integrated of some finite order.¹¹² Such instances fall under the category of ‘weak sustainability’. As has been implicit in the analysis to this point, we concentrate on the ‘strong sustainability’ hypothesis given its more rigorous economic policy implications and also our preliminary tests of the data (reference is always made to the current account to GDP ratio).¹¹³

To gauge the persistence of the current account for each country, we estimate linear AR(1) and augmented AR specifications, and employ the concept of the half-life as our measure of the degree of mean-reversion.¹¹⁴ Given the use of lower frequency data and thus small number of observations per country, estimation of more elaborate non-linear models is not feasible. Specifically, for each country we consider:

$$\Delta ca_t = \varrho_0 + \varrho_1 ca_{t-1} + \varepsilon_t \quad (4.11)$$

and

$$\Delta ca_t = \varrho_0 + \beta t + \varrho_1 ca_{t-1} + \sum_{i=1}^p \vartheta_i \Delta ca_{t-i} + \varepsilon_t \quad (4.12)$$

In turn, we retrieve the half-life, defined as the number of years required for a deviation from equilibrium to dissipate permanently by 50 percent, from:

$$\hat{h} = \frac{\ln(.5)}{\ln(1 + \hat{\varrho}_1)} \quad (4.13)$$

Using these estimates, we non-parametrically and graphically inspect the cross section pairwise relation between 1) current account persistence and real exchange rate persistence, and 2) current account/real exchange rate persistence and nominal exchange rate volatility. In line with chapter 3, we next parametrically relate current account

¹¹² Also see Ghosh (1995) and Ghosh and Ostry (1995) on the matter.

¹¹³ Note that in a growing economy persistent non-relative to GDP current account deficits are strongly sustainable if their expected value does not grow at a rate faster than that of output, implying that ca is stationary.

¹¹⁴ An AR(1) is an autoregressive process of order one.

inertia to nominal exchange rate variability and a set of other control factors detailed in the data section:

$$hl_i^{ca} = \kappa_0 + \kappa_1 nerv_i + \kappa_2 NFA_i + \kappa_3 GBB_i + \kappa_4 to_i + \kappa_5 ifi_i + \kappa_6 res_i + \kappa_7 ydr_i + \kappa_8 odr_i + \kappa_9 fdev_i + \kappa_{10} pci_i + \kappa_{11} PG_i + \kappa_{12} cas_i + \varepsilon_i \quad (4.14)$$

where lowercase-letter variables are in logarithms, hl^{ca} is the current account half-life, $nerv$ is nominal exchange rate volatility (or alternatively exchange rate regime is used), NFA is net foreign assets, GBB is the government budget balance, to is trade openness, ifi is international financial integration, res is international reserves, ydr is the youth dependency ratio, odr is the old dependency ratio, $fdev$ is financial development, pci is per capita income, PG is productivity growth, and cas is current account size.

These additional determinants of current account persistence are collected as averages over the sample period for each country. In the literature on the determinants of the current account, some studies have followed the ‘External Balance Assessment’ methodology of the IMF in the sense that right hand-side variables have been constructed relative to a ‘world’ or ‘sample’ counterpart in each year.¹¹⁵ One may argue that this is appropriate given that a country’s current account is really a multilateral variable based on trade with the rest of the world and that only idiosyncratic changes in fundamentals should matter. However, in our analysis we are concerned with the persistence, and not the level, of the current account (to GDP), which is technically a country-specific non-multilateral measure. Therefore in a similar manner we consider regressors in their non-relative form.¹¹⁶ Ultimately, this is in line with other studies of the same variety.¹¹⁷

To compensate in some way for not capturing non-linear current account adjustment in univariate time series specifications (4.11) and (4.12), we distinguish over

¹¹⁵ See Lane and Milesi-Ferretti (2011) for example who consider determinants relative to the weighted average of a country’s trading partners in each year. Chinn and Prasad (2003), Clower and Ito (2012), Chinn and Wei (2013) and Pancaro (2013) are examples of those that use country-specific (i.e. non-relative to world) regressors.

¹¹⁶ As a check, we also considered relative-to-sample regressors and the results remained largely unchanged. This may be due to the netting out of the denominator effect after averaging over the sample period.

¹¹⁷ See Cheung and Lai (2001) and Cashin and McDermott (2006) in the context of bilateral and multilateral real exchange rates respectively.

the cross section between predominantly surplus and predominantly deficit countries and conduct additional regression analyses on these sub-samples in order to identify any asymmetries. In particular, we label a country as a surplus (deficit) nation if more than 50 percent of its annual current account balances are in surplus (deficit) during the period.¹¹⁸ The other common type of non-linearity that can arise is along the size dimension. For this purpose, one could split the sample along an indicator that equals 1 when more than x percent of a country's current account balances are greater than 3 percent (of GDP) in absolute value, and 0 otherwise. Subsequently, regressions could be executed on the resulting sub-samples. However, we do not pursue the strategy in our analysis as this would entail omitting the current account size variable from the full specification (4.14), and thus impair comparison-making exercises.¹¹⁹

4.3 Data Set Details

Our study is conducted for 73 economies over the period 1973-2010. The countries used are listed and categorised in Appendix A. We discard all countries with nominal GDP below \$20 billion in 2007 and in the process also eliminate very low-income nations (i.e. those with per capita nominal GDP less than \$500).¹²⁰ Moreover, we also exclude oil-dominated countries as their current account dynamics are highly dictated by the price of petroleum. The omission of small and very low-income nations is justified by the fact that small countries can experience high or outsized current account volatility, while the external balances of very poor economies are typically influenced by external aid and debt reduction or forgiveness agreements following episodes of large deficits.

¹¹⁸ In the rare case that a country has an equal number of surplus and deficit observations, the sign of the average current account balance over the period determines its classification e.g. a positive average results in a surplus status. A dummy variable that represents the aforementioned surplus vs. deficit distinction was originally included in the full sample specification. However, it proved to be highly insignificant and was ultimately dropped.

¹¹⁹ In a background check, we apply this method for the threshold $x = 40$ percent (as opposed to $x = 50$ percent in order to improve the sub-sample sizes) and, after dropping the current account size regressor, find that the absolute coefficient values are slightly larger in the sub-sample of countries characterised by bigger current account imbalances. The results across both sub-samples are overall qualitatively similar to the full sample specification results (in which the size variable is included).

¹²⁰ This criterion is used by Lane and Milesi-Ferretti (2011). We varied the nominal GDP threshold (as well as the year) accordingly and found no significant change in the results. Furthermore, employing a 1 million population threshold instead has no qualitative impact on our findings. Results are insensitive to the exclusion of Kenya and Bangladesh, the only two nations with per capita nominal GDP less than \$1000 in 2007. The two countries are still defined as low income by the World Bank though recent data show that these countries have passed the \$1000 per capita threshold.

All of these factors could potentially impede any type of meaningful assessment of the relation between the current account, real exchange rate and nominal exchange rate flexibility.

Table 4.4 shows the *de facto* fine and coarse nominal exchange rate regime classification codes of Ilzetski, Reinhart and Rogoff (2011), while Table 4.5 indicates how we re-categorise these codes for the purposes of our study. Using the new classification scheme, tables 4.6-4.7 indicate that the majority of the observations over the sample typically fall under the fixed exchange rate arrangement. In particular, advanced and developing economies have the largest shares of fixed exchange rate regime observations. Conversely, emerging market economies have larger shares of the more flexible regime observations. Table 4.7 furthermore reveals that less flexible regimes are associated with lower nominal exchange rate volatility, a trend consistent with the findings of Mussa (1986).

To be sure, we also repeat the analysis of tables 4.6-4.7 for observations corresponding to relatively large external imbalances. For the sample of bilateral real exchange rate countries, tables 4.8-4.9 show across regimes and country groups the spread of observations and levels of average annual bilateral nominal exchange rate volatility corresponding to current account balances that are in absolute terms greater than 3 percent of GDP. Tables 4.10-4.11 do the same in the case of the real effective exchange rate sample of countries and report multilateral nominal exchange rate volatility levels instead of bilateral ones. Collectively, tables 4.8-4.11 again indicate that less rigid exchange rate systems entail higher nominal exchange rate variability.

However, we do recognise that regime rigidity according to the discrete measure may not always be associated with low volatility, and similarly for the opposite scenario. For instance, although classified as fixed exchange rate regime countries in the year 1994, the CFA Franc users of Central and West Africa observed significant nominal exchange rate volatility at this time as the currency was sharply devalued in an attempt to aid exports in the region. In this case, volatility changes while the binary variables reflecting flexibility do not. Consequently, *de facto* nominal exchange rate volatility captures more precisely the actual behaviour or flexibility of the nominal exchange rate than the discrete measure. Indeed, the latter can obscure the implications for the dynamics of the current account by yielding insignificant estimates. It may

moreover be argued that the classification of binary variables can be quite arbitrary for intermediate regimes. Given the aggregated and inaccurate manner in which the discrete measure can proxy for nominal exchange rate flexibility, it is important to bolster the analysis with the continuous variable.

Throughout the analysis we employ annual data except when constructing annual nominal exchange rate volatility measures in our panel specifications. In this instance, monthly exchange rate data are used. With regards to the current account in panel equations, we focus solely on balances that are in absolute terms greater than 3 percent of GDP since large external imbalances are the ones of greatest concern to the global community.¹²¹ In addition, we drop observations in years prior to 1996 for Central and Eastern European economies as these were times of great structural change (both political and economic) and volatility in such transitional nations. Consequently, we are left with an unbalanced panel data set. Nevertheless, in the cross-sectional examination of persistence we are obliged to use the full sample of current account observations in order to mitigate the inadequate power issue. Appendix B lists the full set of variables employed in this study, as well as their mnemonics, definitions and sources.

4.4 Linear panel estimates

Tables 4.12-4.13 present the findings for the baseline linear current account-real exchange rate specification under the different estimation procedures.^{122, 123} The overriding message is that the current account on average has a persistence coefficient of around 0.70, and a negative contemporaneous and long-run relation with the real

¹²¹ Findings are qualitatively similar when imbalances greater than 5 percent in absolute value are analysed, though sample size becomes an issue. On the other hand, results are generally weaker when imbalances less than 3 percent in absolute terms are included in the study. See Obstfeld (2012) on the importance of large current account imbalances.

¹²² It is worth noting that we always check whether instrument proliferation is driving our difference and system GMM results by collapsing the instrument set or limiting its lag length (or further limiting the lag length in cases where this has already been done). Ultimately, the findings never change too much when we do so. Instrument proliferation however does inflate the p-value of the test for overidentifying restrictions (SH) towards 1. This p-value is generally smaller in our instrument proliferation robustness checks, but still sufficiently large to fail to reject the null of valid overidentifying restrictions (or that the population moment conditions hold). In the reported tables, the number of instruments is always below the number of observations. See Roodman (2009a,b) for further information on instrument proliferation.

¹²³ Standard errors produced using the usual textbook formulas for the two-step GMM estimator are downward biased in finite samples. Windmeijer (2005) provides a correction for this. We err on the side of caution and employ the Windmeijer-corrected cluster-robust standard errors in GMM regressions.

exchange rate. The former indicates that, controlling for the real exchange rate, the current account exhibits relatively high inertia, while the latter suggests that price and nominal exchange rate movements can indeed, at least partly, allow for external adjustment through the expenditure-switching channel. The average long-run real exchange rate coefficient across the two tables is weakly negative and stands at approximately -0.01. This implies that a 10 percent real currency appreciation is associated with a 0.001 decline in the current account, that is, a 0.10 percentage point fall which is a relatively small multiplier.^{124,125}

However, aggregating or pooling over disparate exchange rate regimes may blur the lines of analysis by biasing the sum of the real exchange rate coefficients towards zero. This can occur if the correlations across the different exchange rate arrangements offset each other. In particular, one might anticipate that in the presence of low nominal exchange rate flexibility and high price or wage rigidities, equating to a real rigidity, effective expenditure switching will be prevented thus leading to pressure on demand adjustment in order to correct large external imbalances (often these adjustments are abrupt). Naturally, the latter may only provide a temporary solution if output is moving away from potential output. Here, we are concerned with whether higher exchange rate flexibility can accommodate easier current account adjustment by commanding the dynamics of the real exchange rate (namely by inducing faster and smoother real exchange rate adjustment).

Tables 4.14-4.15 display the augmented linear specification results in the cases of continuous and discrete measures of nominal exchange rate flexibility. For large imbalances, we find that the degree of regime flexibility plays a significant role in the current account-real exchange rate relation as well as the average persistence of the current account itself. With respect to the latter, regardless of the flexibility measure employed, the estimates unequivocally indicate that less rigid exchange rates are connected with less persistent external imbalances. Figure 4.1 graphically illustrates this

¹²⁴ A 10 percent real currency appreciation refers to a +10 percent change in the real exchange rate.

¹²⁵ Krugman (1989) contends that a small expenditure-switching effect may amplify nominal exchange rate volatility. He notes that the smaller the impact of exchange rate changes on relative prices, and thus on relative demands, the larger the required exchange rate change for achieving equilibrium (this argument and its limitations are furthered discussed by Devereux and Engel (2002) in the context of new open economy macroeconomic models). However, the expenditure-switching effect of a given real exchange rate movement may also change at higher nominal exchange rate variability levels if the pricing strategies of firms or the frequency with which import and export volume contracts are reset change (i.e. are influenced by the higher volatility) for example.

point in the case of table 4.14. Specifically, figure 4.1 shows that the sum of the current account coefficients, representing the rate of own-current account adjustment, typically declines towards lower positive values as nominal exchange rate volatility in the sample increases. For example, the first graph of the figure indicates that, after controlling for relative prices multilaterally, current account persistence coefficients across the different estimators can rise above 1 (non-convergence) at the lowest levels of nominal effective exchange rate volatility, and fall below 0.60 at the highest levels of such variability. One potential explanation for this is that under more volatile or flexible exchange rate regimes, relatively larger and more frequent interest rate changes may arise in anticipation of exchange rate movement, thus leading to output-shifting-based external adjustment.

Over both measures, the tables also reveal that the contemporaneous inverse relation found earlier in equation (4.1) normally disappears under more inflexible exchange rate arrangements, with the pattern of real exchange rate coefficient values reminiscent of a J-curve effect.¹²⁶ The only exception to this result is the REER case under the discrete measure, where the contemporaneous correlation remains negative and statistically significant. Focusing on the system GMM output, as exchange rate flexibility rises, it either gradually reintroduces the negative contemporaneous relation between the current account and real exchange rate while attenuating any negative correlations with lags of the real exchange rate, or has no effect on the contemporaneous link but induces an inverse relation with the lags.

Notably, the long-run real exchange rate coefficients reported at the bottom of tables 4.14-4.15 indicate that a negative comovement between the current account and real exchange rate is established at greater nominal exchange rate variability or flexibility levels. This result tends to hold across almost all estimation procedures. For table 4.14, figure 4.2 graphically depicts the link between the sum of the real exchange rate coefficient estimates and nominal exchange rate variability, while figure 4.3 does the same for the link between the long-run real exchange rate coefficient and nominal exchange rate variability. Both figures normally show an inverse correlation, with less variable exchange rates being associated with less negative or more positive (summed or long-run) real exchange rate coefficients.

¹²⁶ See, for instance, Leonard and Stockman (2002) for a formal definition of the J-curve.

Table 4.14 gives the long-run real exchange rate effects at low, moderate and high nominal exchange rate volatility levels whenever the calculation is possible. Specifically, low volatility represents volatility levels that are effectively zero and therefore base estimates are employed in the computation of the long-run coefficient; moderate volatility denotes the average, which is approximately equal to the median, level of volatility in the sample of concern; and high volatility reflects the maximum value of volatility found in the sample. For nominal exchange rate volatility levels close to zero, the current account typically exhibits explosive dynamics, thus violating the condition required for the calculation of the long-run coefficient. However, based on the cases where the computation is feasible in this instance, statistically insignificant positive coefficients are reported. For moderate volatility levels, the average long-run real exchange rate coefficient across the different specifications is -0.12 implying that a 10 percent real currency appreciation is associated with approximately a 0.01, or 1 percentage point, decline in the current account. Examining the high volatility scenario, the average coefficient is -0.32 suggesting that a 10 percent real currency appreciation is correlated with roughly a 0.03, or 3 percentage point, attenuation of the current account balance.

Using de facto exchange rate regime indicators, the long-run coefficients in table 4.15 indeed also suggest a similar trend, with intermediate regimes displaying the strongest inverse current account-real exchange rate relations. In particular, under fixed exchange rate arrangements, the average long-run real exchange rate impact across the columns is -0.03. On the other hand, in the case of the intermediate exchange rate regime the average coefficient drops to -0.42, while under the flexible regime it drops to -0.07.

Overall, higher exchange rate flexibility acts to facilitate a stabilising relation between the real exchange rate and current account, in the sense that it helps to induce a stronger inverse relation between the two variables, thus accommodating any required adjustments. Appendix C reports the findings for different country groups, which are broadly commensurate with the aggregate results.¹²⁷ One salient feature of the tables is

¹²⁷ In particular, the grouped tables C4.1.1-C4.1.4, C4.2.1-C4.2.4, and C4.3.1-C4.3.4 provide the baseline, nominal exchange rate volatility augmented, and nominal exchange rate regime augmented linear specification results respectively. Estimates are only provided for REER-based regressions since BRER-based findings are similar. In addition, euro zone results are not provided for the augmented specification

that, controlling for the real exchange rate, non-advanced economies are typically shown to have lower current account persistence.¹²⁸

Tables 4.16-4.19 split the sample by nominal currency appreciation and depreciation periods respectively, and repeat the preceding analysis in the case of REERs.¹²⁹ The regressions are executed separately for each of the samples in order to avoid overloading the model with interaction terms. The results from the baseline specification indicate that a negative long-run current account-real exchange rate relation is virtually non-existent during effective currency devaluation episodes (table 4.17). However, augmenting the specification with nominal exchange rate volatility or regime dummies reveals a negative bivariate link during currency devaluations, with the same type of pattern across variability levels observed as before. Intuitively, one would expect greater nominal exchange rate variability to matter relatively more for devaluations and external adjustment in the presence of downward price or nominal wage stickiness. Although sample size may be an influential factor, we note that statistically significant long-run coefficients only appear on the $\Delta neer_t < 0$ side in tables 4.18 and 4.19. Moreover, despite being insignificant, the difference and system GMM long-run real exchange rate coefficients in table 4.18 are larger in absolute terms at the high volatility level for the $\Delta neer_t < 0$ sample.

4.5 Non-linear analysis

We now turn to examining whether differential results exist across relatively appreciated and relatively depreciated real exchange rate scenarios. Table 4.20 shows results for the baseline non-linear specification. We note again, from a theoretical standpoint, that high (low) values of rer_{t-1} are associated with current account deterioration (improvement) due to competitiveness losses (gains) and that in this upper (lower) regime the relevant regressor coefficients are approximately $\mu + \mu^*$ (μ),

when the discrete measure of nominal exchange rate rigidity is employed given the insufficient number of flexible regime observations.

¹²⁸ This result could be related to the fact that advanced economies have better access to international capital markets and therefore are able to sustain imbalances for longer. A recent exception has been the tightening of external financing conditions for some of the euro area economies characterised by high external liabilities. The outcome for such economies has been sharp current account adjustment (post 2008).

¹²⁹ Similar results are found for BRERs.

representing the sum of the linear and non-linear coefficients (linear coefficient) as the transition function tends to one (zero).¹³⁰ To facilitate interpretation, we focus on the regression coefficients corresponding to the extreme lower and upper regimes at $G(\text{rer}_{i,t-1}; \sigma, c) = 0$ and 1 respectively.

The baseline results indicate significant differences in the dynamics of the current account-real exchange rate relation across the upper and lower regimes of current account movement. Moreover, the results also vary somewhat over multilateral and bilateral exchange rates. The overall R^2 values are reasonably high while the regression standard errors are low implying that the data have been fitted well.¹³¹ We note that the transition parameter is statistically significant in all samples except one, namely the full BRER-based sample in column (2), thus providing support for the non-linear approach. Columns (3) and (4) provide comparable samples of the same 50 countries. Focusing on the respective full sample and sub-sample cases, it is evident that the results are not greatly altered by the exclusion of the US in column (3), and the exclusion of the Baltic countries, some developing countries, and other Eastern European nations in column (4).

From table 4.20, one can arrive at current account persistence coefficients of around 0.33 and 0.78 when $G(.) = 0$ in the case of REER and BRER-based samples respectively. On the other hand, the typical coefficients for these samples are 0.85 and 0.59 when $G(.) = 1$. The REER-based results suggest that the current account on average is less persistent in the lower regime associated with current account improvement (i.e. falling deficits or rising surpluses) than in the upper regime, while the reverse holds in the BRER-based sample. This discrepancy across multilateral and US-based bilateral real exchange rates may come as somewhat surprising given the high empirical correlation between the two series, but is most likely due to differences in the estimated threshold parameter.

However, the implications of the real exchange rate coefficients are qualitatively the same across REER and BRER samples. Specifically, the baseline regressions reveal that contemporaneous real exchange rate appreciation is connected to a worsening of

¹³⁰ This link between the current account and real exchange rate may differ for pegger countries as illustrated in our linear analysis in section 4.4 and by Lane and Milesi-Ferretti (2011) over the short time interval 2007-2010.

¹³¹ Nevertheless, we still interpret these statistics with caution given the tendency for non-linear models to overfit the data.

the current account in the lower regime, whereas past real exchange rate appreciation tends to be linked to improving current account balances in the same regime. In contrast, the contemporaneous negative relation between the current account and real exchange rate is attenuated in the upper regime (becoming positive), while an inverse relation with the second lag of the real exchange rate develops as one moves towards this regime. These dynamics are therefore suggestive of a J-curve effect in the upper regime.

The bottom of table 4.20 shows that the long-run real exchange rate coefficient in the lower regime across the 4 columns is always negative and around -0.04 on average. In contrast, this coefficient turns positive in the upper regime in the case of multilateral exchange rates, with the average estimate across the different samples standing at -0.00. We investigate these baseline results further by decomposing our samples into high and middle to low income country groups. In particular, significant discrepancies in dynamics and real exchange rate thresholds across the two groups could be skewing results at the aggregate level. Table 4.21 reports the baseline estimates for these two country groups and offers some evidence of heterogeneity. Across the samples, there is more consistent support for faster current account convergence in the lower regime after controlling for the real exchange rate. Middle-low income economies are characterised by a negative long-run coefficient in each of the two regimes, with a much stronger negative and significant estimate in the lower regime. In contrast, the results are reversed for high income nations with almost no evidence of a negative long-run relation between the current account and real exchange rate in either regime.

Table 4.22 reports the augmented non-linear panel estimates and casts doubt over the baseline specification results by showing that the current account-real exchange rate relation varies across differing degrees of nominal exchange rate variability. First, across all samples we observe that the transition parameter is statistically significant and furthermore that the R^2 values are now higher. Results also appear to be more consistent qualitatively across REER and BRER samples.

For fixed exchange rate regimes, as proxied by low nominal exchange rate volatility, the estimates suggest that the current account is more persistent in the upper regime, and in fact becomes explosive. This evidence coincides with the highly persistent current account deficits of the euro area peripheral economies (from around

1998), which are considered to have had overvalued real exchange rates. Interestingly, the rate of current account persistence tends to decline with nominal exchange rate flexibility in both regimes, but generally by more in the upper regime when prices need to come down in order to improve the current account via expenditure switching. More generally, higher volatility can entail greater economic uncertainty or instability and thus stimulate capital outflows thereby forcing current account re-adjustment as the private funds for running deficits dry up.¹³²

Nominal exchange rate rigidity further implies no significant connection or at the very most a positive relation between the current account and real exchange rate in the lower regime based on the individual base contemporaneous and lagged real exchange rate coefficients. Indeed, the cumulative real exchange rate impact at the low volatility level is positive, but insignificant, indicating that exchange rate-driven external adjustment is difficult to achieve in such an environment. However, increasing nominal exchange rate volatility in the lower regime of current account movement tends to engender a negative link between the current account and real exchange rate. In particular, the average long-run real exchange rate coefficients across the samples at the moderate and high levels of volatility are -0.06 and -0.21 respectively.

In the upper regime, most of the base correlations between the current account and real exchange rate, contemporaneous and lagged, are negative or less positive when compared to those of the opposite regime. In fact, the sum of the base real exchange rate coefficients is negative in all cases in table 4.22. This provides broad evidence in favour of the idea that for large deteriorating imbalances, associated with high real exchange rate appreciation under a fixed exchange rate regime, a threshold may eventually be reached that prompts downward price or wage flexibility and hence a reversal. Indeed, some of the euro peripheral economies (GIIPS) observed substantial current account deficit reversals from 2008 onwards when unit labour costs were decreasing.¹³³

¹³² Although in the euro area of fixed exchange rates, in the presence of uncertainty coupled with high risk aversion, private capital flows effectively vanished and in the initial years of the crisis were replaced by Target 2 imbalances which allowed the deficits to persist in peripheral economies.

¹³³ GIIPS is an abbreviation used for the countries Greece, Ireland, Italy, Portugal and Spain. However, Ireland was the only country to see a real fall in unit labour costs. For example, unit labour cost declines in Spain were to a certain extent prompted by emigration and a reduction in the labour force. However, examining the last three decades as a whole, Ordóñez et al. (2014) find that the GIIPS succeeded in reducing their real unit labour costs by more than their northern partners. The authors report that, with the exception of Ireland, technological progress was weak and that capital intensification was the underlying reason for gains in efficiency and competitiveness in peripheral economies.

Strikingly, the long-run relation between the current account and real exchange rate in the upper regime of current account movement is positive, and thus destabilising, at higher degrees of nominal exchange rate variability. Specifically, the average long-run coefficients for moderate and high volatility are 0.17 and 0.37 respectively. A possible interpretation of this result in the upper regime is that most of the adjustment under greater volatility occurs directly through expenditure reduction (rather than expenditure switching), as reflected by the current account coefficients, given capital outflows due to the uncertainty. Alternatively, the finding could be the product of sufficiently heterogeneous country groups within the overall samples.

With the latter point in mind, we also present the augmented non-linear specification estimates by country income levels in Table 4.23. The results suggest that the high-income cohort of nations is the driver of the earlier upper regime findings in table 4.22. To be exact, these economies generally display positive long-run real exchange rate coefficients in both regimes when nominal exchange rate variability is higher. Moreover, *ceteris paribus*, they tend to exhibit lower current account persistence with higher nominal exchange rate volatility in either regime. On the other hand, an inverse link between the cumulative real exchange rate effect and volatility is reported in the lower and upper regimes for middle-low income nations, with typically stronger negative long-run coefficients in the former regime. Nevertheless, evidence for an inverse relation between current account persistence and volatility in both regimes is weaker in this case. In fact, a negative link between the two can only be observed in the REER-based sample when inspecting the upper regime. Focusing on column (2) of table 4.23, the implication for non-high income countries under less rigid exchange rates is that both expenditure-switching and output-shifting can contribute to adjustment in the upper regime where a current account improvement may be required. Overall, these results are in line with the observation that nominal or real exchange rate volatility and faster external adjustment have been a relatively more notable characteristic of the developing world.

4.6 Cross-section findings on current account persistence and covariates

Current account balances across countries typically displayed very low persistence over the sample period, with the overall mean and median half-lives from equation (4.12) standing at 1.33 and 0.95 years respectively (much lower than that of annual real exchange rates). Table 4.24 also indicates that advanced economies observed more protracted external imbalances than non-industrial countries perhaps reflecting their relative ease of access to financial markets. Specifically, emerging and developing economies are characterised by a half-life of less than 1 year, roughly half of that of advanced nations. The same general pattern holds for AR(1) estimates, although the half-life is now around 1.50 years for the former cohort of countries according to the median statistics. Consistent with these results, the table also shows that countries classified as 'high income' display greater inertia in external imbalances. Categorising by nominal exchange rate arrangement, table 4.24 lastly provides some evidence in favour of slower current account adjustment for economies that largely maintained, or averaged, a fixed exchange rate over the 1973-2010 period. We focus on current account persistence estimates from (4.12) in order to be as closely consistent with the real exchange rate equivalents adopted from chapter 2.¹³⁴

Figure 4.4 plots current account persistence (in logs) against both REER and BRER persistence (in logs) and yields new findings. The salient feature of the graphs is the positive and statistically significant bivariate relation in each case, with correlations of 0.31 and 0.48 respectively, suggesting that real exchange rate misalignment durability has an important role to play in the correction of external imbalances. Moreover, although unreported, this relation continues to hold across country groups and nominal exchange rate regimes with greater flexibility normally entailing lower inertia in both variables.¹³⁵ Noting the red dashed reference line designating the 1-year half-life mark on either axis, we can see that pegger countries such as euro area and European ERM (Exchange Rate Mechanism) II members predominantly populate the

¹³⁴ Note that, for a given country, (4.12) may end up as (4.11) if the lags and trend are all insignificant. The use of AR(1)-based current account persistence estimates does not change the findings in the cross-sectional regression analysis that follows.

¹³⁵ For the fixed exchange rate regime, one observes relatively higher levels of current account and real exchange rate persistence than in other regimes as shown in chapter 3 and earlier in table 4.24. Results available upon request.

top right quadrants, though Latvia and Lithuania fall slightly below the 1-year current account persistence level.

Interestingly, figures 4.5 and 4.6 reveal directly that current account and real exchange rate persistence both negatively co-vary with nominal exchange rate volatility. As the graphs illustrate, emerging and developing economies, in particular Latin American and Eastern European regions, experienced the highest rates of volatility and lowest rates of persistence simultaneously. This preliminary graphical evidence strongly opposes the conclusion of Chinn and Wei (2013) who contend that the latter factor has no role in the persistence of real exchange rates and thus current account adjustments either.¹³⁶ However, as we have stressed, persistence is a short-run issue and so nominal factors should influence it.

Table 4.25 reports the OLS results from the cross-section regressions of current account persistence on nominal exchange rate volatility and other potential determinants. Collectively, the regressors explain about 40 percent of the variation in current account half-lives. Corroborating the graphical analysis, the estimates invariably point to a highly statistically significant inverse association between current account persistence and nominal exchange rate volatility.¹³⁷ Moreover, the magnitude of the coefficient on nominal exchange rate volatility is notable at -0.31 on average, implying that a 3 percent increase in exchange rate volatility is associated with approximately a 1 percent decrease in the half-life of external imbalances.¹³⁸ In addition, as shown in columns (5)-(8), employing discrete measures of nominal exchange rate flexibility yields evidence of faster reversion in the current account under intermediate and flexible exchange rate regimes.

Splitting the sample into predominantly current account surplus and predominantly current account deficit countries over the period of study, table 4.26 now indicates that the comovement with nominal exchange rate volatility is mainly significant in the latter case. At the same time, we recognise that sample size may be the problem in the former group. The large coefficient in the surplus sample is due to the outliers of Hong Kong, Singapore, and Russia. Again, this result might coincide with

¹³⁶ Specifically, they focus on binary measures of exchange rate flexibility.
¹³⁷ In chapter 3, we perform a similar parametric exercise for real exchange rate persistence and obtain a negative coefficient on nominal exchange rate volatility.
¹³⁸ This estimate is quite robust to different specifications.

our earlier reasoning, namely that nominal exchange rate flexibility may be more useful in a deficit scenario when downward price or wage rigidities are prevalent.

Table 4.27 reports that the negative correlation also tends to hold across all country groups. However, the majority of the estimates are statistically insignificant due to small sample sizes. On the other hand, we note that significance can be achieved under more parsimonious specifications that exclude highly insignificant covariates.¹³⁹ Continuing with the full specification results of table 4.27, the volatility coefficient for industrial countries is highly influenced by Iceland, whose currency has historically been relatively volatile. Of note, the Icelandic krona plummeted in value during the country's crisis before its collapse in the final quarter of 2008.

From table 4.25, we also see that current account persistence falls with the absolute size of imbalances. Noting that countries that observed largely deficits over time dominate the sample, this result is in accord with the sharp reversals that sometimes arise at deficit thresholds due to a loss of financing. Indeed, ignoring statistical significance, the deficit sample in table 4.26 shows a negative coefficient on size whereas the surplus sample yields a positive one.

An assessment of the remaining coefficients reveals that a number of other statistically significant covariates emerge. For instance, the net foreign asset position, a variable that varies substantially across countries but is relatively more stable within countries over time, has a negative relation with current account persistence in full sample specifications. This implies that countries with larger levels of external debt run more persistent imbalances. Indeed, financial constraints on international borrowing can mean a country may have to run persistent surpluses to pay off its debt before being able to borrow again. Conversely, external debt may also be associated with persistent deficits (as long as threshold is not reached) if the economy is attempting to smooth consumption in anticipation of higher income levels in the future. Analysis across country groups indicates that the relation is positive, but insignificant, for emerging economies. China is an example of a transitional economy that has built up its net foreign asset position (through the purchase of US T-bills/securities) by maintaining persistently large current account surpluses.

¹³⁹ Results available upon request.

The government budget balance, our proxy for public debt, generally comoves negatively with the persistence rate. Thus, budget surpluses tend to be related to less persistent external imbalances. This suggests that twin deficits can arise as budget deficits may be related to more persistent current account deficits. In recovery periods, nations may observe an attenuation of current account deficits while the government moves from budget deficit to surplus.

Current account persistence also falls with trade openness but rises with international financial integration (volume-based measure) and domestic financial development, as measured by domestic private credit creation, in full sample cases. Greater trade openness or liberalisation can result in faster external adjustment by inducing real exchange rate or relative price effects on the trade balance. The implications of heightened capital market openness and development are more equivocal. Improved international financial integration can help delink savings and investment thereby permitting more persistent current account imbalances but at the same time may also attenuate persistence through the transmission of financial shocks across nations. Inadequate domestic financial market conditions can prompt persistent outflows of capital from the home country associated with persistent current account surpluses. This capital may in turn provide the recipient country, characterised by more sophisticated capital markets, with the ammunition to run persistent deficits.¹⁴⁰ Indeed, our point estimates provide evidence that greater international financial integration and less developed domestic financial markets are both associated with more persistent imbalances in emerging and developing economies.¹⁴¹ Basing the analysis on just coefficient signs, the opposite is the case for industrial countries.

With respect to demographic factors, youth and old-age dependency ratios are consistently negatively related to current account inertia.¹⁴² The only exception is in the case of industrial countries for which the old-age dependency ratio comoves positively

¹⁴⁰ In the absence of significant capital controls.

¹⁴¹ Greater international financial integration can facilitate higher levels of international borrowing by non-industrial economies during the convergence process (to higher income levels due to expected growth). We also employed alternative measures of international financial integration as well as financial development and found similar results. These include the equity-based measure of financial integration and the Chinn and Ito index of financial openness for the former, and different World Bank financial development variables for the latter. These alternative measures are labelled as *ifi2*, *fopen*, *fdev2*, and *fdev3* in appendix B and are comprehensively defined therein.

¹⁴² Population growth was also employed instead of the youth dependency ratio and the results were unaltered. See appendix B for definition of population growth.

with persistence (albeit insignificantly) perhaps implying that retirees in these economies have larger savings to draw on, making reversals in deficit countries more difficult.¹⁴³ Surpluses on the other hand would become less persistent (e.g. emerging Asia). The very old are also less likely to borrow or be lent to while the very young (under 15 years of age) generally do not save or officially borrow (for larger investments/consumption, such as buying a house or car). These tendencies are likely to be associated with less persistent deficits and surpluses.

Finally, current account persistence is positively tied to per capita income and, somewhat counter-intuitively, negatively to productivity growth in the full sample. Across country groups and different samples in table 4.27 however, the coefficients are by and large statistically insignificant. Industrial countries form the only group for which the sign of the productivity growth coefficient is positive. This is consistent with the notion that nations characterised by higher economic growth are able to convince markets more easily that loans will be repaid and therefore borrow more to smooth the consumption path.

4.7 Conclusion

Based on a sample of 73 economies over the post Bretton Woods era, this paper examines the empirical bivariate relation between large external imbalances and the real exchange rate for different levels of nominal exchange rate flexibility. The study ultimately finds that greater nominal exchange rate variability generally acts to stabilise the current account-real exchange rate relation, in the sense that it engenders more effective and immediate expenditure-switching-based adjustment. Indeed, under more rigid regimes the link is normally weak with the pattern of real exchange rate coefficients reminiscent of the J-curve effect. In addition, we find evidence that nominal exchange rate flexibility plays a relatively more important role during (nominal) currency devaluations which is intuitively plausible if prices or nominal wages are more downward than upward inflexible. Interestingly, we do however retain results suggesting that the current account-real exchange rate relation can become destabilising

¹⁴³ We do note though that more benevolent old agents are likely to consume less of their savings as they continue to save for their offspring. This may be particularly true in (non-advanced) economies in which economic conditions are not the best. This would act to mitigate the effects on persistence.

at high levels of nominal exchange rate volatility when the real exchange rate is sufficiently relatively appreciated. Dissecting the findings, we observe that this result is being predominantly driven by high-income countries.

Along the cross section dimension, we observe a striking positive correlation between current account and real exchange rate persistence. Significantly, evidence consistently points to an inverse relation between persistence in either of the main variables and nominal exchange rate variability or flexibility. Although there is a positive link between nominal exchange rate regime flexibility and nominal exchange rate volatility in our study, it is important to stress that flexible regimes are not strictly akin to unstable nominal exchange rates. According to Friedman (1953), instability of the nominal exchange rate arises from instability in the underlying economic structure. In contrast to some of the recently conducted research, our systematic empirical investigation has offered support for the notion that more variable nominal exchange rates can aid in the prevention of explosive or highly persistent global imbalances. Nevertheless, the related question of whether there exists a higher incidence of real and nominal shocks under more flexible arrangements that could ultimately be prompting real exchange rate volatility and thus observed current account behaviour still remains (see Clarida and Gali (1994) for example). Furthermore, the extent and sources of such shocks across different countries is also of interest since the policy objective, as Friedman envisaged it, should be to reach a state in which the nominal exchange rate is relatively stable but at the same time is free to vary. Indeed, these questions warrant further attention in the particular context of current account adjustment and are left to future research.

4.8 References

- Anderson, T.W. and Hsiao, C. 1981. Estimation of Dynamic Models with Error Components. *Journal of the American Statistical Association*, Vol.76, No.375, pp598-606.
- Arellano, M. and Bond, S. 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, Vol.58, No.2, pp277-297.
- Auer, R.A. 2013. What Drives Target2 Balances? Evidence From a Panel Analysis. Working Paper prepared for the 57th Panel Meeting of Economic Policy in Dublin.
- Blundell, R. and Bond, S. 1998. Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics*, Vol.87, No.1, pp115-143.
- Bohn, H. 2007. Are Stationarity and Cointegration Restrictions Really Necessary for the Intertemporal Budget Constraint? *Journal of Monetary Economics*, Vol.54, No.7, pp1837-1847.
- Cashin, P. and McDermott, C.J. 2006. Parity Reversion in Real Exchange Rates: Fast, Slow, or Not at All? *IMF Staff Papers*, Vol.53, No.1, pp89-119.
- Cheung, Y.-W. and Lai, K.S. 2000a. On Cross-Country Differences in the Persistence of Real Exchange Rates. *Journal of International Economics*, Vol.50, No.2, pp375-397.
- Chinn, M. and Prasad, E. 2003. Medium-Term Determinants of Current Accounts in Industrial and Developing Countries: An Empirical Exploration. *Journal of International Economics*, Vol.59, No.1, pp47-76.
- Chinn, M. and Wei, S.-J. 2013. A Faith-based Initiative: Do We Really Know that a Flexible Exchange Rate Regime Facilitates Current Account Adjustment? *Review of Economics and Statistics*, Vol.95, pp168-184.
- Clarida, R. and Gali, J. 1994. Sources of Real Exchange Rate Fluctuations: How Important are Nominal Shocks? CEPR Discussion Paper No.951.

Clower, E. and Ito, H. 2012. The Persistence and Determinants of Current Account Balances: The Implications for Global Rebalancing. Asian Development Bank Institute Working Paper Series, Research Paper No.400.

Cuestas, J.C. and Regis, P.J. 2013. On the relationship between exchange rates and external imbalances: East and Southeast Asia. Working Papers on International Economics and Finance DEFI 13-08.

Debelle, G. and Faruquee, H. 1996. What Determines the Current Account? A Cross-Sectional and Panel Approach. IMF Working Paper 96/58.

Devereux, M.B. and Engel, C. 2002. Exchange Rate Pass-Through, Exchange Rate Volatility, and Exchange Rate Disconnect. *Journal of Monetary Economics*, Vol.49, No.5, pp913-940.

Edwards, S. 2007. On Current Account Surpluses and the Correction of Global Imbalances. National Bureau of Economic Research Working Paper No.12904.

Engel, C. 2002. Expenditure Switching and Exchange-Rate Policy. In *National Bureau of Economic Research Macroeconomics Annual 2002*, ed. by Gertler, M. and Rogoff, K. (MIT Press), pp231-272.

Engel, C. 2012. Real Exchange Rate Convergence: The Roles of Price Stickiness and Monetary Policy. Working Paper, University of Wisconsin.

Freund, C. 2005. Current Account Adjustment in Industrialized Countries. *Journal of International Money and Finance*, Vol.24, No.8 pp1278-1298.

Freund, C. and Warnock, F. 2005. Current Account Deficits in Industrial Countries: The Bigger they are, the Harder they Fall? National Bureau of Economic Research Paper No. 11823.

Friedman, M. 1953. The Case for Flexible Exchange Rates. In *Essays in Positive Economics*, ed. by Friedman, M., Chicago: The University of Chicago Press (pp157-203).

Ghosh, A.R. 1995. International Capital Mobility Amongst the Major Industrialised Countries: Too Little or Too Much? *The Economic Journal*, Vol.105, No.428, pp107-128.

Ghosh, A.R. and Ostry, J.D. 1995. The Current Account in Developing Countries: A Perspective from the Consumption-Smoothing Approach. *The World Bank Economic Review*, Vol.9, No.2, pp305-333.

Ghosh, A.R., Terrones, M. and Zettelmeyer, J. 2010. Exchange Rate Regimes and External Adjustment: New Answers to an Old Debate. In *The New International Monetary System: Essays in Honor Of Alexander Swoboda*, ed. by Wyplosz, C., (London: Routledge, 2010).

Goldfajn, I. and Valdés, R.O. 1999. The Aftermath of Appreciations. *Quarterly Journal of Economics*, Vol.114, No.1, pp229-262.

González, A., Teräsvirta, T. and van Dijk, D. 2005. Panel Smooth Transition Regression Models. SSE/EFI Working Paper Series in Economics and Finance. Research Paper No. 604.

Hansen, B. 1999. Threshold Effects in Non-Dynamic Panels: Estimation, Testing, and Inference. *Journal of Econometrics*, Vol.93, No.2, pp345-368.

Hjalmarsson, E. and Österholm, P. 2007. Testing for Cointegration Using the Johansen Methodology when Variables are Near-Integrated. Board of Governors of the Federal Reserve System, International Finance Discussion Paper No.915.

Ilzetki, E., Reinhart, C. and Rogoff, K.S. 2011. The Country Chronologies and Background Material to Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold? Mimeo.

Judson, R.A. and Owen, A.L. 1999. Estimating Dynamic Panel Data Models: A Guide for Macroeconomists. *Economics Letters*, Vol.65, No.1, pp9-15.

Krugman, P. 1989. *Exchange Rate Instability*. Cambridge: MIT Press.

Lane, P.R. and Milesi-Ferretti, G.M. 2011. External Adjustment and the Global Crisis. Institute for International Integration Studies Discussion Paper No.369.

Lane, P.R. and Milesi-Ferretti, G.M. 2013. Global Imbalances and External Adjustment After the Crisis. Prepared for Central Bank of Chile's Annual Research Conference.

Lee, J. and Chinn, M.D. 2006. Current account and real exchange rate dynamics in the G7 countries. *Journal of International Money and Finance*, Vol.25, pp257-274.

Lee, J., Milesi-Ferretti, G.M., Ostry, J., Prati, A. and Ricci, L.A. 2008. Exchange Rate Assessments: CGER Methodologies. International Monetary Fund Occasional Paper No.261.

Leonard, G. and Stockman, A.C. 2002. Current Accounts and Exchange Rates: A New Look at the Evidence. *Review of International Economics*, Vol.10, No.3, pp483-496.

Mussa, M. 1986. Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications. *Carnegie-Rochester Series on Public Policy*, Vol.25, No.1, pp117-214.

Nam, D. 2011. The Roles of Nominal Exchange Rate and Relative Price Adjustment in PPP Reversion. *Journal of Money, Credit and Banking*, Vol.43, No.4, pp775-785.

Obstfeld, M. 2012. Does the Current Account Still Matter? *American Economic Review*, Vol.102, No.3, pp1-23.

Obstfeld, M. and Rogoff, K.S. 1995. Exchange Rate Dynamics Redux. *Journal of Political Economy*, Vol.103, No.3, pp624-660.

Obstfeld, M. and Rogoff, K.S. 1998. Risk and Exchange Rates. National Bureau of Economic Research Working Paper No.6694.

Obstfeld, M. and Rogoff, K.S. 2000a. New Directions for Stochastic Open Economy Models. *Journal of International Economics*, Vol.50, No.1, pp117-153.

Obstfeld, M. and Rogoff, K.S. 2001. The Six Major Puzzles in International Macroeconomics: Is There a Common Cause? In *National Bureau of Economic Research Macroeconomics Annual 2000*, ed. by Bernanke, B.S. and Rogoff, K.S. (MIT Press), pp339-412.

Obstfeld, M. and Rogoff, K.S. 2005. Global Current Account Imbalances and Exchange Rate Adjustments. *Brookings Papers on Economic Activity*, Vol.36, No.1, pp67-146.

Obstfeld, M. and Rogoff, K.S. 2007. The Unsustainable U.S. Current Account Position Revisited. In *G7 Current Account Imbalances: Sustainability and Adjustment*, ed. by Clarida, R. (NBER Inc.), pp339-376.

Ordóñez, J., Sala, H. and Silva, J.I. 2014. Real Unit Labour Costs in Eurozone Countries: Drivers and Clusters. Universitat Autònoma de Barcelona, Departament d'Economia Aplicada, Document De Treball 14.05.

Pancaro, C. 2013. Current Account Reversals in Industrial Countries: Does the Exchange Rate Regime Matter? European Central Bank Working Paper No.1547.

Roodman, D.M. 2009a. A Note on the Theme of Too Many Instruments. *Oxford Bulletin of Economics and Statistics*, Vol.71, No.1, pp135-158.

Roodman, D.M. 2009b. How to do xtabond2: An Introduction to Difference and System GMM in Stata. *Stata Journal*, Vol.9, No.1, pp86-136.

Schmitz, M., De Clercq, M., Fidora, M., Lauro, B. and Pinheiro, C. 2012. Revisiting the Effective Exchange Rates of the Euro. European Central Bank Occasional Paper No.134.

Teräsvirta, T. 1994. Specification, Estimation and Evaluation of Smooth Transition Autoregressive Models. *Journal of the American Statistical Association*, Vol.89, No.425, pp208-218.

Windmeijer, F. 2005. A Finite Sample Correction for the Variance of Linear Efficient Two-Step GMM Estimators. *Journal of Econometrics*, Vol.126, No.1, pp25-51.

Table 4.1A: Current Account Panel Unit Root Tests: Unbalanced Panel of 73 countries, all CA balances, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.00	0.00	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag	0.00	0.00	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, no lags, demeaned	0.00	0.02	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag, demeaned	0.00	0.01	0.00	0.00	0.00	0.00
Pesaran CADF, no lags	0.00	0.01	0.00	0.00	0.00	0.00
Pesaran CADF, 1 lag	0.00	0.07	0.00	0.00	0.00	0.00

Notes: Current account to GDP ratio is employed. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the demeaned option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects null.

Table 4.1B: Current Account Panel Unit Root Tests: Balanced Panel of 54 countries, 1980-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
Levin, Lin and Chu, no lags	0.00	0.00	0.00	0.00	0.00	0.00
Levin, Lin and Chu, 1 lag	0.00	0.00	0.00	0.00	0.00	0.00
Levin, Lin and Chu, no lags, demeaned	0.00	0.01	0.00	0.00	0.00	0.00
Levin, Lin and Chu, 1 lag, demeaned	0.00	0.00	0.00	0.00	0.00	0.00
Im, Pesaran and Shin, no lags	0.00	0.03	0.00	0.00	0.00	0.00
Im, Pesaran and Shin, 1 lag	0.00	0.00	0.00	0.00	0.00	0.00
Im, Pesaran and Shin, no lags, demeaned	0.00	0.06	0.00	0.00	0.01	0.00
Im, Pesaran and Shin, 1 lag, demeaned	0.00	0.01	0.00	0.00	0.00	0.00

Notes: Current account to GDP ratio is employed. P-values are displayed. Null hypothesis is that all panels contain unit roots. The alternative hypothesis in the Levin, Lin and Chu test is that 'all panels are stationary', while in the Im, Pesaran and Shin test it is that 'some panels are stationary'. The Fisher test and Pesaran CADF panel unit root test with cross section dependence also reject the null of non-stationarity.

Table 4.1C: Current Account Panel Unit Root Tests: Unbalanced Panel of 73 countries, $|CA| > 3\%$, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.00	0.00	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag	0.00	0.00	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, no lags, demeaned	0.09	0.19	0.53	0.18	0.02	0.43
PP-Fisher, chi-squared, 1 lag, demeaned	0.03	0.19	0.33	0.20	0.00	0.39
Pesaran CADF, no lags	0.10	0.09	0.10	0.10	0.06	0.05

Notes: Current account to GDP ratio is employed. $|CA| > 3\%$ refers to the sample of current account balances that are in absolute terms greater than 3 percent of GDP. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the ‘demeaned’ option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects null.

Table 4.2A: ln(REER) Panel Unit Root Tests: Unbalanced Panel of 51 countries, full sample, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.00	0.02	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag	0.00	0.00	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, no lags, demeaned	0.00	0.00	0.00	0.05	0.00	0.07
PP-Fisher, chi-squared, 1 lag, demeaned	0.00	0.00	0.00	0.04	0.00	0.04
Pesaran CADF, no lags	0.00	0.28	0.10	0.00	0.05	0.00
Pesaran CADF, 1 lag	0.00	0.03	0.00	0.01	0.00	0.00

Notes: ln(REER) denotes the natural logarithm of the real effective exchange rate. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the ‘demeaned’ option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects the null.

Table 4.2B: ln(REER) Panel Unit Root Tests: Unbalanced Panel of 51 countries, when $|CA| > 3\%$, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.00	0.45	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag	0.00	0.34	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, no lags, demeaned	0.00	0.10	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag, demeaned	0.00	0.09	0.00	0.00	0.00	0.00
Pesaran CADF, no lags	0.07	0.64	0.43	0.03	0.54	0.10

Note: ln(REER) denotes the natural logarithm of the real effective exchange rate. $|CA| > 3\%$ refers to the sample of observations corresponding to current account balances that are greater than 3 percent of GDP in absolute terms. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the ‘demeaned’ option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects the null. The inverse chi-squared, inverse normal, inverse logit and modified inverse chi-squared statistics generally yield consistent conclusions in Fisher tests, particularly in the case of null rejection.

Table 4.3A: ln(BRER) Panel Unit Root Tests: Unbalanced Panel of 72 countries, full sample, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.00	0.24	0.00	0.00	0.09	0.00
PP-Fisher, chi-squared, 1 lag	0.00	0.01	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, no lags, demeaned	0.00	0.01	0.00	0.00	0.81	0.00
PP-Fisher, chi-squared, 1 lag, demeaned	0.00	0.00	0.00	0.00	0.62	0.00
Pesaran CADF, no lags	0.00	0.12	0.54	0.01	0.59	0.00
Pesaran CADF, 1 lag	0.10	0.09	0.98	0.25	0.00	0.12

Notes: ln(BRER) denotes the natural logarithm of the bilateral real exchange rate. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the ‘demeaned’ option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects the null. The inverse chi-squared, inverse normal, inverse logit and modified inverse chi-squared statistics generally yield consistent conclusions in Fisher tests, particularly in the case of null rejection.

Table 4.3B: ln(BRER) Panel Unit Root Tests: Unbalanced Panel of 72 countries, when $|CA| > 3\%$, 1973-2010

Panel Unit Root Test	Full Sample	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
PP-Fisher, chi-squared, no lags	0.04	0.96	0.00	0.92	0.91	0.00
PP-Fisher, chi-squared, 1 lag	0.03	0.00	0.00	0.91	0.00	0.04
PP-Fisher, chi-squared, no lags, demeaned	0.00	0.10	0.00	0.00	0.00	0.00
PP-Fisher, chi-squared, 1 lag, demeaned	0.00	0.10	0.00	0.00	0.00	0.00
Pesaran CADF, no lags	0.04	0.78	0.43	0.43	0.79	0.05

Notes: ln(BRER) denotes the natural logarithm of the bilateral real exchange rate. $|CA| > 3\%$ refers to the sample of observations corresponding to current account balances that are greater than 3 percent of GDP in absolute terms. P-values are displayed. Null hypothesis is that all panels contain unit roots. In tests where the ‘demeaned’ option is specified cross-sectional averages are removed from the data to help mitigate the impact of cross-sectional dependence. Pesaran CADF test is robust to cross-sectional dependence, assumed to arise from a common factor. ADF version of Fisher test also convincingly rejects the null. The inverse chi-squared, inverse normal, inverse logit and modified inverse chi-squared statistics generally yield consistent conclusions in Fisher tests, particularly in the case of null rejection.

Table 4.4: Nominal Exchange Rate Regime Classification: Ilzetski, Reinhart, and Rogoff (IRR) (2011)

Natural Classification	Fine Class. Codes	Coarse Class. Codes
No separate legal tender	1	1
Pre-announced peg or currency board arrangement	2	1
Pre-announced horizontal band that is narrower than or equal to $\pm 2\%$	3	1
De facto peg	4	1
Pre-announced crawling peg	5	2
Pre-announced crawling band that is narrower than or equal to $\pm 2\%$	6	2
De facto crawling peg	7	2
De facto crawling band that is narrower than or equal to $\pm 2\%$	8	2
Pre-announced crawling band that is wider than $\pm 2\%$	9	3
De facto crawling band that is narrower than or equal to $\pm 5\%$	10	3
Moving band that is narrower than or equal to $\pm 2\%$ ¹⁴⁴	11	3
Managed floating	12	3
Freely floating	13	4
Freely falling	14	5
Dual market in which parallel market data is missing	15	6

Table 4.5: Aggregated Nominal Exchange Rate Regime Classification

Classification employed by us	IRR Fine Class. Codes	IRR Coarse Class. Codes
Fixed Exchange Rate Regime (FERR)	1, 2, 3, 4, 5, 6, 7, 8	1, 2
Intermediate Exchange Rate Regime (IERR)	9, 10, 11, 12	3
Flexible Exchange Rate Regime (FIERR)	13, 14	4, 5

¹⁴⁴ i.e. allows for both appreciation and depreciation over time.

Table 4.6: Nominal Exchange Rate Regimes (NERRs) across country groups, 1973-2010 BRER sample

NERR	Advanced Economies		Emerging Economies		Developing Economies		High Income		Middle Income		Low Income		All Countries	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
FERR	559	67	517	54	393	72	748	66	674	59	47	80	1469	63
IERR	181	22	301	32	84	15	274	24	282	25	10	17	566	24
FIERR	96	11	131	14	68	13	109	10	184	16	2	3	295	13
Total	836	100	949	100	545	100	1131	100	1140	100	59	100	2330	100

Notes: ‘BRER sample’ refers to the bilateral real exchange rate sample of countries. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively.

Table 4.7: Nominal Exchange Rate Volatility by Nominal Exchange Rate Regime (NERR) across country groups, 1973-2010 BRER sample

Advanced Economies			Emerging Economies			Developing Economies			High Income			Middle Income			Low Income			All Countries		
Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$
559	67	0.02	514	58	0.01	393	73	0.02	748	66	0.02	671	63	0.02	47	80	0.01	1466	65	0.02
181	22	0.02	291	33	0.02	83	16	0.02	273	24	0.02	272	25	0.02	10	17	0.03	555	25	0.02
96	11	0.03	83	9	0.08	59	11	0.07	108	10	0.03	128	12	0.08	2	3	0.04	238	10	0.05
836	100	0.02	888	100	0.02	535	100	0.02	1129	100	0.02	1071	100	0.02	59	100	0.02	2259	100	0.02

Notes: ‘BRER sample’ refers to the bilateral real exchange rate sample of countries. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively. Nominal exchange rate volatility for year t is calculated as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate during year t. $\bar{v}$ is the sample average annual bilateral nominal exchange rate volatility. The trend in volatility across regimes also holds for median values. That is, lower flexibility is related to lower volatility.

Table 4.8: Nominal Exchange Rate Regimes (NERRs) across country groups, 1973-2010 BRER and $|CA| > 3\%$ sample (72 countries)

NERR	Advanced Economies		Emerging Economies		Developing Economies		High Income		Middle Income		Low Income		All Countries	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
FERR	230	61	266	54	210	75	335	60	358	63	13	57	706	61
IERR	104	28	164	33	50	18	168	30	141	25	9	39	318	28
FIERR	41	11	62	13	20	7	53	10	69	12	1	4	123	11
Total	375	100	492	100	280	100	556	100	568	100	23	100	1147	100

Notes: 'BRER and $|CA| > 3\%$ sample' refers to the bilateral real exchange rate sample of countries and observations for which the absolute value of the current account balance is greater than 3 percent of GDP. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively.

Table 4.9: Nominal Bilateral Exchange Rate Volatility by Nominal Exchange Rate Regime (NERR) across country groups, 1973-2010 BRER and $|CA| > 3\%$ sample (72 countries)

NERR	Advanced Economies			Emerging Economies			Developing Economies			High Income			Middle Income			Low Income			All Countries		
	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$
FERR	230	61	0.02	265	57	0.02	210	76	0.02	335	61	0.02	357	66	0.02	13	57	0.02	705	63	0.02
IERR	104	28	0.03	160	35	0.02	50	18	0.02	167	30	0.02	138	26	0.02	9	39	0.03	314	28	0.02
FIERR	41	11	0.03	39	8	0.08	18	6	0.06	52	9	0.03	45	8	0.08	1	4	0.08	98	9	0.05
Total	375	100	0.02	464	100	0.02	278	100	0.02	554	100	0.02	540	100	0.02	23	100	0.02	1117	100	0.02

Notes: 'BRER and $|CA| > 3\%$ sample' refers to the bilateral real exchange rate sample of countries and observations for which the absolute value of the current account balance is greater than 3 percent of GDP. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively. Nominal bilateral exchange rate volatility for year t is calculated as the standard deviation of the change in the natural logarithm of the monthly nominal bilateral exchange rate during year t . $\bar{v}$ is the sample average annual bilateral nominal exchange rate volatility. The trend in volatility across regimes also holds for median values. That is, lower flexibility is related to lower volatility.

Table 4.10: Nominal Exchange Rate Regimes (NERRs) across country groups, 1973-2010 REER and $|CA| > 3\%$ sample (51 countries)

NERR	Advanced Economies		Emerging Economies		Developing Economies		High Income		Middle Income		All Countries	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%
FERR	230	59	169	53	109	69	299	57	209	62	508	59
IERR	104	27	116	36	32	20	165	31	87	26	252	29
FIERR	54	14	35	11	18	11	65	12	42	12	107	12
Total	388	100	320	100	159	100	529	100	338	100	867	100

Notes: ‘REER and $|CA| > 3\%$ sample’ refers to the real effective exchange rate sample of countries and observations for which the absolute value of the current account balance is greater than 3 percent of GDP. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively.

Table 4.11: Nominal Effective Exchange Rate Volatility by Nominal Exchange Rate Regime (NERR) across country groups, 1973-2010 REER and $|CA| > 3\%$ sample (51 countries)

NERR	Advanced Economies			Emerging Economies			Developing Economies			High Income			Middle Income			All Countries		
	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$	Ob.	%	$\bar{v}$
FERR	224	59	0.01	168	53	0.02	107	68	0.01	293	57	0.01	206	62	0.02	499	59	0.01
IERR	103	27	0.02	112	36	0.02	32	20	0.02	161	31	0.01	86	26	0.03	247	29	0.02
FIERR	54	14	0.02	34	11	0.14	18	12	0.10	64	12	0.02	42	12	0.15	106	12	0.07
Total	381	100	0.01	314	100	0.03	157	100	0.03	518	100	0.01	334	100	0.04	852	100	0.02

Notes: ‘REER and $|CA| > 3\%$ sample’ refers to the real effective exchange rate sample of countries and observations for which the absolute value of the current account balance is greater than 3 percent of GDP. FERR, IERR and FIERR denote the fixed, intermediate and flexible nominal exchange rate regimes respectively. Nominal effective exchange rate volatility for year t is calculated as the standard deviation of the change in the natural logarithm of the monthly nominal effective exchange rate during year t . $\bar{v}$ is the sample average annual nominal effective/multilateral exchange rate volatility. Median statistics in the case of the flexible exchange rate regime are significantly smaller for emerging, developing, and middle income countries, standing at 0.04, 0.03, and 0.04 respectively implying that the data are notably skewed for this particular regime when applied to these country groups. However, the conclusions remain unaltered; namely that more flexible exchange rate regimes entail higher nominal exchange rate volatility.

Table 4.12: Baseline linear CA-REER specification results (equation 4.1 estimates)

$ ca > 0.03$	Pooled OLS	Fixed Effects I	Fixed Effects II	two-step difference- GMM I	two-step difference- GMM II	two-step system- GMM I	two-step system- GMM II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$ca_{i,t-1}$	0.892*** (0.043)	0.777*** (0.049)	0.762*** (0.044)	0.510*** (0.092)	0.571* (0.342)	0.892*** (0.062)	0.894*** (0.049)
$ca_{i,t-2}$	0.069 (0.052)	0.011 (0.058)	-0.001 (0.057)	-0.236*** (0.080)	-0.454 (0.309)	0.071 (0.053)	-0.001 (0.077)
$reer_{i,t}$	-0.077*** (0.015)	-0.066*** (0.018)	-0.060*** (0.015)	-0.051* (0.030)	0.062 (0.097)	-0.086** (0.034)	-0.225*** (0.081)
$reer_{i,t-1}$	0.040* (0.021)	0.026 (0.024)	0.019 (0.022)	-0.019 (0.049)	-0.090 (0.075)	0.058 (0.053)	0.207** (0.086)
$reer_{i,t-2}$	0.038** (0.018)	0.035* (0.019)	0.039** (0.018)	-0.056** (0.024)	-0.076 (0.154)	0.042 (0.037)	0.024 (0.031)
Observations	733	733	733	705	705	733	733
No. of countries	50	50	50	50	50	50	50
Country FEs	No	Yes	Yes				
Time FEs	No	No	Yes	No	Yes	No	Yes
SH test				0.91	1.00	1.00	0.10
AB(1)				0.01	0.06	0.00	0.00
AB(2)				0.23	0.23	0.60	0.89
AB(3)				0.77	0.51	0.53	0.85
Within R ²		0.64	0.68				
Between R ²		0.98	0.98				
Overall R ²	0.84	0.84	0.85				
<i>Long-run coefficient</i>							
$reer$	0.035 (0.095)	-0.024 (0.045)	-0.006 (0.035)	-0.173*** (0.055)	-0.117 (0.146)	0.396 (0.530)	0.051 (0.358)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Analysis reported for 50 countries common to both REER (real effective exchange rate) and BRER (bilateral real exchange rate) series. Results are similar for respective full country samples.

Table 4.13: Baseline linear CA-BRER specification results (equation 4.1 estimates)

$ ca >0.03$	Pooled OLS	Fixed Effects I	Fixed Effects II	two-step difference- GMM I	two-step difference- GMM II	two-step system- GMM I	two-step system- GMM II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$ca_{i,t-1}$	0.894*** (0.045)	0.758*** (0.046)	0.741*** (0.040)	0.284*** (0.077)	0.416*** (0.138)	0.882*** (0.089)	0.825*** (0.170)
$ca_{i,t-2}$	0.062 (0.053)	0.011 (0.061)	0.011 (0.057)	-0.074 (0.058)	-0.084 (0.069)	0.030 (0.096)	-0.196 (0.272)
$brer_{i,t}$	-0.036** (0.014)	-0.038*** (0.015)	-0.050** (0.020)	-0.052** (0.023)	-0.165* (0.094)	-0.036* (0.022)	-0.087 (0.076)
$brer_{i,t-1}$	-0.006 (0.025)	-0.009 (0.024)	-0.006 (0.024)	-0.003 (0.033)	0.061 (0.072)	-0.004 (0.038)	0.052 (0.135)
$brer_{i,t-2}$	0.042** (0.017)	0.030** (0.014)	0.054*** (0.017)	-0.027 (0.018)	0.009 (0.022)	0.030 (0.020)	0.093 (0.104)
Observations	753	753	753	727	727	753	753
No. of countries	50	50	50	49	49	50	50
Country FEs	No	Yes	Yes				
Time FEs	No	No	Yes				
SH test				No	Yes	No	Yes
AB(1)				1.00	0.49	1.00	1.00
AB(2)				0.02	0.00	0.01	0.02
AB(3)				0.88	0.53	0.75	0.55
Within R ²		0.66	0.69	0.41	0.31	0.67	0.74
Between R ²		0.99	0.98				
Overall R ²	0.84	0.83	0.85				
Long-run coefficient							
brer	0.015 (0.110)	-0.074*** (0.024)	-0.010 (0.035)	-0.104*** (0.026)	-0.142* (0.078)	-0.115 (0.100)	0.156 (0.234)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t. $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run bilateral real exchange rate coefficient (brer) is calculated as the sum of the contemporaneous and lagged bilateral real exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Analysis reported for 50 countries common to both REER (real effective exchange rate) and BRER (bilateral real exchange rate) series. Results are similar for respective full country samples.

Table 4.14: Nominal exchange rate volatility augmented linear specification results (equation 4.7 estimates)

ca >0.03	REER-based analysis (1-4)				BRER-based analysis (5-8)			
	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ca _{i,t-1}	1.255*** (0.129)	1.126*** (0.119)	0.935*** (0.274)	1.369*** (0.234)	2.068*** (0.525)	2.162*** (0.510)	1.430 (1.064)	1.122 (1.012)
ca _{i,t-2}	-0.043 (0.184)	-0.057 (0.191)	-0.502* (0.259)	-0.108 (0.265)	-0.121 (0.582)	0.084 (0.551)	0.368 (0.683)	-0.789 (0.562)
ca _{i,t-1} × nervol _{i,t-1}	-0.076*** (0.028)	-0.075*** (0.027)	-0.110** (0.053)	-0.108** (0.047)	-0.152** (0.067)	-0.185*** (0.066)	-0.149 (0.134)	-0.039 (0.131)
ca _{i,t-2} × nervol _{i,t-2}	0.021 (0.039)	0.012 (0.039)	0.075* (0.045)	0.009 (0.055)	0.023 (0.073)	-0.009 (0.067)	-0.046 (0.091)	0.097 (0.071)
rer _{i,t}	-0.098*** (0.023)	-0.117*** (0.026)	0.121 (0.138)	0.093 (0.149)	0.141 (0.112)	0.127 (0.105)	0.271* (0.155)	0.685** (0.311)
rer _{i,t-1}	0.081 (0.073)	0.053 (0.078)	0.175 (0.166)	0.431*** (0.159)	-0.231 (0.148)	-0.188 (0.140)	0.014 (0.201)	-0.553** (0.241)
rer _{i,t-2}	0.066 (0.083)	0.037 (0.077)	-0.036 (0.097)	0.047 (0.146)	0.100 (0.098)	0.079 (0.085)	0.211 (0.146)	-0.008 (0.270)
rer _{i,t} × nervol _{i,t}	0.004* (0.002)	0.008*** (0.002)	-0.035 (0.031)	-0.030 (0.023)	-0.022 (0.015)	-0.021 (0.014)	-0.039* (0.021)	-0.096** (0.039)
rer _{i,t-1} × nervol _{i,t-1}	-0.008 (0.013)	-0.004 (0.014)	-0.033 (0.032)	-0.074** (0.032)	0.029 (0.020)	0.024 (0.018)	-0.006 (0.025)	0.067** (0.031)
rer _{i,t-2} × nervol _{i,t-2}	-0.007 (0.014)	-0.002 (0.013)	-0.000 (0.018)	-0.002 (0.025)	-0.007 (0.013)	-0.007 (0.011)	-0.028 (0.018)	0.008 (0.032)
Observations	733	733	705	733	714	714	681	714
No. of countries	50	50	50	50	50	50	49	50
Country FEs	No	Yes			No	Yes		
Time FEs	No	No		No	No	No	No	No
SH test			1.00	1.00			1.00	1.00
AB(1)			0.00	0.00			0.05	0.00
AB(2)			0.72	0.71			0.43	0.97
AB(3)			0.84	0.42			0.58	0.90
Within R ²		0.65				0.66		
Between R ²		0.98				0.98		
Overall R ²	0.84	0.84			0.84	0.83		
Long-run coefficients								
rer (low nervol)			0.459 (0.646)					0.184 (0.630)
rer (mod. nervol)	-0.116 (0.107)	-0.051 (0.034)	-0.190* (0.102)	-0.200* (0.120)	0.046 (0.074)	-0.118 (0.088)	-0.121*** (0.036)	-0.242** (0.114)
rer (high nervol)	-0.179 (0.163)	-0.014 (0.081)	-0.457 (0.338)	-0.674 (0.472)	0.008 (0.066)	-0.058** (0.023)	-0.208*** (0.076)	-1.006 (3.499)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. nervol is multilateral/effective nominal exchange rate volatility in the case of regressions that employ the real effective exchange rate (REER), and bilateral nominal exchange rate volatility in the case of regressions that employ the bilateral real exchange rate (BRER). FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. At each of the nominal exchange rate volatility levels, low, moderate, and high, the long-run real exchange rate coefficient (rer) is calculated as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Analysis reported for 50 countries common to both REER and BRER series. Results are similar for respective full country samples.

Table 4.15: Nominal exchange rate regime augmented linear specification results (equation 4.8 estimates)

ca >0.03	REER-based analysis (1-4)				BRER-based analysis (5-8)			
	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ca _{i,t-1}	0.855*** (0.045)	0.708*** (0.056)	0.376*** (0.137)	0.867*** (0.063)	0.886*** (0.049)	0.732*** (0.054)	0.394*** (0.089)	0.834*** (0.079)
ca _{i,t-2}	0.100* (0.055)	0.030 (0.059)	-0.124 (0.140)	0.078 (0.099)	0.076 (0.059)	-0.004 (0.059)	-0.060 (0.064)	0.083 (0.095)
ca _{i,t-1} × irrerr2 _{i,t-1}	0.029 (0.049)	0.070 (0.052)	-0.021 (0.157)	-0.002 (0.105)	-0.014 (0.053)	0.022 (0.049)	-0.145 (0.137)	0.046 (0.121)
ca _{i,t-1} × irrerr3 _{i,t-1}	0.218* (0.115)	0.200** (0.101)	-0.094 (0.245)	0.109 (0.190)	0.208* (0.109)	0.169* (0.101)	0.122 (0.139)	-0.086 (0.243)
ca _{i,t-2} × irrerr2 _{i,t-2}	-0.001 (0.063)	0.023 (0.069)	0.145 (0.178)	-0.095 (0.133)	0.015 (0.061)	0.058 (0.071)	-0.068 (0.117)	0.020 (0.136)
ca _{i,t-2} × irrerr3 _{i,t-2}	-0.288*** (0.088)	-0.291*** (0.069)	-0.314** (0.131)	-0.345* (0.201)	-0.266*** (0.073)	-0.274*** (0.057)	-0.312* (0.174)	-0.708*** (0.240)
rer _{i,t}	-0.088*** (0.022)	-0.091*** (0.026)	-0.097* (0.050)	-0.127* (0.072)	-0.018 (0.017)	-0.023 (0.019)	-0.048 (0.034)	-0.055 (0.056)
rer _{i,t-1}	0.035 (0.027)	0.021 (0.029)	0.025 (0.056)	0.084 (0.058)	-0.022 (0.029)	-0.024 (0.028)	0.005 (0.047)	-0.071 (0.061)
rer _{i,t-2}	0.059*** (0.019)	0.057*** (0.020)	-0.029 (0.043)	0.047** (0.019)	0.043*** (0.016)	0.030** (0.015)	-0.012 (0.034)	0.109** (0.047)
rer _{i,t} × irrerr2 _{i,t}	0.010 (0.021)	0.007 (0.021)	-0.010 (0.044)	0.073 (0.065)	-0.018 (0.015)	-0.015 (0.016)	0.044 (0.042)	0.017 (0.060)
rer _{i,t} × irrerr3 _{i,t}	0.013 (0.024)	0.018 (0.024)	0.015 (0.070)	0.034 (0.066)	-0.066** (0.032)	-0.056** (0.027)	-0.014 (0.046)	0.041 (0.092)
rer _{i,t-1} × irrerr2 _{i,t-1}	-0.039 (0.031)	-0.029 (0.027)	-0.007 (0.055)	-0.101* (0.055)	-0.001 (0.026)	0.003 (0.023)	-0.159** (0.067)	-0.026 (0.073)
rer _{i,t-1} × irrerr3 _{i,t-1}	0.037* (0.019)	0.045** (0.019)	0.064 (0.054)	0.028 (0.050)	0.027 (0.027)	0.028 (0.026)	-0.040 (0.064)	0.105 (0.076)
rer _{i,t-2} × irrerr2 _{i,t-2}	0.011 (0.025)	-0.004 (0.024)	-0.010 (0.051)	0.013 (0.042)	0.020 (0.023)	0.010 (0.019)	0.051 (0.048)	-0.008 (0.043)
rer _{i,t-2} × irrerr3 _{i,t-2}	-0.060*** (0.023)	-0.048** (0.022)	-0.027 (0.046)	-0.057*** (0.022)	-0.001 (0.018)	0.010 (0.013)	0.047 (0.053)	-0.122** (0.052)
Observations	733	733	705	733	753	753	727	753
No. of countries	50	50	50	50	50	50	49	50
Country FEs	No	Yes			No	Yes		
Time FEs	No	No	No	No	No	No	No	No
SH test			1.00	1.00			1.00	0.99
AB(1)			0.03	0.00			0.00	0.00
AB(2)			0.84	0.90			0.32	0.72
AB(3)			0.49	0.68			0.27	0.99
Within R ²		0.65				0.67		
Between R ²		0.98				0.99		
Overall R ²	0.84	0.84			0.84	0.83		
Long-run coefficients								
rer (fixed)	0.124 (0.136)	-0.052 (0.048)	-0.134** (0.067)	0.059 (1.018)	0.098 (0.137)	-0.061** (0.031)	-0.083** (0.039)	-0.206 (0.377)
rer (intermediate)	-0.723 (0.957)	-0.232* (0.123)	-0.203*** (0.080)	-0.078 (0.299)	0.125 (0.373)	-0.100* (0.060)	-0.136*** (0.050)	-2.030 (15.110)
rer (flexible)	-0.039 (0.055)	0.004 (0.022)	-0.042 (0.055)	0.031 (0.097)	-0.385 (0.461)	-0.091 (0.076)	-0.073* (0.045)	0.009 (0.056)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. irrerr2 is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. irrerr3 is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both irrerr2 and irrerr3 are based on the de facto nominal exchange rate arrangement classifications of Ilzetzi, Reinhart and Rogoff (2011). Thus we have the label ‘irrerr’ denoting Ilzetzi, Reinhart and Rogoff exchange rate regime. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real exchange rate coefficient (rer) is calculated as the sum of

the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Analysis reported for 50 countries common to both REER (real effective exchange rate) and BRER (bilateral real exchange rate) series. Results are similar for respective full country samples.

Table 4.16: Baseline linear CA-REER specification results for nominal effective currency appreciation periods, $\Delta neer_t > 0$
(equation 4.1 estimates)

$ ca >0.03$	Pooled OLS	Fixed Effects I	Fixed Effects II	two-step difference- GMM I	two-step difference- GMM II	two-step system- GMM I	two-step system- GMM II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$ca_{i,t-1}$	0.980*** (0.057)	0.852*** (0.057)	0.871*** (0.063)	0.702** (0.306)	0.786 (0.651)	0.852*** (0.138)	0.904*** (0.115)
$ca_{i,t-2}$	-0.027 (0.068)	-0.078 (0.075)	-0.171** (0.068)	-0.343** (0.146)	-0.180 (0.184)	-0.204** (0.103)	-0.241* (0.131)
$reer_{i,t}$	-0.014 (0.031)	-0.020 (0.040)	-0.021 (0.045)	-0.204 (0.129)	-0.107 (0.214)	-0.172*** (0.060)	-0.211 (0.160)
$reer_{i,t-1}$	0.010 (0.041)	0.001 (0.044)	0.026 (0.060)	0.228 (0.197)	0.048 (0.509)	-0.015 (0.084)	-0.054 (0.191)
$reer_{i,t-2}$	0.019 (0.030)	0.009 (0.035)	0.000 (0.044)	-0.169 (0.158)	-0.054 (0.345)	0.028 (0.083)	-0.009 (0.147)
Observations	348	348	348	341	341	348	348
No. of countries	49	49	49	49	49	49	49
Country FEs	No	Yes	Yes				
Time FEs	No	No	Yes	No	Yes	No	Yes
SH test				0.38	0.50	0.98	0.90
AB(1)				0.08	0.49	0.06	0.04
AB(2)				0.83	0.60	0.81	0.92
AB(3)				0.17	0.20	0.18	0.29
Within R ²		0.70	0.76				
Between R ²		0.97	0.94				
Overall R ²	0.88	0.87	0.87				
Long-run coefficient							
$reer$	0.297 (0.191)	-0.045 (0.056)	0.019 (0.063)	-0.226 (0.179)	-0.287 (0.477)	-0.452** (0.232)	-0.812** (0.345)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. $\Delta neer$ denotes the change in the logarithm of the nominal effective exchange rate. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table 4.17: Baseline linear CA-REER specification results for nominal effective currency devaluation periods, $\Delta neer_t < 0$
(equation 4.1 estimates)

$ ca >0.03$	Pooled OLS	Fixed Effects I	Fixed Effects II	two-step difference- GMM I	two-step difference- GMM II	two-step system- GMM I	two-step system- GMM II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$ca_{i,t-1}$	0.821*** (0.072)	0.695*** (0.073)	0.647*** (0.061)	0.241* (0.138)	0.581* (0.328)	0.629*** (0.110)	0.771*** (0.148)
$ca_{i,t-2}$	0.153* (0.084)	0.133 (0.093)	0.125 (0.088)	0.034 (0.156)	-0.038 (0.195)	0.085 (0.190)	0.022 (0.123)
$reer_{i,t}$	-0.106*** (0.028)	-0.092*** (0.030)	-0.071*** (0.026)	-0.034 (0.040)	-0.004 (0.123)	-0.080*** (0.030)	-0.064 (0.092)
$reer_{i,t-1}$	0.055** (0.028)	0.035 (0.030)	0.004 (0.026)	0.079 (0.099)	0.270 (0.178)	0.013 (0.064)	0.163 (0.107)
$reer_{i,t-2}$	0.051*** (0.020)	0.058*** (0.022)	0.068*** (0.018)	-0.062 (0.087)	-0.105 (0.106)	0.107 (0.082)	-0.096* (0.057)
Observations	398	398	398	377	377	398	398
No. of countries	50	50	50	50	50	50	50
Country FEs	No	Yes	Yes				
Time FEs	No	No	Yes	No	Yes	No	Yes
SH test				0.21	0.67	0.99	0.49
AB(1)				0.07	0.10	0.01	0.01
AB(2)				0.91	0.76	0.57	0.82
AB(3)				0.67	0.48	0.37	0.90
Within R ²		0.58	0.64				
Between R ²		0.96	0.95				
Overall R ²	0.81	0.80	0.82				
Long-run coefficient							
reer	0.027 (0.271)	0.005 (0.073)	0.004 (0.047)	-0.023 (0.072)	0.333 (0.547)	0.141 (0.181)	0.013 (0.176)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. $\Delta neer$ denotes the change in the logarithm of the nominal effective exchange rate. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run real effective exchange rate coefficient (reer) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table 4.18: Nominal exchange rate volatility augmented linear specification results for nominal effective currency appreciation and depreciation samples (equation 4.7 estimates)

	$\Delta neer_t > 0$ sample (1-4)				$\Delta neer_t < 0$ sample (5-8)			
$ ca > 0.03$	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM	Pooled OLS	Fixed Effects	two-step difference-GMM	two-step system-GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$ca_{i,t-1}$	1.287*** (0.188)	1.315*** (0.169)	1.086*** (0.383)	1.704*** (0.439)	1.192*** (0.136)	0.910*** (0.117)	0.659* (0.369)	0.830* (0.449)
$ca_{i,t-2}$	-0.114 (0.220)	-0.141 (0.231)	-0.176 (0.258)	-0.022 (0.267)	0.042 (0.316)	0.069 (0.351)	-0.341 (0.549)	-0.354 (0.395)
$ca_{i,t-1} \times neervol_{i,t-1}$	-0.070** (0.035)	-0.106*** (0.035)	-0.122 (0.089)	-0.195** (0.094)	-0.075** (0.030)	-0.047* (0.027)	-0.105 (0.080)	-0.028 (0.086)
$ca_{i,t-2} \times neervol_{i,t-2}$	0.020 (0.039)	0.015 (0.040)	-0.013 (0.050)	-0.034 (0.055)	0.021 (0.072)	0.015 (0.079)	0.106 (0.108)	0.081 (0.076)
$reer_{i,t}$	-0.066 (0.062)	-0.104 (0.068)	-0.115 (0.266)	-0.045 (0.274)	-0.171*** (0.038)	-0.190*** (0.044)	0.201 (0.156)	0.007 (0.184)
$reer_{i,t-1}$	0.147 (0.108)	0.137 (0.121)	0.442 (0.494)	0.428 (0.289)	0.089 (0.090)	0.036 (0.100)	-0.151 (0.217)	0.381** (0.164)
$reer_{i,t-2}$	0.022 (0.093)	0.023 (0.086)	0.016 (0.269)	0.231 (0.199)	0.061 (0.102)	0.012 (0.115)	0.181 (0.264)	-0.019 (0.207)
$reer_{i,t} \times neervol_{i,t}$	0.009 (0.011)	0.017 (0.012)	0.001 (0.047)	-0.000 (0.052)	0.009*** (0.003)	0.013*** (0.004)	-0.042* (0.024)	-0.017 (0.029)
$reer_{i,t-1} \times neervol_{i,t-1}$	-0.024 (0.017)	-0.025 (0.020)	-0.079 (0.093)	-0.078 (0.058)	-0.004 (0.015)	0.003 (0.017)	0.012 (0.039)	-0.062** (0.030)
$reer_{i,t-2} \times neervol_{i,t-2}$	-0.003 (0.015)	-0.006 (0.013)	-0.005 (0.047)	-0.053 (0.037)	-0.003 (0.018)	0.008 (0.020)	-0.030 (0.043)	0.023 (0.030)
Observations	348	348	341	348	398	398	377	398
No. of countries	49	49	49	49	50	50	50	50
SH test			0.37	1.00			1.00	0.38
AB(1)			0.08	0.04			0.10	0.01
AB(2)			0.61	0.65			0.53	0.74
AB(3)			0.14	0.27			0.93	0.51
Within R ²		0.72				0.60		
Between R ²		0.96				0.96		
Overall R ²	0.88	0.87			0.81	0.81		
Long-run coefficients								
reer (low neervol)			3.823 (28.052)			-6.705 (101.805)	0.339 (0.640)	0.704 (1.052)
reer (mod. neervol)	-0.068 (0.243)	-0.068 (0.096)	-0.169 (0.184)	-0.250 (0.243)	-0.118 (0.222)	-0.007 (0.070)	-0.197** (0.099)	0.181 (0.422)
reer (high neervol)	-0.253 (0.382)	-0.108 (0.191)	-0.334 (0.453)	-0.433 (0.483)	-0.010 (0.178)	0.270 (0.325)	-0.559 (0.499)	-0.745 (4.007)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. $\Delta neer$ denotes the change in the natural logarithm of the nominal effective exchange rate. FEs denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. At each of the nominal effective exchange rate volatility (neervol) levels, low, moderate, and high, the long-run real exchange rate coefficient (rer) is calculated as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table 4.19: Nominal exchange rate regime augmented linear specification results for nominal effective currency appreciation and depreciation samples (equation 4.8 estimates)

ca >0.03	$\Delta neer_t > 0$ sample (1-4)				$\Delta neer_t < 0$ sample (5-8)			
	Pooled OLS	Fixed Effects	two-step difference- GMM	two-step system- GMM	Pooled OLS	Fixed Effects	two-step difference- GMM	two-step system- GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ca _{i,t-1}	0.938*** (0.097)	0.821*** (0.094)	0.631** (0.255)	0.830*** (0.146)	0.773*** (0.065)	0.602*** (0.073)	0.110 (0.096)	0.499*** (0.088)
ca _{i,t-2}	0.014 (0.121)	-0.098 (0.140)	-0.261 (0.270)	-0.187 (0.203)	0.190*** (0.060)	0.163*** (0.063)	0.077 (0.105)	0.199 (0.141)
ca _{i,t-1} × irrerr2 _{i,t-1}	0.090 (0.098)	0.087 (0.103)	-0.551* (0.299)	-0.135 (0.252)	-0.014 (0.062)	0.033 (0.060)	-0.045 (0.083)	0.003 (0.118)
ca _{i,t-1} × irrerr3 _{i,t-1}	0.269** (0.130)	0.259** (0.113)	-0.788 (0.549)	-0.340 (0.401)	0.205 (0.127)	0.237** (0.105)	0.233 (0.175)	-0.011 (0.260)
ca _{i,t-2} × irrerr2 _{i,t-2}	-0.068 (0.121)	0.015 (0.140)	0.074 (0.195)	-0.028 (0.183)	0.064 (0.097)	0.087 (0.104)	-0.053 (0.221)	-0.109 (0.279)
ca _{i,t-2} × irrerr3 _{i,t-2}	-0.321*** (0.115)	-0.281** (0.116)	-0.737 (0.526)	-0.536 (0.349)	-0.273* (0.143)	-0.335*** (0.109)	-0.213 (0.287)	-0.476** (0.234)
reer _{i,t}	-0.024 (0.040)	-0.036 (0.053)	-0.212 (0.166)	-0.162*** (0.062)	-0.144*** (0.043)	-0.143*** (0.050)	-0.068 (0.070)	-0.073 (0.075)
reer _{i,t-1}	0.044 (0.047)	0.054 (0.060)	0.254* (0.133)	0.120* (0.065)	0.046 (0.037)	0.027 (0.037)	-0.076 (0.064)	-0.011 (0.093)
reer _{i,t-2}	-0.003 (0.025)	-0.034 (0.034)	-0.021 (0.063)	0.060 (0.058)	0.093*** (0.026)	0.090*** (0.027)	0.049 (0.061)	0.224** (0.098)
reer _{i,t} × irrerr2 _{i,t}	0.054 (0.042)	0.077 (0.052)	0.104 (0.181)	0.059 (0.074)	0.011 (0.036)	-0.001 (0.037)	0.007 (0.070)	-0.016 (0.077)
reer _{i,t} × irrerr3 _{i,t}	0.070 (0.045)	0.050 (0.044)	0.086 (0.164)	0.087 (0.221)	0.041 (0.040)	0.033 (0.043)	0.029 (0.075)	0.043 (0.107)
reer _{i,t-1} × irrerr2 _{i,t-1}	-0.143*** (0.050)	-0.166*** (0.050)	-0.234** (0.115)	-0.200* (0.106)	-0.022 (0.040)	-0.010 (0.037)	-0.033 (0.036)	-0.042 (0.068)
reer _{i,t-1} × irrerr3 _{i,t-1}	-0.036 (0.048)	-0.028 (0.041)	-0.229 (0.176)	-0.096 (0.136)	0.054 (0.035)	0.066** (0.029)	0.095** (0.043)	0.120* (0.065)
reer _{i,t-2} × irrerr2 _{i,t-2}	0.088* (0.046)	0.087** (0.043)	-0.069 (0.105)	0.051 (0.111)	-0.007 (0.027)	-0.008 (0.030)	-0.042 (0.049)	-0.117* (0.070)
reer _{i,t-2} × irrerr3 _{i,t-2}	-0.005 (0.034)	0.013 (0.034)	-0.064 (0.131)	-0.119 (0.076)	-0.085*** (0.033)	-0.061* (0.036)	-0.040 (0.053)	-0.156** (0.078)
Observations	348	348	341	348	398	398	377	398
No. of countries	49	49	49	49	50	50	50	50
SH test			0.99	1.00			1.00	1.00
AB(1)			0.07	0.04			0.04	0.01
AB(2)			0.82	0.71			0.72	0.39
AB(3)			0.10	0.13			0.66	0.50
Within R ²		0.72				0.61		
Between R ²		0.95				0.95		
Overall R ²	0.88	0.87			0.81	0.81		
Long-run coefficients								
reer (fixed)	0.361 (0.283)	-0.058 (0.057)	0.033 (0.142)	0.051 (0.267)	-0.162 (0.274)	-0.111 (0.093)	-0.117** (0.055)	0.460 (0.399)
reer (intermediate)	0.606 (0.727)	-0.101 (0.112)	-0.161 (0.136)	-0.138 (0.206)		-0.397 (0.322)	-0.179** (0.072)	-0.089 (0.131)
reer (flexible)	0.472 (0.387)	0.065 (0.090)	-0.086 (0.100)	-0.089 (0.143)	0.032 (0.106)	0.036 (0.032)	-0.013 (0.057)	0.186 (0.205)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses with Windmeijer-corrected cluster-robust standard errors in the case of generalised method of moments (GMM) regressions. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Δneer denotes the change in the natural logarithm of the nominal effective exchange rate. irrerr2 is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. irrerr3 is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both irrerr2 and irrerr3 are based on the de facto nominal exchange rate arrangement classifications of Ilzetki, Reinhart and Rogoff (2011). Thus we have the label ‘irrerr’ denoting Ilzetki, Reinhart and Rogoff exchange rate regime. FE denotes fixed effects. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real exchange rate coefficient (rer) is calculated as the sum of the relevant contemporaneous

and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table 4.20: Baseline non-linear CA-RER specification results

$ ca > 0.03$	Full REER-based sample	Full BRER-based sample	REER-based sub-sample	BRER-based sub-sample
	(1)	(2)	(3)	(4)
$ca_{i,t-1}$	0.482*** (0.091)	0.734*** (0.038)	0.481*** (0.092)	0.737*** (0.037)
$ca_{i,t-2}$	-0.149* (0.091)	0.063 (0.042)	-0.151* (0.092)	0.033 (0.037)
$rer_{i,t}$	-0.099*** (0.037)	-0.055*** (0.013)	-0.099*** (0.038)	-0.044*** (0.012)
$rer_{i,t-1}$	0.035 (0.051)	0.013 (0.017)	0.036 (0.051)	-0.008 (0.018)
$rer_{i,t-2}$	0.046 (0.029)	0.033*** (0.011)	0.046 (0.029)	0.034*** (0.012)
$ca_{i,t-1}^{NL}$	0.302*** (0.110)	-0.007 (0.083)	0.303*** (0.112)	0.459 (0.297)
$ca_{i,t-2}^{NL}$	0.216** (0.111)	-0.256*** (0.093)	0.217* (0.113)	-0.576* (0.339)
$rer_{i,t}^{NL}$	0.044 (0.045)	0.008 (0.018)	0.043 (0.046)	0.160* (0.097)
$rer_{i,t-1}^{NL}$	0.043 (0.063)	0.016 (0.035)	0.045 (0.064)	0.492* (0.273)
$rer_{i,t-2}^{NL}$	-0.064* (0.039)	-0.052* (0.030)	-0.066* (0.040)	-0.636** (0.309)
σ	23.641*** (6.215)	22.118 (16.377)	23.206*** (6.168)	23.861* (14.159)
c	-0.077*** (0.022)	0.202*** (0.042)	-0.077*** (0.023)	0.549*** (0.064)
Observations	746	1013	733	753
No. of countries	51	72	50	50
Country FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	No	No
R^2	0.78	0.83	0.78	0.87
Adjusted- R^2	0.74	0.82	0.74	0.86
Regression SE	0.03	0.03	0.03	0.03
<i>Lower Regime, $G(.) = 0$: Long-Run coefficient</i>				
rer	-0.027*	-0.044*	-0.025*	-0.078**
<i>Upper Regime, $G(.) = 1$: Long-Run coefficient</i>				
rer	0.034	-0.079*	0.033	-0.006

*** significant at 1% level; ** significant at 5% level; * significant at 10% level

Fixed effects dynamic panel smooth transition regression (DPSTR) estimation via non-linear least squares. Robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. REER denotes the real effective exchange rate, while BRER denotes the bilateral real exchange rate. Current account and real exchange rate variables with the superscript NL give the estimates from the non-linear component of the DPSTR model (these estimates effectively represent the difference between the coefficient estimates of the extreme lower regime and those of the extreme upper regime). σ is the estimate of the slope or smoothness parameter that determines the speed of transition between regimes. c is the estimate of the (real exchange rate) threshold parameter. FEs denote fixed effects. Regression SE is the regression standard error. In the extreme lower and upper regimes of current account adjustment associated with the transition function values of $G(.) = 0$ and $G(.) = 1$ respectively, the long-run real exchange rate coefficient (rer) is calculated as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given extreme regime of current account movement. Statistical significance of long-run real exchange rate coefficients determined by the delta method.

Table 4.21: Baseline non-linear CA-RER specification results by income group

$ ca >0.03$	REER-based, Full sample, High Income	REER-based, Full sample, Mid-Low Income	BRER-based, Full sample, High Income	BRER-based, Full sample, Mid-Low Income
	(1)	(2)	(3)	(4)
$ca_{i,t-1}$	0.469*** (0.096)	0.494*** (0.142)	0.551*** (0.167)	0.540*** (0.074)
$ca_{i,t-2}$	-0.089 (0.097)	-0.190 (0.129)	-0.079 (0.128)	0.012 (0.076)
$rer_{i,t}$	-0.060 (0.045)	-0.141*** (0.043)	-0.012 (0.047)	-0.100*** (0.022)
$rer_{i,t-1}$	0.062 (0.068)	0.028 (0.055)	0.024 (0.089)	0.024 (0.029)
$rer_{i,t-2}$	0.008 (0.035)	0.023 (0.034)	0.019 (0.066)	0.023 (0.017)
$ca_{i,t-1}^{NL}$	0.336*** (0.128)	0.256 (0.162)	0.234 (0.181)	0.016 (0.148)
$ca_{i,t-2}^{NL}$	0.208* (0.128)	0.267* (0.152)	0.140 (0.144)	-0.130 (0.160)
$rer_{i,t}^{NL}$	0.079 (0.066)	0.053 (0.050)	-0.005 (0.053)	0.097*** (0.029)
$rer_{i,t-1}^{NL}$	-0.045 (0.091)	0.042 (0.071)	-0.028 (0.096)	-0.002 (0.049)
$rer_{i,t-2}^{NL}$	-0.028 (0.055)	-0.008 (0.046)	-0.017 (0.071)	-0.054 (0.044)
σ	3.402** (1.505)	23.199 (14.882)	3.829 (3.497)	2.547*** (0.954)
c	-0.080*** (0.021)	-0.001 (0.009)	-0.300*** (0.063)	0.217*** (0.056)
Observations	467	279	507	506
No. of countries	31	20	34	38
Country FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	No	No
R^2	0.90	0.78	0.89	0.73
Adjusted- R^2	0.89	0.73	0.88	0.68
Regression SE	0.03	0.03	0.03	0.03
<i>Lower Regime, $G(.) = 0$: Long-Run coefficient</i>				
rer	0.016	-0.129*	0.059	-0.118**
<i>Upper Regime, $G(.) = 1$: Long-Run coefficient</i>				
rer	0.211*	-0.017	-0.123*	-0.021

*** significant at 1% level; ** significant at 5% level; * significant at 10% level

Fixed effects dynamic panel smooth transition regression estimation via non-linear least squares. Robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. REER denotes the real effective exchange rate, while BRER denotes the bilateral real exchange rate. Current account and real exchange rate variables with the superscript NL give the estimates from the non-linear component of the DPSTR model (these estimates effectively represent the difference between the coefficient estimates of the extreme lower regime and those of the extreme upper regime). σ is the estimate of the slope or smoothness parameter that determines the speed of transition between regimes. c is the estimate of the (real exchange rate) threshold parameter. FEs denote fixed effects. Regression SE is the regression standard error. In the extreme lower and upper regimes of current account adjustment associated with the transition function values of $G(.) = 0$ and $G(.) = 1$ respectively, the long-run real exchange rate coefficient (rer) is calculated as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given extreme regime of current account movement. Statistical significance of long-run real exchange rate coefficients determined by the delta method.

Table 4.22: Nominal exchange rate volatility augmented non-linear specification results

$ ca >0.03$	Full REER-based sample	Full BRER-based sample	REER-based sub-sample	BRER-based sub-sample
	(1)	(2)	(3)	(4)
$ca_{i,t-1}$	0.568** (0.237)	1.375*** (0.370)	0.584** (0.239)	2.145*** (0.831)
$ca_{i,t-2}$	0.074 (0.237)	0.476 (0.376)	0.060 (0.239)	-0.286 (0.923)
$ca_{i,t-1} \times nervol_{i,t-1}$	-0.005 (0.043)	-0.087* (0.047)	-0.007 (0.043)	-0.202** (0.103)
$ca_{i,t-2} \times nervol_{i,t-2}$	-0.025 (0.042)	-0.051 (0.048)	-0.023 (0.042)	0.018 (0.114)
$rer_{i,t}$	0.081 (0.109)	-0.040 (0.157)	0.078 (0.110)	-0.521 (0.488)
$rer_{i,t-1}$	0.095 (0.116)	-0.029 (0.172)	0.094 (0.117)	-0.022 (0.505)
$rer_{i,t-2}$	0.017 (0.074)	0.172 (0.115)	0.015 (0.075)	1.056*** (0.353)
$rer_{i,t} \times nervol_{i,t}$	-0.032* (0.019)	-0.001 (0.020)	-0.032* (0.019)	0.068 (0.062)
$rer_{i,t-1} \times nervol_{i,t-1}$	-0.011 (0.020)	0.005 (0.021)	-0.010 (0.020)	-0.006 (0.063)
$rer_{i,t-2} \times nervol_{i,t-2}$	0.002 (0.013)	-0.018 (0.014)	0.002 (0.013)	-0.126*** (0.044)
$ca_{i,t-1}^{NL}$	0.515* (0.296)	1.968** (0.810)	0.481* (0.297)	-0.661 (0.962)
$ca_{i,t-2}^{NL}$	0.005 (0.299)	0.062 (1.056)	0.062 (0.301)	-0.197 (1.051)
$(ca_{i,t-1} \times nervol_{i,t-1})^{NL}$	-0.049 (0.056)	-0.261** (0.107)	-0.043 (0.056)	0.104 (0.121)
$(ca_{i,t-2} \times nervol_{i,t-2})^{NL}$	0.024 (0.056)	-0.052 (0.141)	0.013 (0.056)	0.053 (0.132)
$rer_{i,t}^{NL}$	-0.218* (0.115)	0.162 (0.238)	-0.215* (0.116)	0.581 (0.512)
$rer_{i,t-1}^{NL}$	-0.094 (0.135)	0.418 (0.323)	-0.095 (0.136)	-0.271 (0.532)
$rer_{i,t-2}^{NL}$	-0.125 (0.095)	-0.698*** (0.237)	-0.113 (0.096)	-1.039*** (0.382)
$(rer_{i,t} \times nervol_{i,t})^{NL}$	0.051** (0.020)	-0.019 (0.029)	0.050** (0.020)	-0.082 (0.065)
$(rer_{i,t-1} \times nervol_{i,t-1})^{NL}$	0.020 (0.023)	-0.045 (0.041)	0.020 (0.023)	0.051 (0.067)
$(rer_{i,t-2} \times nervol_{i,t-2})^{NL}$	0.020 (0.017)	0.081*** (0.030)	0.018 (0.017)	0.123*** (0.048)
σ	15.719*** (3.508)	30.396* (16.389)	16.054*** (3.590)	11.074** (4.549)
c	-0.026*** (0.009)	0.210*** (0.024)	-0.026*** (0.009)	-0.086*** (0.015)
Observations	746	910	733	714
No. of countries	51	70	50	50
Country FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	No	No
R^2	0.85	0.85	0.85	0.89
Adjusted- R^2	0.83	0.84	0.83	0.86
Regression SE	0.03	0.03	0.03	0.03
<i>Lower Regime, $G(.) = 0$: Long-Run coefficients</i>				
rer (low nervol)	0.539		0.525	
rer (moderate nervol)	-0.099*	-0.036	-0.099*	0.002
rer (high nervol)	-0.330**	-0.070	-0.325**	-0.129*

Upper Regime, $G(.) = 1$: Long-Run coefficients

rer (low nervol)				
rer (moderate nervol)	0.333*	0.012	0.301*	0.037
rer (high nervol)	0.660*	0.009	0.591*	0.238

*** significant at 1% level; ** significant at 5% level; * significant at 10% level

Fixed effects dynamic panel smooth transition regression (DPSTR) estimation via non-linear least squares. Robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. nervol is multilateral nominal exchange rate volatility in the case of regressions that employ the real effective exchange rate (REER), and bilateral nominal exchange rate volatility in the case of regressions that employ the bilateral real exchange rate (BRER). Current account, real exchange rate and interaction term variables with the superscript NL give the estimates from the non-linear component of the DPSTR model (these estimates effectively represent the difference between the coefficient estimates of the extreme lower regime and those of the extreme upper regime). sigma is the estimate of the slope or smoothness parameter that determines the speed of transition between regimes. c is the estimate of the (real exchange rate) threshold parameter. FEs denote fixed effects. Regression SE is the regression standard error. In the extreme lower and upper regimes of current account adjustment associated with the transition function values of $G(.) = 0$ and $G(.) = 1$ respectively, the long-run real exchange rate coefficient (rer) is calculated at each of the nominal exchange rate volatility levels (low, moderate, and high) as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the volatility level of concern in the given extreme regime of current account movement. Statistical significance of long-run real exchange rate coefficients determined by the delta method.

Table 4.23: Nominal exchange rate volatility augmented non-linear specification results by income group

$ ca >0.03$	REER-based, Full sample, High Income	REER-based, Full sample, Mid-Low Income	BRER-based, Full sample, High Income	BRER-based, Full sample, Mid-Low Income
	(1)	(2)	(3)	(4)
$ca_{i,t-1}$	1.625*** (0.371)	0.155 (0.552)	3.992*** (1.045)	0.126 (0.585)
$ca_{i,t-2}$	-0.887* (0.516)	0.009 (0.462)	0.130 (1.264)	0.211 (0.586)
$ca_{i,t-1} \times nervol_{i,t-1}$	-0.225*** (0.071)	0.054 (0.092)	-0.436*** (0.130)	0.058 (0.076)
$ca_{i,t-2} \times nervol_{i,t-2}$	0.155 (0.096)	-0.024 (0.073)	-0.027 (0.157)	-0.026 (0.074)
$rer_{i,t}$	-0.722** (0.315)	0.392 (0.263)	-1.577*** (0.583)	0.243 (0.225)
$rer_{i,t-1}$	0.144 (0.301)	-0.039 (0.242)	0.049 (0.696)	-0.159 (0.244)
$rer_{i,t-2}$	-0.204 (0.193)	0.170 (0.146)	-0.021 (0.513)	0.125 (0.159)
$rer_{i,t} \times nervol_{i,t}$	0.131** (0.061)	-0.089** (0.044)	0.197*** (0.073)	-0.044 (0.028)
$rer_{i,t-1} \times nervol_{i,t-1}$	-0.007 (0.060)	0.007 (0.041)	-0.005 (0.088)	0.021 (0.029)
$rer_{i,t-2} \times nervol_{i,t-2}$	0.042 (0.035)	-0.024 (0.024)	0.003 (0.065)	-0.013 (0.019)
$ca_{i,t-1}^{NL}$	-0.609 (0.491)	0.335 (0.631)	-2.441** (1.236)	3.141* (1.615)
$ca_{i,t-2}^{NL}$	0.725 (0.648)	1.001* (0.549)	-0.522 (1.420)	-3.481* (1.913)
$(ca_{i,t-1} \times nervol_{i,t-1})^{NL}$	0.184** (0.095)	0.006 (0.109)	0.336** (0.155)	-0.427** (0.215)
$(ca_{i,t-2} \times nervol_{i,t-2})^{NL}$	-0.092 (0.123)	-0.175* (0.095)	0.090 (0.178)	0.456* (0.260)
$rer_{i,t}^{NL}$	0.314 (0.343)	-0.471* (0.266)	1.984*** (0.722)	0.100 (0.331)
$rer_{i,t-1}^{NL}$	0.028 (0.283)	-0.015 (0.256)	-0.074 (0.758)	0.322 (0.415)
$rer_{i,t-2}^{NL}$	-0.150 (0.222)	0.037 (0.163)	-0.327 (0.608)	0.279 (0.408)
$(rer_{i,t} \times nervol_{i,t})^{NL}$	-0.051 (0.067)	0.086** (0.044)	-0.253*** (0.091)	-0.004 (0.040)
$(rer_{i,t-1} \times nervol_{i,t-1})^{NL}$	-0.007 (0.052)	0.015 (0.043)	0.012 (0.096)	-0.039 (0.052)
$(rer_{i,t-2} \times nervol_{i,t-2})^{NL}$	0.020 (0.040)	-0.013 (0.027)	0.043 (0.077)	-0.046 (0.052)
sigma	2.882*** (1.015)	36.004 (31.615)	6.883*** (2.501)	5.474*** (2.062)
c	-0.055** (0.024)	-0.003 (0.007)	-0.052*** (0.019)	0.197*** (0.026)
Observations	467	279	501	409
No. of countries	31	20	34	36
Country FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	No	No
R ²	0.91	0.76	0.91	0.80
Adjusted-R ²	0.89	0.70	0.89	0.75
Regression SE	0.03	0.03	0.03	0.03

Lower Regime, $G(.) = 0$: Long-Run coefficients

rer (low nervol)	-2.985	0.626		0.315*
rer (moderate nervol)	0.314*	-0.172*	0.019	-0.194*
rer (high nervol)	0.664*	-1.002*	0.197**	-0.440*

Upper Regime, $G(.) = 1$: Long-Run coefficients

rer (low nervol)	-4.041			0.907*
rer (moderate nervol)	12.714	-0.102*	0.073*	-0.175*
rer (high nervol)		-0.119*	0.040*	-0.865*

*** significant at 1% level; ** significant at 5% level; * significant at 10% level

Fixed effects dynamic panel smooth transition regression (DPSTR) estimation via non-linear least squares. Robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. nervol is multilateral nominal exchange rate volatility in the case of regressions that employ the real effective exchange rate (REER), and bilateral nominal exchange rate volatility in the case of regressions that employ the bilateral real exchange rate (BRER). Current account, real exchange rate and interaction term variables with the superscript NL give the estimates from the non-linear component of the DPSTR model (these estimates effectively represent the difference between the coefficient estimates of the extreme lower regime and those of the extreme upper regime). sigma is the estimate of the slope or smoothness parameter that determines the speed of transition between regimes. c is the estimate of the (real exchange rate) threshold parameter. FEs denote fixed effects. Regression SE is the regression standard error. In the extreme lower and upper regimes of current account adjustment associated with the transition function values of $G(.) = 0$ and $G(.) = 1$ respectively, the long-run real exchange rate coefficient (rer) is calculated at each of the nominal exchange rate volatility levels (low, moderate, and high) as the sum of the relevant contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the volatility level of concern in the given extreme regime of current account movement. Statistical significance of long-run real exchange rate coefficients determined by the delta method.

Table 4.24: Current account half-lives by stage of economic development and nominal exchange rate regime

sample	size	regime			
		simple AR model		augmented AR model	
		CA half-life		CA half-life	
		mean (1)	median (2)	mean (3)	median (4)
Whole	69	2.60	1.85	1.33	0.95
Industrial	23	4.35	3.27	2.11	1.57
Emerging	32	1.90	1.80	0.94	0.86
Developing	14	1.30	0.98	0.92	0.90
Test of Equal		11.03***	16.34***	7.10***	8.39**
Sub-Group Means/Medians		[0.00]	[0.00]	[0.00]	[0.02]
High Income	35	3.47	2.37	1.65	1.04
Middle & Low Income	34	1.70	1.68	1.00	0.91
Test of Equal		9.36***	5.24**	4.40**	1.76
Sub-Group Means/Medians		[0.00]	[0.02]	[0.04]	[0.18]
<i>Exchange Rate Regime</i>					
Fixed Regime	29	3.14	2.10	1.68	1.04
Intermediate Regime	30	2.09	1.62	1.02	0.89
Flexible Regime	10	2.53	2.41	1.25	0.98
Test of Equal		1.46	3.38	2.33*	2.05
Sub-Group Means/Medians		[0.24]	[0.18]	[0.10]	[0.36]

* significant at 10%; ** significant at 5%; *** significant at 1%

'Test of equal sub-group means' tests the null hypothesis of equal means across the relevant sub-groups using the F*-test. Since the Levene and Bartlett tests often reject the null of equal variances across the sub-groups of concern, the F*-test of equal means is employed. This test is more robust to violations of the homogeneity of variances across sub-groups assumption than the traditional F-test. For the tests, the F* statistic and corresponding p-value in square brackets are reported. The results of the F*-test are consistent with those of the W test of equal means. 'Test of equal sub-group medians' tests the null hypothesis of equal medians across the relevant sub-groups using the non-parametric Mood's median test. For the tests, the Pearson χ^2 statistic and corresponding p-value in square brackets are reported. The Pearson χ^2 and Fisher exact versions of the test lead to consistent conclusions. The results of the median test are consistent with those of the Kruskal-Wallis test. Unlike Mood's median test, the Kruskal-Wallis test assumes that the variances across the sub-group samples of concern are approximately equal. Nevertheless, it is a more powerful (efficient) test for moderate to large samples. A country is characterised by the nominal exchange rate regime that accounts for more than 50 percent of its total number of arrangement observations over the period, or alternatively by the average regime prevailing over the period if the former rule does not apply.

Table 4.25: Cross-sectional current account persistence regressions

dependent variable: ca persistence (hl ^{ca})	NEER full sample	BNER full sample	NEER sub- sample	BNER sub- sample	NEER full sample	BNER full sample	NEER sub- sample	BNER sub- sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ner volatility (nerv)	-0.274** (0.131)	-0.315*** (0.095)	-0.273** (0.130)	-0.373*** (0.118)				
intermediate regime (IERR)					-0.052 (0.237)	-0.284 (0.196)	-0.050 (0.239)	-0.174 (0.253)
flexible regime (FLERR)					-0.693** (0.292)	-0.769*** (0.289)	-0.689** (0.289)	-0.788*** (0.292)
net foreign assets (NFA)	-0.008** (0.003)	-0.006** (0.003)	-0.008** (0.003)	-0.009*** (0.003)	-0.007** (0.003)	-0.005* (0.003)	-0.007** (0.003)	-0.008** (0.003)
govt. budget balance (GBB)	-0.009 (0.027)	-0.037* (0.021)	-0.009 (0.027)	-0.012 (0.022)	0.005 (0.027)	-0.031 (0.023)	0.005 (0.028)	-0.005 (0.026)
trade openness (to)	-0.451 (0.320)	-0.493** (0.244)	-0.449 (0.321)	-0.326 (0.359)	-0.327 (0.254)	-0.454** (0.208)	-0.326 (0.257)	-0.309 (0.267)
financial integration (ifi1)	0.295 (0.229)	0.332* (0.199)	0.288 (0.243)	0.244 (0.249)	0.222 (0.236)	0.214 (0.210)	0.215 (0.253)	0.128 (0.256)
reserves (ir)	0.145 (0.141)	0.141 (0.146)	0.137 (0.165)	-0.000 (0.165)	0.019 (0.143)	0.082 (0.140)	0.010 (0.174)	-0.072 (0.165)
youth dependency (ydr)	-1.533** (0.724)	-0.390 (0.647)	-1.535** (0.729)	-0.796 (0.765)	-1.479* (0.820)	-0.516 (0.736)	-1.483* (0.828)	-0.952 (0.937)
old dependency (odr)	-1.164** (0.550)	-0.478 (0.467)	-1.164** (0.552)	-0.606 (0.564)	-1.305** (0.568)	-0.804 (0.520)	-1.306** (0.570)	-1.030* (0.626)
financial development (fdev)	-0.006 (0.206)	0.031 (0.165)	-0.000 (0.212)	0.146 (0.221)	0.394* (0.226)	0.320* (0.170)	0.399* (0.236)	0.534** (0.228)
per capita income (pci)	0.105 (0.137)	0.188* (0.110)	0.106 (0.139)	0.114 (0.138)	0.145 (0.144)	0.214* (0.112)	0.146 (0.145)	0.173 (0.156)
productivity growth (PG)	-0.075 (0.069)	-0.089* (0.052)	-0.075 (0.069)	-0.083 (0.062)	-0.117* (0.061)	-0.126** (0.058)	-0.116* (0.061)	-0.141** (0.067)
absolute ca size (cas)	-0.530** (0.257)	-0.313* (0.175)	-0.524* (0.270)	-0.424** (0.212)	-0.571** (0.232)	-0.290* (0.180)	-0.563** (0.245)	-0.389* (0.220)
Observations	51	68	50	50	51	69	50	50
R ²	0.42	0.34	0.42	0.41	0.45	0.36	0.45	0.43

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
'NEER full sample' refers to the full sample of countries for which nominal effective exchange rate data is available. 'BNER full sample' refers to the full sample of countries for which bilateral nominal exchange rate data (against the US dollar) is available. 'NEER sub-sample' and 'BNER sub-sample' use the pool of countries for which both multilateral/effective and bilateral nominal exchange rate data are available. ner volatility is nominal effective exchange rate volatility in the case of NEER samples, and bilateral nominal exchange rate volatility in the case of BNER samples. All variables are in logarithm, except for IERR (dummy), FLERR (dummy), NFA, GBB and PG. Current account persistence is measured by the half-life (in years), so the dependent variable is the natural logarithm of the current account half-life.

Table 4.26: Cross-sectional current account persistence regressions by deficits and surpluses

dependent variable: ca persistence (hl ^{ca})	NEER ca deficit sample	NEER ca surplus sample	BNER ca deficit sample	BNER ca surplus sample
	(1)	(2)	(3)	(4)
ner volatility	-0.207*	-0.413	-0.206**	-4.437*
(nerv)	(0.112)	(1.829)	(0.101)	(2.166)
net foreign assets	-0.005*	0.012	-0.000	0.011
(NFA)	(0.003)	(0.027)	(0.003)	(0.010)
govt. budget balance	-0.082*	-0.118	-0.079**	0.011
(GBB)	(0.045)	(0.798)	(0.038)	(0.107)
trade openness	-0.905**	1.674	-0.715***	0.058
(to)	(0.420)	(3.758)	(0.226)	(2.200)
financial integration	1.004***	-2.416	0.880***	-0.996
(ifil)	(0.314)	(4.599)	(0.238)	(1.056)
reserves	0.043	-1.449	-0.001	-1.557
(ir)	(0.219)	(2.150)	(0.187)	(0.874)
youth dependency	-1.688**	-2.787	-1.014	-3.418
(ydr)	(0.826)	(8.864)	(0.715)	(2.537)
old dependency	-1.487**	-0.952	-1.131*	-0.880
(odr)	(0.728)	(5.896)	(0.605)	(1.491)
financial development	-0.048	-0.948	-0.027	-1.401
(fdev)	(0.283)	(6.253)	(0.217)	(2.019)
per capita income	0.012	0.704	0.083	-1.394
(pci)	(0.146)	(4.892)	(0.125)	(1.009)
productivity growth	-0.116	0.226	-0.043	-0.753
(PG)	(0.100)	(2.370)	(0.066)	(0.472)
absolute ca size	-0.176	1.271	-0.113	0.022
(cas)	(0.241)	(8.031)	(0.152)	(0.737)
Observations	37	14	52	16
R ²	0.64	0.59	0.56	0.78

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.

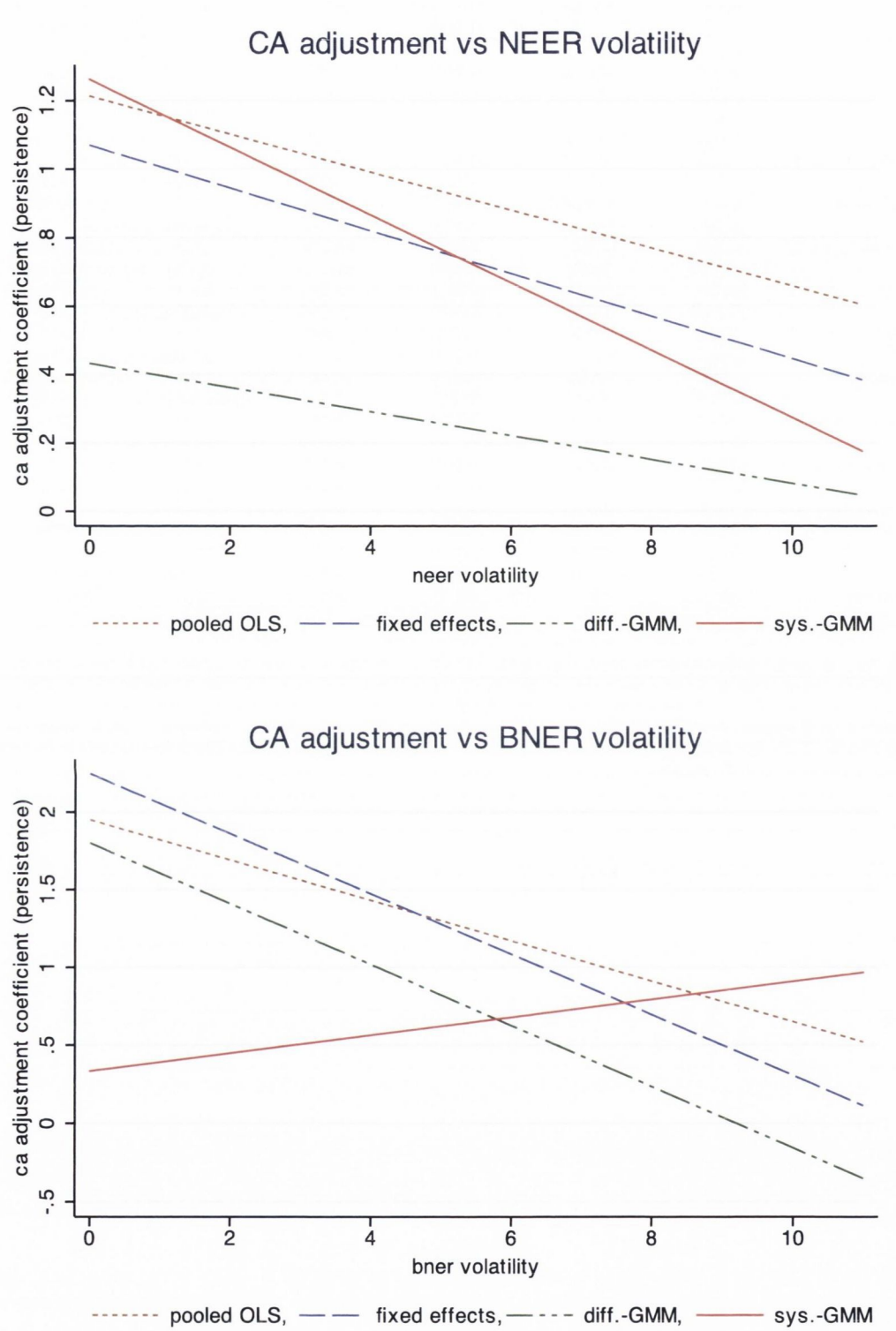
A country is classified as a current account deficit (surplus) country if more than 50 percent of the country's current account balances over the period are negative (positive). 'NEER ca deficit (surplus) sample' refers to the sample of current account deficit (surplus) countries for which nominal effective exchange rate data is available. 'BNER ca deficit (surplus) sample' refers to the sample of current account deficit (surplus) countries for which bilateral nominal exchange rate data (against the US dollar) is available. ner volatility is nominal effective exchange rate volatility in the case of NEER samples, and bilateral nominal exchange rate volatility in the case of BNER samples. All variables are in logarithm, except for NFA, GBB and PG. Current account persistence is measured by the half-life (in years), so the dependent variable is the natural logarithm of the current account half-life.

Table 4.27: Cross-sectional current account persistence regressions by stage of economic development

dependent variable: ca persistence (hl ^{ca})	NEER industrial sample	NEER emerging sample	NEER emerging & developing sample	BNER industrial sample	BNER emerging sample	BNER emerging & developing sample
	(1)	(2)	(3)	(4)	(5)	(6)
ner volatility (nerv)	-0.077 (0.728)	-0.023 (0.149)	-0.201 (0.138)	-0.942 (0.956)	-0.146 (0.107)	-0.178* (0.096)
net foreign assets (NFA)	-0.007 (0.010)	0.003 (0.005)	-0.004 (0.004)	-0.010 (0.014)	0.000 (0.004)	-0.004* (0.002)
govt. budget balance (GBB)	-0.028 (0.071)	-0.103* (0.052)	-0.029 (0.055)	-0.068 (0.048)	-0.044* (0.025)	-0.039 (0.025)
trade openness (to)	0.368 (1.336)	-1.025** (0.344)	-1.023*** (0.374)	0.287 (1.450)	-0.599* (0.309)	-0.698*** (0.221)
financial integration (ifi1)	-0.228 (0.705)	0.912 (0.542)	0.402 (0.501)	-0.138 (1.115)	0.389 (0.336)	0.568** (0.250)
reserves (ir)	-0.115 (0.309)	0.168 (0.338)	0.285 (0.308)	-0.089 (0.636)	0.179 (0.191)	0.275 (0.218)
youth dependency (ydr)	-1.275 (3.107)	-1.338 (0.997)	-1.342 (0.911)	-0.464 (4.731)	-0.965 (0.818)	-0.825 (0.599)
old dependency (odr)	1.008 (1.697)	-1.562* (0.859)	-1.305* (0.745)	2.181 (1.565)	-1.072* (0.598)	-1.046** (0.498)
financial development (fdev)	0.153 (0.826)	-0.014 (0.333)	0.158 (0.272)	0.093 (0.893)	-0.081 (0.185)	-0.033 (0.181)
per capita income (pci)	-0.141 (0.575)	-0.011 (0.237)	0.105 (0.180)	0.124 (0.464)	0.012 (0.125)	0.092 (0.109)
productivity growth (PG)	0.364 (0.299)	-0.138 (0.113)	-0.162* (0.087)	0.331 (0.332)	-0.088 (0.067)	-0.087 (0.059)
absolute ca size (cas)	-0.412 (0.514)	0.430 (0.552)	0.263 (0.378)	-0.225 (0.476)	0.073 (0.193)	-0.077 (0.144)
Observations	23	19	28	22	32	46
R ²	0.49	0.83	0.57	0.51	0.57	0.41

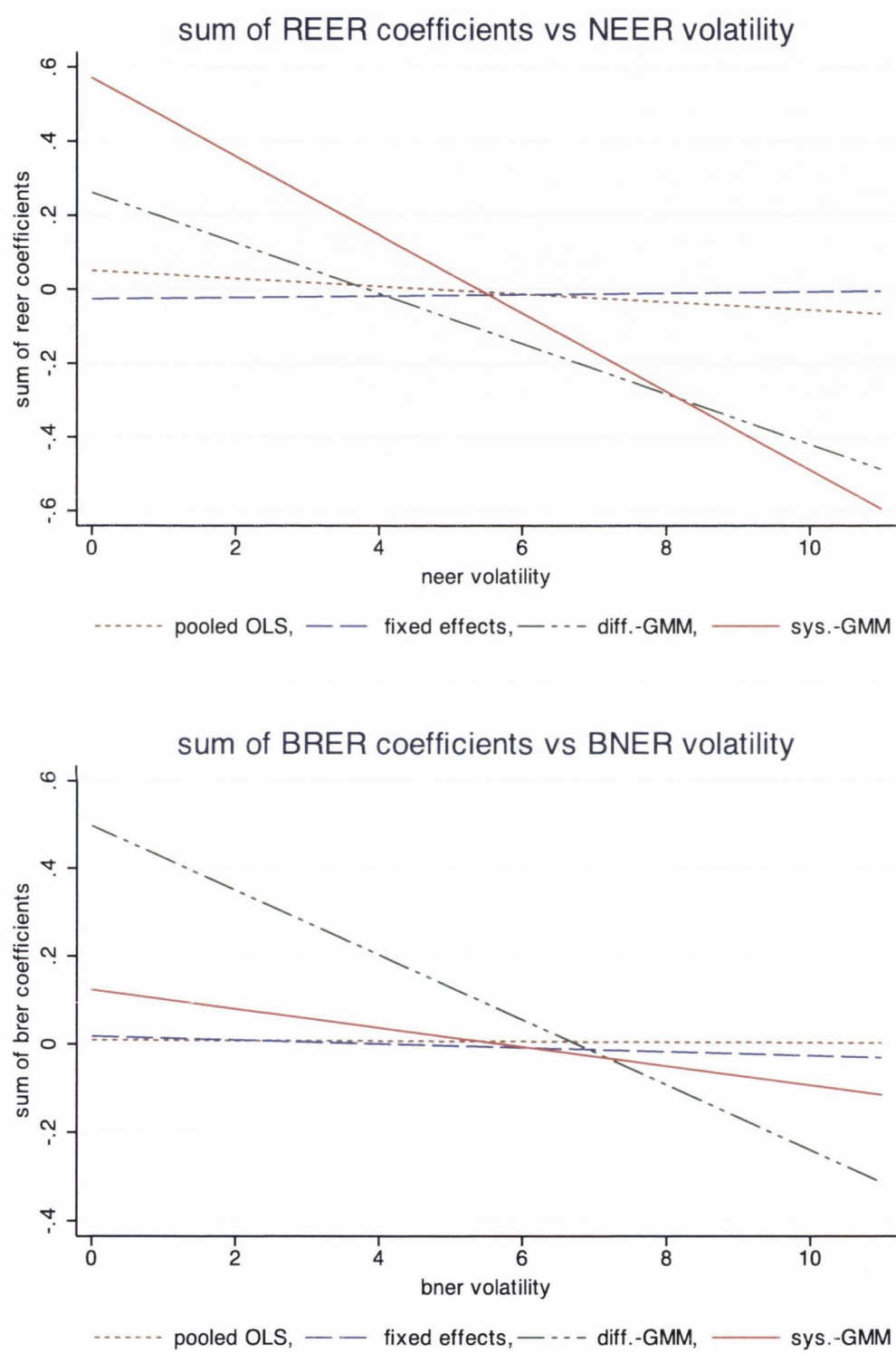
* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.
NEER samples across the different country groups (columns 1-3) consist of countries for which nominal effective exchange rate data is available. BNER samples across the different country groups (columns 4-6) consist of countries for which bilateral nominal exchange rate data (against the US dollar) is available. ner volatility is nominal effective exchange rate volatility in the case of NEER samples, and bilateral nominal exchange rate volatility in the case of BNER samples. All variables are in logarithm, except for NFA, GBB and PG. Current account persistence is measured by the half-life (in years), so the dependent variable is the natural logarithm of the current account half-life.

Figure 4.1: Own-Current Account Adjustment Coefficient vs. Nominal Exchange Rate Volatility



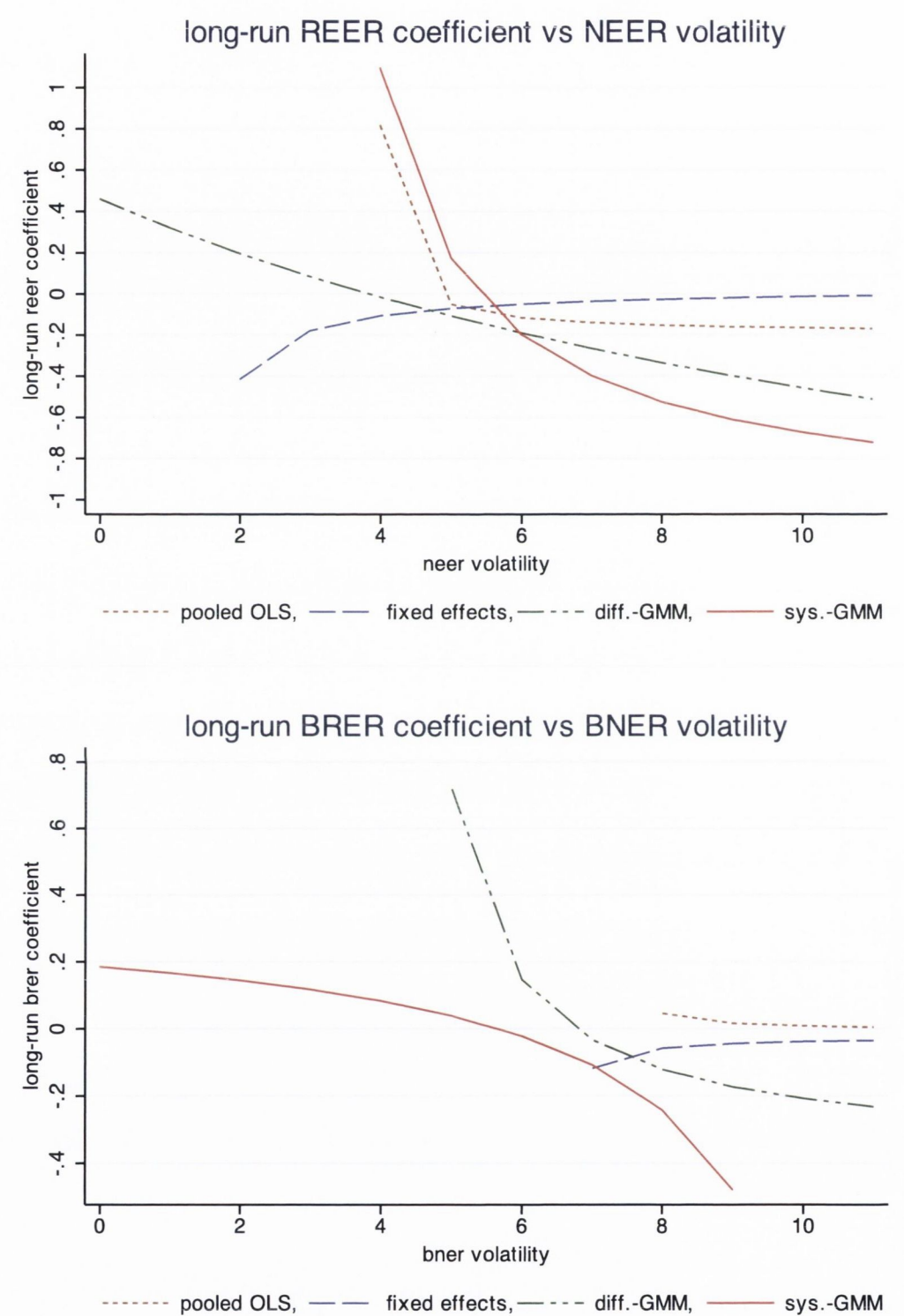
Notes: ca adjustment coefficient is the sum of the current account coefficients at the given level of nominal exchange rate volatility in the linear model, and, holding the real exchange rate constant, is a measure of current account persistence. NEER and BNER denote nominal effective exchange rate and bilateral nominal exchange rate respectively. Nominal (effective or bilateral) exchange rate volatility within a given year is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Nominal exchange rate volatility is rescaled so that it lies between 0 and 11.

Figure 4.2: Sum of Real Exchange Rate Coefficients vs. Nominal Exchange Rate Volatility



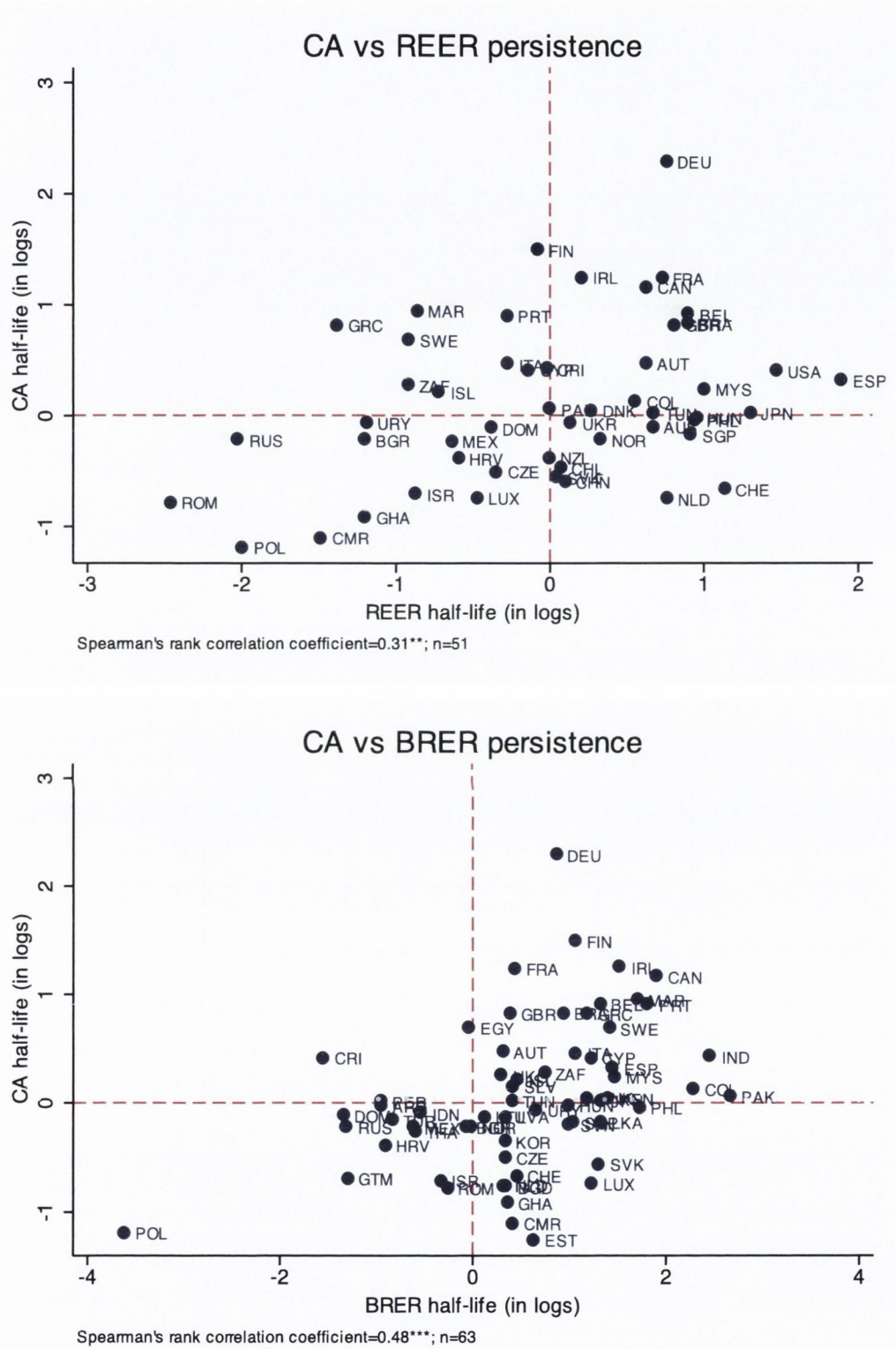
Notes: R(N)EER and BR(N)ER denote real (nominal) effective exchange rate and bilateral real (nominal) exchange rate respectively. Estimates from linear model. Nominal (effective or bilateral) exchange rate volatility within a given year is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Nominal exchange rate volatility is rescaled so that it lies between 0 and 11.

Figure 4.3: Long-Run Real Exchange Rate Coefficient vs. Nominal Exchange Rate Volatility



Notes: R(N)EER and BR(N)ER denote real (nominal) effective exchange rate and bilateral real (nominal) exchange rate respectively. Estimates from linear model. The long-run real exchange rate coefficient is the sum of the contemporaneous and lagged real exchange rate coefficient estimates divided by one minus the sum of the current account coefficient estimates at the given nominal exchange rate volatility level, provided that the current account does not exhibit explosive dynamics at that volatility level. Nominal (effective or bilateral) exchange rate volatility within a given year is defined as the standard deviation of the change in the natural logarithm of the monthly nominal exchange rate. Nominal exchange rate volatility is rescaled so that it lies between 0 and 11.

Figure 4.4: Current Account Persistence vs. Real Exchange Rate Persistence;
Cross-Sectional Evidence over 1973-2010



Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. CA, REER, and BRER denote current account, real effective exchange rate, and bilateral real exchange rate respectively. n is the country sample size. Persistence is gauged by the half-life, given in years. Real exchange rate persistence is given by the selected model I half-life of chapter 2. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = "0.02", -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e), 4 = "54.60" (20.09 x e).

Figure 4.5: Current Account Persistence vs. Nominal Exchange Rate Volatility;
Cross-Sectional Evidence over 1973-2010

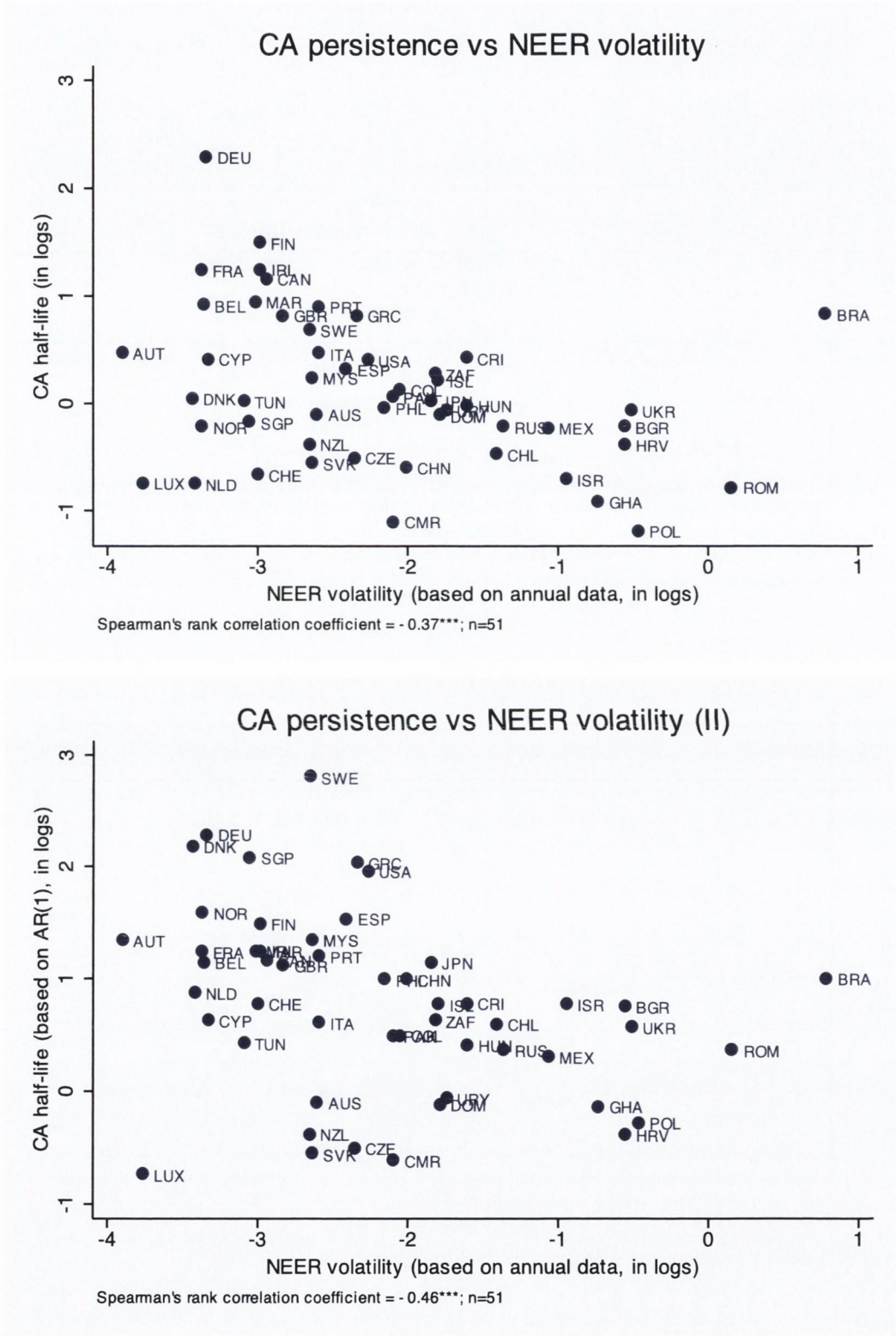
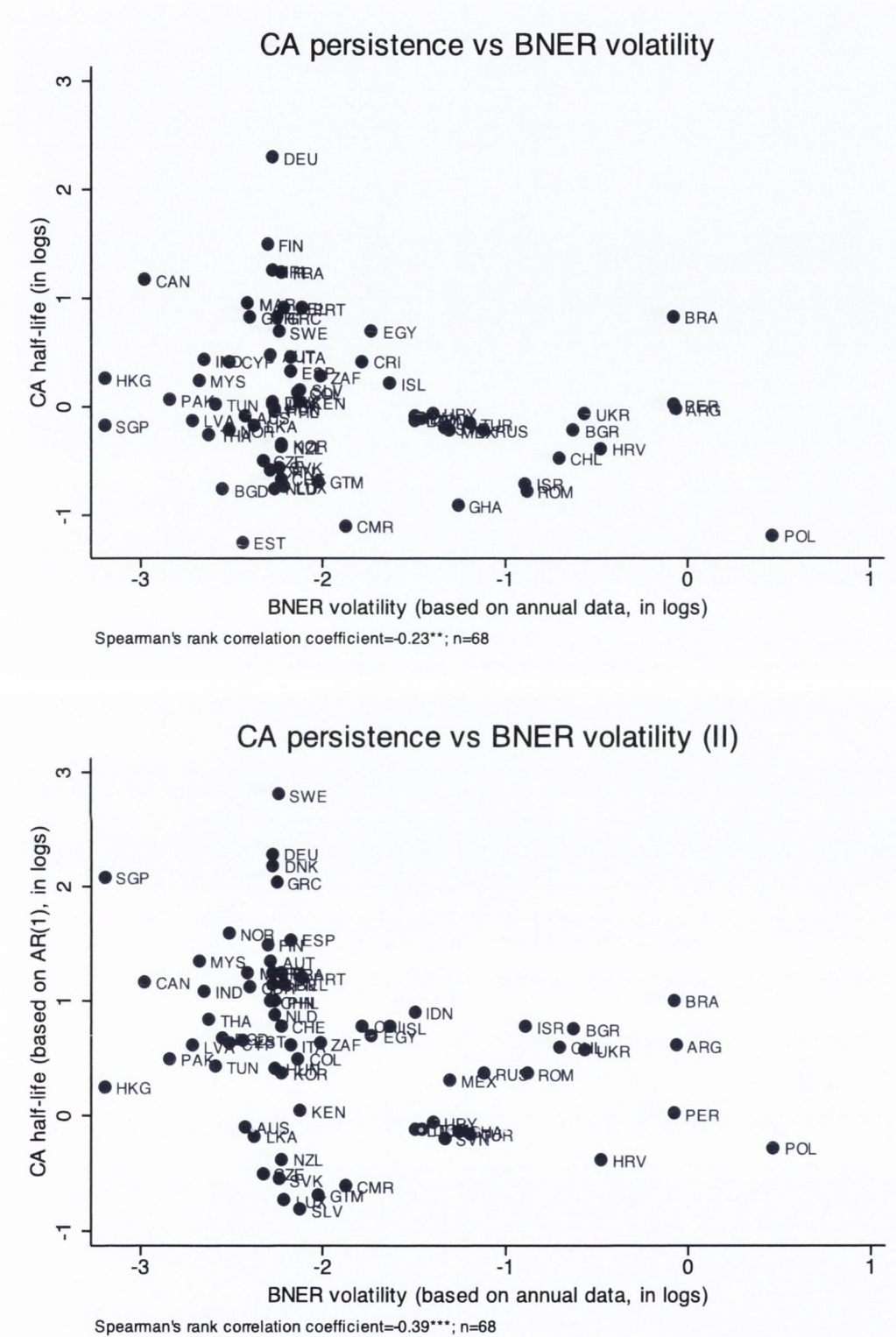


Figure 4.5 continued



Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. CA, NEER, and BNER denote current account, nominal effective exchange rate, and bilateral nominal exchange rate respectively. n is the country sample size. Persistence is gauged by the half-life, given in years. Nominal exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the annual nominal exchange rate over the period of study. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -4 = "0.02", -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e).

Figure 4.6: Real Exchange Rate Persistence vs. Nominal Exchange Rate Volatility;
Cross-Sectional Evidence over 1973-2010

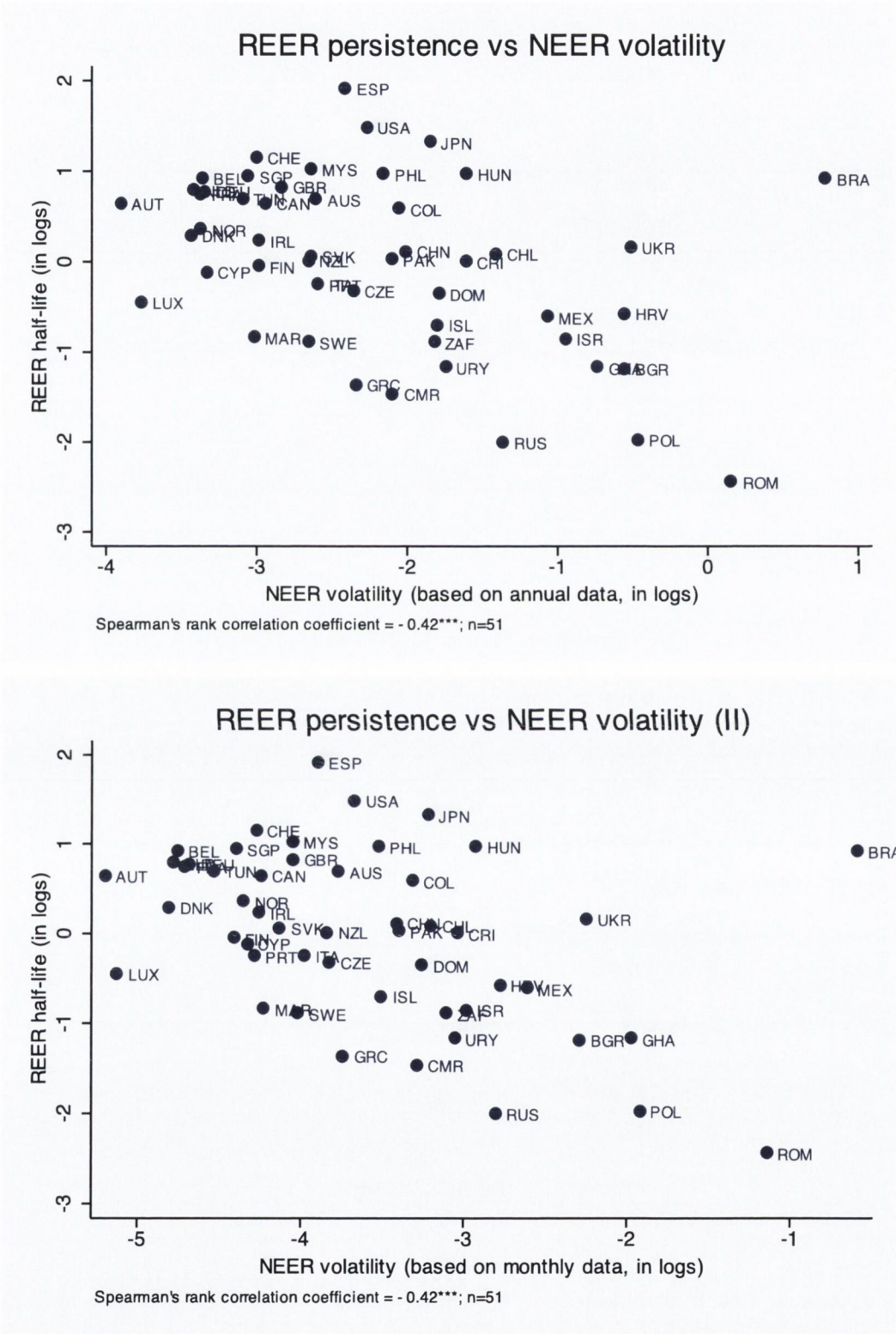
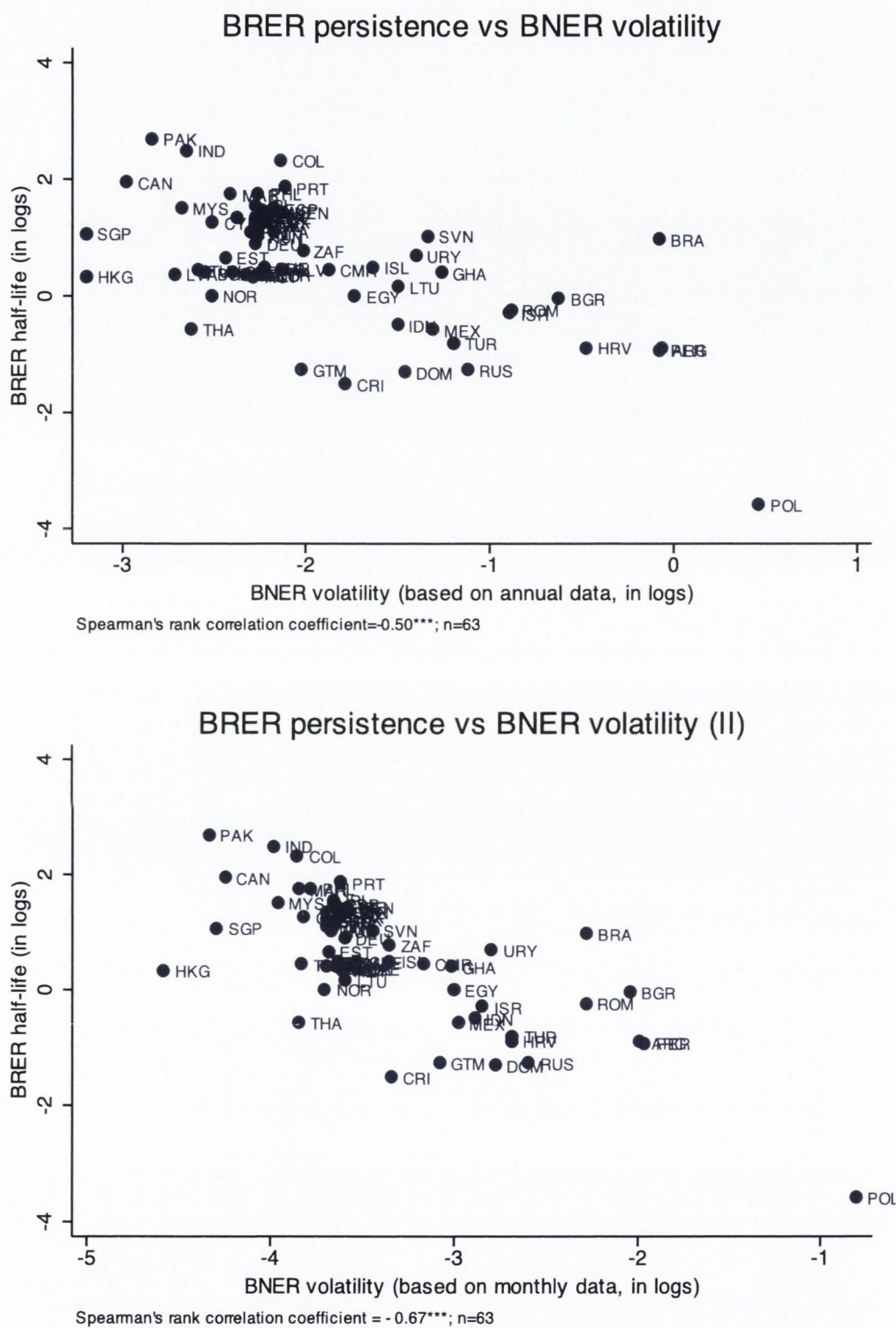


Figure 4.6 continued



Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. R(N)EER and BR(N)ER denote real (nominal) effective exchange rate and bilateral real (nominal) exchange rate respectively. n is the country sample size. Real exchange rate persistence is gauged by the selected model I half-life of chapter 2, given in years. Nominal exchange rate volatility is defined as the standard deviation of the change in the natural logarithm of the annual or monthly nominal exchange rate over the period of study. Noting that the mathematical constant $e \approx 2.72$ is the base of the natural logarithm, it is easy to convert the log scales back to the original variable scales. With log scale data on the left of the equality and approximate original variable data in inverted commas on the right of the equality: -5 = "0.01", -4 = "0.02" (0.01 x e), -3 = "0.05" (0.02 x e), -2 = "0.14" (0.05 x e), -1 = "0.37" (0.14 x e), 0 = "1" (0.37 x e), 1 = "2.72" (1 x e), 2 = "7.39" (2.72 x e), 3 = "20.09" (7.39 x e), 4 = "54.60" (20.09 x e).

4.9 Appendix A: Country Lists (only countries with current US dollar GDP > \$20 billion in 2007 are included in the sample with the exception of oil-dominated countries satisfying this criterion which are excluded)

Advanced Economies: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Iceland (ISL), Ireland (IRL), Italy (ITA), Japan (JPN), Luxembourg (LUX), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), United States (USA).

Emerging Economies: Argentina (ARG), Brazil (BRA), Bulgaria (BGR), Chile (CHL), China (Mainland) (CHN), Colombia (COL), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Egypt, Arab Rep. (EGY), Estonia (EST), Hong Kong S.A.R. (HKG), Hungary (HUN), India (IND), Indonesia (IDN), Israel (ISR), Korea Rep. (KOR), Latvia (LVA), Lithuania (LTU), Malaysia (MYS), Mexico (MEX), Pakistan (PAK), Peru (PER), Philippines (PHL), Poland (POL), Russia (RUS), Singapore (SGP), Slovak Republic (SVK), Slovenia (SVN), South Africa (ZAF), Thailand (THA), Turkey (TUR).

Developing Economies: Bangladesh (BGD), Cameroon (CMR), Costa Rica (CRI), Dominican Republic (DOM), El Salvador (SLV), Ghana (GHA), Guatemala (GTM), Kenya (KEN), Lebanon (LBN), Morocco (MAR), Romania (ROM), Serbia (SRB), Sri Lanka (LKA), Sudan (SDN), Tunisia (TUN), Ukraine (UKR), Uruguay (URY), Vietnam (VNM).

*High-Income Economies [World Bank 2010 classification]:*¹⁴⁵ Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hong Kong SAR China (HKG), Hungary (HUN), Iceland (ISL), Ireland (IRL), Israel (ISR), Italy (ITA), Japan (JPN), Korea Rep. (KOR), Luxembourg (LUX), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Poland

¹⁴⁵ High-income economies (sometimes referred to as developed economies by the World Bank, while the others are collectively termed developing) consist of OECD and non-OECD high-income countries.

(POL), Portugal (PRT), Singapore (SGP), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), United States (USA).

*Middle-Income Economies [World Bank 2010 classification]:*¹⁴⁶ Argentina (ARG), Brazil (BRA), Bulgaria (BGR), Cameroon (CMR), Chile (CHL), China (Mainland) (CHN), Colombia (COL), Costa Rica (CRI), Dominican Republic (DOM), Egypt, Arab Rep. (EGY), El Salvador (SLV), Ghana (GHA), Guatemala (GTM), India (IND), Indonesia (IDN), Latvia (LVA), Lebanon (LBN), Lithuania (LTU), Malaysia (MYS), Mexico (MEX), Morocco (MAR), Pakistan (PAK), Peru (PER), Philippines (PHL), Romania (ROM), Russian Federation (RUS), Serbia (SRB), South Africa (ZAF), Sri Lanka (LKA), Sudan (SDN), Thailand (THA), Tunisia (TUN), Turkey (TUR), Ukraine (UKR), Uruguay (URY), Vietnam (VNM).

Low-Income Economies [World Bank 2010 classification]: Bangladesh (BGD), Kenya (KEN).

BRER sample of countries: Bilateral real exchange rates (BRERs) against the US are available for all of the above countries (excluding the US since it is used as the reference country).

REER sample of countries: Australia (AUS), Austria (AUT), Belgium (BEL), Brazil (BRA), Bulgaria (BGR), Cameroon (CMR), Canada (CAN), Chile (CHL), China (Mainland) (CHN), Colombia (COL), Costa Rica (CRI), Croatia (HRV), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Dominican Republic (DOM), Finland (FIN), France (FRA), Germany (DEU), Ghana (GHA), Greece (GRC), Hungary (HUN), Iceland (ISL), Ireland (IRL), Israel (ISR), Italy (ITA), Japan (JPN), Luxembourg (LUX), Malaysia (MYS), Mexico (MEX), Morocco (MAR), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Pakistan (PAK), Philippines (PHL), Poland (POL), Portugal (PRT), Romania (ROM), Russian Federation (RUS), Singapore (SGP), Slovak Republic (SVK), South Africa (ZAF), Spain (ESP), Sweden (SWE), Switzerland (CHE), Tunisia (TUN), Ukraine (UKR), United Kingdom (GBR), United States (USA), Uruguay (URY).

¹⁴⁶ Middle-income economies consist of upper and lower middle-income countries.

4.10 Appendix B: Variable mnemonics, definitions and sources¹⁴⁷

Current account (ca): expressed as a fraction of GDP; WB's WDI.

Real effective exchange rate (reer): logarithm of multilateral real exchange rate with 2005 as the base year, constructed as a geometric weighted average of CPI-based bilateral real exchange rates between the home country and its trade partners where the weights imposed are updated discretely and are based on the composition of trade in commodities, manufactures and tourism/non-tourism services (non-tourism services use the same weights as manufactures), an increase in the series indicates a real currency appreciation; IMF's IFS.

Note: Bank for International Settlements, OECD, Federal Reserve and Bank of England use chain-linked effective exchange rate series with more frequently updated weights. A statistical disadvantage of chain-linking is that changes in trade weights impart a permanent effect on the level of the effective exchange rate index, even when exchange rates and weights revert to initial levels (see 'The New BIS Effective Exchange Rate Indices' by Klau, M. and Fung, S.S. 2006 in *BIS Quarterly Review* and 'Measuring the Real Exchange Rate: Pitfalls and Practicalities' by Ellis, L. 2001 in the Reserve Bank of Australia Discussion Paper Series).

Bilateral real exchange rate (brer): logarithm of bilateral real exchange rate vis-à-vis the US with 2005 as the base year, constructed using the relevant bilateral nominal exchange rate and consumer price indices, an increase in the series indicates a real currency appreciation; IMF's IFS.

Nominal effective exchange rate volatility (neervol): logarithm of the standard deviation of the approximate proportionate change in the nominal effective exchange rate, with annual volatility based on monthly data (in the case of annual volatility, the data are rescaled so that they lie in the range 0 to 11), continuous measure; IMF's IFS.

Note: in cross section regressions nominal exchange rate volatility is denoted by nerv.

Bilateral nominal exchange rate volatility (bnervol): logarithm of the standard deviation of the approximate proportionate change in the bilateral nominal exchange rate vis-à-vis the US, with annual volatility based on monthly data (in the case of annual volatility, the data are rescaled so that they lie in the range 0 to 11) continuous measure; IMF's IFS.

Note: in cross section regressions nominal exchange rate volatility is denoted by nerv.

Nominal exchange rate regime (nerr): de facto measure of nominal exchange rate flexibility consisting of fixed, intermediate, and flexible regime variables (ferr, ierr, flerr) each of which equals 1 if the regime in question is realised and 0 otherwise, discrete measure; IRR (2011).

¹⁴⁷ Sources are for the raw data used to construct the series. WB's WDI: World Bank's World Development Indicators; WB's GFDD: World Bank's Global Financial Development Database; IMF's IFS: International Monetary Fund's International Financial Statistics; IRR: Ilzetski, Reinhart, and Rogoff; EWN II: External Wealth of Nations Mark II database provided by Philip Lane and Gian Milesi-Ferretti; PWT: Penn World Tables (6.1.0). Note that the IRR, EWN II, and Chinn & Ito databases have been updated to include data up until the end of 2010. Year in parentheses refers to when the update was made.

Net foreign assets (nfa): total foreign assets minus total foreign liabilities expressed as a percentage of GDP; EWN II (2012).

International financial integration 1 (ifi1): logarithm of total foreign assets plus total foreign liabilities expressed as a fraction of GDP, volume-based de facto measure; EWN II (2012).

International financial integration 2 (ifi2): logarithm of portfolio equity assets plus foreign direct investment assets plus portfolio equity liabilities plus foreign direct investment liabilities expressed as a fraction of GDP, equity-based de facto measure; EWN II (2012).

Financial openness (fopen): logarithm of normalised index of financial openness ranging from 0 (lowest) to 1 (highest), de jure measure; Chinn & Ito (2012).

Financial development 1 (fdev): logarithm of private credit by deposit money banks and other (non-bank) financial institutions expressed as a fraction of GDP; WB's GFDD.

Financial development 2 (fdev2): logarithm of domestic credit to private sector expressed as a fraction of GDP; WB's WDI.

Financial development 3 (fdev3): logarithm of domestic credit provided by banking sector expressed as a fraction of GDP; WB's WDI.

Trade openness (to): logarithm of exports plus imports of goods and services expressed as a fraction of GDP (all in current US dollars); WB's WDI.

Age dependency ratio (adr): logarithm of population under 15 or over 64 expressed as a fraction of the working-age population (those between 15 and 64 years of age); WB's WDI.

Old dependency ratio (odr): logarithm of population over 64 expressed as a fraction of the working-age population (those between 15 and 64 years of age); WB's WDI.

Youth dependency ratio (ydr): logarithm of population under 15 expressed as a fraction of the working-age population (those between 15 and 64 years of age); WB's WDI.

Population growth (popgr): for year t it is the exponential rate of growth of mid-year population from year $t - 1$ to t expressed as a percentage; WB's WDI.

Government budget balance (gbb): cash surplus/deficit is revenue (including grants) minus expense, minus net acquisition of non-financial assets expressed as a percentage of GDP; WB's WDI.

International reserves (res): logarithm of total reserves minus gold holdings expressed as a fraction of GDP; EWN II (2012).

Productivity growth (pg): growth rate of real GDP chain per capita (index, in 2005 constant prices); PWT.

Relative per capita income (pci): logarithm of per capita GDP in current US dollars (i.e. nominal terms) relative to that of the US; WB's WDI.

Current account size (cas): absolute value of the current account; WB's WDI.

4.11 Appendix C: Country-Group Linear Analysis Results

Table C4.1.1: Baseline linear CA-REER specification results, pooled OLS estimation (equation 4.1 estimates)

 ca >0.03	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
ca_{i,t-1}	0.850*** (0.081)	0.939*** (0.058)	0.727*** (0.101)	0.842*** (0.052)	0.938*** (0.052)	0.946*** (0.063)
ca_{i,t-2}	0.136 (0.085)	0.005 (0.087)	0.015 (0.083)	0.141*** (0.054)	-0.040 (0.070)	0.023 (0.064)
reer_{i,t}	-0.043** (0.020)	-0.089*** (0.027)	-0.090** (0.033)	-0.028* (0.016)	-0.096*** (0.020)	-0.104** (0.050)
reer_{i,t-1}	0.014 (0.045)	0.034 (0.026)	0.074** (0.026)	0.017 (0.039)	0.056** (0.023)	0.162** (0.080)
reer_{i,t-2}	0.030 (0.040)	0.048* (0.026)	0.023 (0.016)	0.021 (0.035)	0.041** (0.019)	-0.040 (0.038)
Observations	350	267	129	467	279	185
No. of countries	23	19	9	31	20	14
R²	0.88	0.83	0.56	0.88	0.76	0.89
<i>Long-run coefficient</i>						
reer	0.095 (0.797)	-0.126 (0.207)	0.028 (0.033)	0.575 (0.612)	0.005 (0.065)	0.591* (0.341)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. The long-run real effective exchange rate coefficient (reer) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.1.2: Baseline linear CA-REER specification results, fixed effects estimation (equation 4.1 estimates)

 ca >0.03	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
ca_{i,t-1}	0.705*** (0.105)	0.831*** (0.039)	0.625*** (0.100)	0.720*** (0.065)	0.844*** (0.049)	0.755*** (0.082)
ca_{i,t-2}	0.073 (0.083)	-0.034 (0.098)	-0.012 (0.080)	0.097 (0.063)	-0.106 (0.076)	-0.031 (0.069)
reer_{i,t}	-0.039* (0.020)	-0.095*** (0.029)	-0.081** (0.029)	-0.034** (0.016)	-0.086*** (0.023)	-0.115** (0.055)
reer_{i,t-1}	-0.011 (0.056)	0.033 (0.028)	0.071** (0.023)	0.001 (0.048)	0.050** (0.022)	0.125 (0.079)
reer_{i,t-2}	0.029 (0.042)	0.034 (0.029)	0.023 (0.020)	0.016 (0.039)	0.032 (0.021)	-0.024 (0.044)
Observations	350	267	129	467	279	185
No. of countries	23	19	9	31	20	14
Within R²	0.64	0.69	0.41	0.67	0.60	0.57
Between R²	0.99	0.98	0.82	0.98	0.95	0.98
Overall R²	0.87	0.83	0.55	0.87	0.76	0.89
<i>Long-run coefficient</i>						
reer	-0.093 (0.066)	-0.140** (0.064)	0.032 (0.024)	-0.090 (0.072)	-0.017 (0.046)	-0.051 (0.095)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. The long-run real effective exchange rate coefficient (reer) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.1.3: Baseline linear CA-REER specification results, two-step difference-GMM estimation (equation 4.1 estimates)

ca >0.03	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
ca _{i,t-1}	0.303** (0.146)	0.036 (0.250)	0.168 (0.785)	0.455*** (0.132)	0.215 (0.160)	0.416** (0.203)
ca _{i,t-2}	0.084 (0.143)	-0.493*** (0.147)	-0.059 (0.826)	-0.261 (0.169)	-0.327* (0.184)	-0.135 (0.590)
reer _{i,t}	-0.091* (0.049)	-0.005 (0.060)	0.042 (0.191)	-0.121* (0.071)	0.002 (0.065)	-0.116 (0.076)
reer _{i,t-1}	0.001 (0.055)	-0.064 (0.062)	-0.097 (0.252)	0.009 (0.036)	-0.005 (0.059)	0.053 (0.124)
reer _{i,t-2}	-0.011 (0.033)	-0.068* (0.039)	-0.049 (0.080)	-0.045 (0.032)	-0.068* (0.042)	-0.083 (0.143)
Observations	341	255	122	452	266	178
No. of countries	23	19	9	31	20	14
SH test	1.00	1.00	1.00	1.00	1.00	1.00
AB(1)	0.20	0.53	0.40	0.07	0.06	0.13
AB(2)	0.79	0.15	0.92	0.24	0.68	0.80
AB(3)	0.02	0.06	0.39	0.05	0.46	0.12
<i>Long-run coefficient</i>						
reer	-0.164* (0.088)	-0.094*** (0.034)	-0.117 (0.238)	-0.194*** (0.070)	-0.063** (0.026)	-0.204 (0.196)

* significant at 10%; ** significant at 5%; *** significant at 1%
Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run real effective exchange rate coefficient (reer) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.1.4: Baseline linear CA-REER specification results, two-step system-GMM estimation (equation 4.1 estimates)

ca >0.03	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
ca _{i,t-1}	0.775*** (0.119)	0.815*** (0.206)	-0.330* (0.161)	0.772*** (0.155)	0.694*** (0.217)	0.816*** (0.258)
ca _{i,t-2}	0.145 (0.101)	-0.139 (0.248)	-0.385 (0.827)	0.177 (0.242)	-0.031 (0.167)	-0.048 (0.202)
reer _{i,t}	-0.077** (0.035)	-0.044 (0.114)	-0.042 (0.278)	-0.074* (0.043)	-0.121* (0.068)	-0.194 (0.141)
reer _{i,t-1}	0.021 (0.053)	-0.031 (0.118)	-0.178 (0.313)	0.009 (0.051)	0.114 (0.079)	0.210 (0.614)
reer _{i,t-2}	0.010 (0.039)	0.024 (0.043)	0.244 (0.142)	0.028 (0.051)	0.011 (0.029)	-0.029 (0.226)
Observations	350	267	129	467	279	185
No. of countries	23	19	9	31	20	14
SH test	1.00	1.00	1.00	1.00	1.00	1.00
AB(1)	0.09	0.08	0.55	0.09	0.07	0.03
AB(2)	0.71	0.90	0.79	0.74	0.48	0.43
AB(3)	0.08	0.78	0.29	0.12	0.18	0.31
<i>Long-run coefficient</i>						
reer	-0.570* (0.337)	-0.157 (0.209)	0.014 (0.119)	-0.721 (4.095)	0.015 (0.087)	-0.053 (1.591)

* significant at 10%; ** significant at 5%; *** significant at 1%
Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. The long-run real effective exchange rate coefficient (reer) is calculated as the sum of the contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.2.1: Nominal effective exchange rate volatility augmented linear specification results, pooled OLS estimation
(equation 4.7 estimates)

$ ca >0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
$ca_{i,t-1}$	1.467*** (0.210)	1.258*** (0.197)	0.766** (0.288)	1.339*** (0.129)	1.050*** (0.205)	1.411*** (0.187)
$ca_{i,t-2}$	-0.419* (0.251)	0.159 (0.315)	0.401 (0.246)	-0.182 (0.190)	0.088 (0.385)	-0.185 (0.238)
$ca_{i,t-1} \times neervol_{i,t-1}$	-0.122*** (0.044)	-0.071* (0.040)	-0.012 (0.042)	-0.105*** (0.028)	-0.023 (0.036)	-0.118*** (0.039)
$ca_{i,t-2} \times neervol_{i,t-2}$	0.111** (0.053)	-0.038 (0.066)	-0.071 (0.046)	0.066 (0.044)	-0.028 (0.068)	0.056 (0.054)
$reer_{i,t}$	-0.048 (0.098)	-0.046 (0.057)	-0.173*** (0.038)	-0.041 (0.079)	-0.136*** (0.033)	0.038 (0.175)
$reer_{i,t-1}$	0.193** (0.076)	0.019 (0.110)	0.274*** (0.067)	0.221*** (0.064)	0.025 (0.095)	0.170* (0.096)
$reer_{i,t-2}$	0.025 (0.140)	0.163 (0.131)	0.013 (0.049)	-0.044 (0.099)	0.165 (0.121)	-0.192 (0.130)
$reer_{i,t} \times neervol_{i,t}$	0.003 (0.020)	-0.007 (0.013)	0.007*** (0.002)	0.004 (0.016)	0.006** (0.003)	-0.027 (0.038)
$reer_{i,t-1} \times neervol_{i,t-1}$	-0.035* (0.019)	0.000 (0.020)	-0.032*** (0.010)	-0.039*** (0.015)	0.006 (0.016)	-0.011 (0.029)
$reer_{i,t-2} \times neervol_{i,t-2}$	-0.003 (0.025)	-0.023 (0.023)	0.001 (0.011)	0.010 (0.017)	-0.024 (0.021)	0.042 (0.028)
Observations	350	267	129	467	279	185
No. of countries	23	19	9	31	20	14
R ²	0.88	0.84	0.58	0.88	0.77	0.90

Long-run coefficients

reer (low neervol)

reer (mod. neervol)	-1.680 (5.013)	-0.175* (0.098)	-0.079 (0.061)	-0.193 (0.578)	-0.110 (0.091)	0.413** (0.186)
reer (high neervol)	-2.116 (5.915)	-0.238* (0.142)	-0.166 (0.150)	-0.423 (0.808)	-0.180 (0.165)	0.207 (0.324)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. At each of the nominal effective exchange rate volatility (neervol) levels, low, moderate, and high, the long-run real effective exchange rate coefficient (reer) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.2.2: Nominal effective exchange rate volatility augmented linear specification results, fixed effects estimation
(equation 4.7 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
$ca_{i,t-1}$	1.275*** (0.217)	1.129*** (0.182)	0.697** (0.242)	1.235*** (0.123)	0.901*** (0.188)	1.120*** (0.235)
$ca_{i,t-2}$	-0.365 (0.247)	0.102 (0.326)	0.375** (0.156)	-0.102 (0.182)	-0.056 (0.403)	-0.162 (0.176)
$ca_{i,t-1} \times neervol_{i,t-1}$	-0.113** (0.047)	-0.064 (0.041)	-0.020 (0.038)	-0.108*** (0.030)	-0.015 (0.036)	-0.096* (0.049)
$ca_{i,t-2} \times neervol_{i,t-2}$	0.086 (0.051)	-0.034 (0.067)	-0.074** (0.032)	0.040 (0.041)	-0.014 (0.071)	0.039 (0.037)
$reer_{i,t}$	-0.126 (0.083)	-0.093 (0.062)	-0.165*** (0.045)	-0.092 (0.069)	-0.162*** (0.036)	-0.083 (0.151)
$reer_{i,t-1}$	0.134* (0.072)	-0.007 (0.115)	0.266*** (0.078)	0.172*** (0.066)	0.009 (0.101)	0.115 (0.081)
$reer_{i,t-2}$	-0.050 (0.138)	0.127 (0.114)	-0.048 (0.052)	-0.095 (0.094)	0.142 (0.107)	-0.243* (0.131)
$reer_{i,t} \times neervol_{i,t}$	0.019 (0.018)	0.001 (0.014)	0.007*** (0.002)	0.013 (0.014)	0.011*** (0.003)	-0.005 (0.029)
$reer_{i,t-1} \times neervol_{i,t-1}$	-0.027* (0.015)	0.005 (0.021)	-0.030** (0.011)	-0.032** (0.014)	0.008 (0.018)	-0.005 (0.023)
$reer_{i,t-2} \times neervol_{i,t-2}$	0.013 (0.025)	-0.018 (0.020)	0.012* (0.006)	0.020 (0.017)	-0.022 (0.018)	0.057* (0.028)
Observations	350	267	129	467	279	185
No. of countries	23	19	9	31	20	14
Within R ²	0.66	0.69	0.45	0.69	0.62	0.61
Between R ²	0.99	0.99	0.88	0.99	0.96	0.99
Overall R ²	0.88	0.83	0.58	0.88	0.76	0.89
<i>Long-run coefficients</i>						
$reer$ (low $neervol$)	-0.472 (1.474)				-0.070 (0.424)	-4.974 (25.144)
$reer$ (mod. $neervol$)	-0.052 (0.126)	-0.121* (0.069)	-0.029 (0.029)	-0.027 (0.099)	-0.082** (0.040)	0.077 (0.093)
$reer$ (high $neervol$)	-0.029 (0.175)	-0.121 (0.132)	-0.062 (0.078)	-0.011 (0.150)	-0.085 (0.136)	0.271 (0.204)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. At each of the nominal effective exchange rate volatility ($neervol$) levels, low, moderate, and high, the long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.2.3: Nominal effective exchange rate volatility augmented linear specification results, two-step difference-GMM estimation (equation 4.7 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
$ca_{i,t-1}$	1.344*** (0.473)	1.178 (1.449)	0.533 (6.771)	0.832*** (0.203)	0.218 (0.863)	0.485* (0.291)
$ca_{i,t-2}$	-0.656 (0.677)	0.051 (0.398)		-0.149 (0.438)	-0.781 (0.765)	-0.371 (1.977)
$ca_{i,t-1} \times neervol_{i,t-1}$	-0.184** (0.088)	-0.269 (0.281)	-0.027 (1.375)	-0.090** (0.039)	0.034 (0.178)	-0.093 (0.093)
$ca_{i,t-2} \times neervol_{i,t-2}$	0.109 (0.116)	0.027 (0.050)		0.022 (0.095)	0.128 (0.132)	0.151 (0.272)
$reer_{i,t}$	-0.437*** (0.166)	-0.267 (0.274)	-0.152 (0.442)	-0.353** (0.155)	0.016 (0.094)	0.002 (1.334)
$reer_{i,t-1}$	0.247 (0.193)	-0.275** (0.118)	1.100 (1.097)	0.191 (0.197)	-0.322 (0.350)	-1.016 (3.577)
$reer_{i,t-2}$	-0.140 (0.136)	0.585* (0.335)	-0.266 (0.406)	-0.052 (0.149)	0.181 (0.149)	-0.306 (0.582)
$reer_{i,t} \times neervol_{i,t}$	0.070** (0.032)	0.027 (0.053)	-0.026 (0.033)	0.050* (0.029)	-0.005 (0.007)	-0.015 (0.421)
$reer_{i,t-1} \times neervol_{i,t-1}$	-0.039 (0.032)	0.030 (0.023)	-0.141** (0.065)	-0.039 (0.039)	0.045 (0.059)	0.229 (0.617)
$reer_{i,t-2} \times neervol_{i,t-2}$	0.021 (0.025)	-0.111* (0.062)	0.056 (0.035)	0.014 (0.028)	-0.024 (0.021)	0.082 (0.150)
Observations	341	255	123	452	266	178
No. of countries	23	19	9	31	20	14
SH test	1.00	1.00	1.00	1.00	1.00	1.00
AB(1)	0.05	0.42	0.45	0.03	0.01	0.74
AB(2)	0.26	0.31	0.62	0.73	0.88	0.69
AB(3)	0.24	0.18	0.79	0.06	0.73	0.98
Long-run coefficients						
$reer$ (low $neervol$)	-1.056 (2.668)		1.463 (19.563)	-0.673 (1.506)	-0.080 (0.218)	-1.490 (9.209)
$reer$ (mod. $neervol$)	-0.022 (0.098)	-0.224* (0.134)	0.020 (0.324)	-0.084 (0.098)	-0.042 (0.115)	0.265 (1.663)
$reer$ (high $neervol$)	0.042 (0.149)	-0.222 (0.228)	-0.455 (3.861)	-0.011 (0.200)	0.236 (3.603)	1.548 (8.281)

* significant at 10%; ** significant at 5%; *** significant at 1%
Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. At each of the nominal effective exchange rate volatility ($neervol$) levels, low, moderate, and high, the long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.2.4: Nominal effective exchange rate volatility augmented linear specification results, two-step system-GMM estimation
(equation 4.7 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income	Euro Zone
	(1)	(2)	(3)	(4)	(5)	(6)
$ca_{i,t-1}$	1.247** (0.480)	1.262** (0.478)	0.464 (18.409)	0.897** (0.361)	-0.174 (1.207)	1.405** (0.692)
$ca_{i,t-2}$	-0.035 (1.338)	0.060 (1.331)		-0.340 (0.539)	0.310 (0.618)	0.320 (1.839)
$ca_{i,t-1} \times neervol_{i,t-1}$	-0.089 (0.091)	-0.078 (0.095)	0.067 (3.579)	-0.029 (0.069)	0.160 (0.229)	-0.254*** (0.080)
$ca_{i,t-2} \times neervol_{i,t-2}$	0.047 (0.212)	-0.058 (0.211)		0.081 (0.111)	-0.054 (0.111)	0.047 (0.368)
$reer_{i,t}$	0.258* (0.134)	-0.556 (0.689)	0.405 (0.911)	-0.300 (0.269)	0.007 (0.106)	0.968* (0.540)
$reer_{i,t-1}$	0.087 (0.187)	-0.446* (0.255)	2.778 (2.127)	0.531** (0.243)	-0.007 (0.158)	0.506 (0.355)
$reer_{i,t-2}$	-0.058 (0.133)	0.005 (0.424)	0.574 (2.524)	-0.064 (0.221)	0.227*** (0.081)	0.827 (1.018)
$reer_{i,t} \times neervol_{i,t}$	-0.055** (0.023)	0.097 (0.114)	-0.206 (0.156)	0.042 (0.048)	-0.011** (0.005)	-0.237* (0.144)
$reer_{i,t-1} \times neervol_{i,t-1}$	-0.019 (0.037)	0.077* (0.040)	-0.345 (0.345)	-0.095** (0.045)	-0.001 (0.021)	-0.118 (0.125)
$reer_{i,t-2} \times neervol_{i,t-2}$	0.020 (0.028)	0.014 (0.078)	-0.020 (0.126)	0.024 (0.041)	-0.026** (0.011)	-0.149 (0.210)
Observations	350	267	130	467	279	185
No. of countries	23	19	9	31	20	14
SH test	1.00	0.99	1.00	1.00	1.00	1.00
AB(1)	0.38	0.13	0.96	0.03	0.08	0.74
AB(2)	0.89	0.71	0.37	0.79	0.28	0.58
AB(3)	0.26	0.25	0.79	0.10	0.17	0.19

Long-run coefficients

$reer$ (low $neervol$)			7.015 (235.132)	0.379 (0.938)	0.262 (0.451)	
$reer$ (mod. $neervol$)	-1.053 (11.608)	0.273 (0.392)	2.479 (58.168)	-0.032 (0.816)	0.020 (0.304)	-0.689 (1.068)
$reer$ (high $neervol$)	-1.184 (10.371)	0.857 (1.505)	-3.517 (351.289)	-2.315 (40.362)	-0.256 (1.258)	-1.681 (2.856)

* significant at 10%; ** significant at 5%; *** significant at 1%
Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. At each of the nominal effective exchange rate volatility ($neervol$) levels, low, moderate, and high, the long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics at the given volatility level. Standard errors for long-run real exchange rate coefficients are computed using the delta method.

Table C4.3.1: Nominal exchange rate regime augmented linear specification results, pooled OLS estimation
(equation 4.8 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
	(1)	(2)	(3)	(4)	(5)
$ca_{i,t-1}$	0.807*** (0.112)	0.928*** (0.074)	0.666*** (0.121)	0.802*** (0.067)	0.899*** (0.063)
$ca_{i,t-2}$	0.187* (0.112)	0.004 (0.106)	0.109 (0.094)	0.183*** (0.065)	0.033 (0.097)
$ca_{i,t-1} \times irrerr2_{i,t-1}$	0.063 (0.044)	-0.016 (0.063)	0.161 (0.146)	0.031 (0.045)	0.032 (0.070)
$ca_{i,t-1} \times irrerr3_{i,t-1}$	0.216** (0.108)	0.159 (0.145)	0.167 (0.192)	0.335*** (0.060)	0.162 (0.148)
$ca_{i,t-2} \times irrerr2_{i,t-2}$	-0.094** (0.042)	0.064 (0.104)	-0.154 (0.122)	-0.031 (0.053)	-0.093 (0.092)
$ca_{i,t-2} \times irrerr3_{i,t-2}$	-0.150 (0.127)	-0.412*** (0.151)	-0.461*** (0.106)	-0.379*** (0.121)	-0.289*** (0.106)
$reer_{i,t}$	0.011 (0.036)	-0.109*** (0.035)	-0.148** (0.062)	-0.009 (0.033)	-0.129*** (0.027)
$reer_{i,t-1}$	-0.024 (0.075)	0.057* (0.034)	0.062 (0.073)	-0.000 (0.061)	0.067** (0.032)
$reer_{i,t-2}$	0.034 (0.058)	0.056** (0.023)	0.095** (0.036)	0.035 (0.044)	0.065*** (0.025)
$reer_{i,t} \times irrerr2_{i,t}$	-0.091* (0.053)	0.030 (0.020)	0.020 (0.063)	-0.046 (0.040)	0.038* (0.020)
$reer_{i,t} \times irrerr3_{i,t}$	-0.057 (0.039)	0.018 (0.041)	0.006 (0.058)	-0.006 (0.053)	0.026 (0.026)
$reer_{i,t-1} \times irrerr2_{i,t-1}$	0.021 (0.139)	-0.059** (0.026)	-0.007 (0.055)	-0.011 (0.080)	-0.072*** (0.025)
$reer_{i,t-1} \times irrerr3_{i,t-1}$	0.064 (0.068)	-0.023 (0.028)	0.080 (0.065)	0.047 (0.057)	0.014 (0.022)
$reer_{i,t-2} \times irrerr2_{i,t-2}$	0.069 (0.099)	0.004 (0.027)	-0.066* (0.037)	0.042 (0.064)	0.004 (0.024)
$reer_{i,t-2} \times irrerr3_{i,t-2}$	-0.059 (0.056)	-0.088* (0.046)	-0.084* (0.041)	-0.082* (0.051)	-0.043* (0.023)
Observations	350	267	129	467	279
No. of countries	23	19	9	31	20
R ²	0.88	0.84	0.62	0.88	0.77
Long-run coefficients					
reer (fixed)	3.767 (14.150)	0.051 (0.170)	0.039 (0.064)	1.666 (2.255)	0.050 (0.118)
reer (intermediate)	0.531 (0.837)	-1.087 (1.570)	-0.206 (0.221)	0.636 (1.312)	-0.204* (0.121)
reer (flexible)		-0.279** (0.112)	0.020** (0.009)	-0.245 (0.601)	0.008 (0.031)

* significant at 10%; ** significant at 5%; *** significant at 1%
Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. $irrerr2$ is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. $irrerr3$ is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both $irrerr2$ and $irrerr3$ are based on the de facto nominal exchange rate arrangement classifications of Ilzetzi, Reinhart and Rogoff (2011). Thus we have the label ‘irrerr’ denoting Ilzetzi, Reinhart and Rogoff exchange rate regime. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real effective exchange rate coefficient (reer) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Results for euro zone sample not available due to an insufficient number of intermediate and flexible exchange rate regime observations.

Table C4.3.2: Nominal exchange rate regime augmented linear specification results, fixed effects estimation

(equation 4.8 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
	(1)	(2)	(3)	(4)	(5)
$ca_{i,t-1}$	0.646*** (0.140)	0.787*** (0.063)	0.552*** (0.144)	0.635*** (0.087)	0.781*** (0.058)
$ca_{i,t-2}$	0.117 (0.121)	-0.032 (0.111)	0.049 (0.077)	0.109 (0.072)	-0.038 (0.103)
$ca_{i,t-1} \times irrerr2_{i,t-1}$	0.105 (0.067)	0.030 (0.060)	0.156 (0.151)	0.095* (0.055)	0.039 (0.068)
$ca_{i,t-1} \times irrerr3_{i,t-1}$	0.187 (0.187)	0.198 (0.145)	0.167 (0.157)	0.280*** (0.103)	0.154 (0.119)
$ca_{i,t-2} \times irrerr2_{i,t-2}$	-0.063 (0.052)	0.083 (0.124)	-0.063 (0.071)	0.017 (0.066)	-0.095 (0.100)
$ca_{i,t-2} \times irrerr3_{i,t-2}$	-0.269** (0.132)	-0.342** (0.155)	-0.430*** (0.108)	-0.418*** (0.108)	-0.280*** (0.108)
$reer_{i,t}$	-0.004 (0.033)	-0.121*** (0.038)	-0.113* (0.058)	-0.021 (0.030)	-0.137*** (0.032)
$reer_{i,t-1}$	-0.040 (0.077)	0.047 (0.033)	0.036 (0.062)	-0.012 (0.066)	0.061** (0.030)
$reer_{i,t-2}$	0.025 (0.054)	0.052* (0.028)	0.075* (0.044)	0.034 (0.046)	0.056** (0.026)
$reer_{i,t} \times irrerr2_{i,t}$	-0.087* (0.049)	0.029 (0.023)	0.005 (0.062)	-0.052 (0.039)	0.039 (0.025)
$reer_{i,t} \times irrerr3_{i,t}$	-0.012 (0.031)	0.028 (0.037)	-0.028 (0.060)	0.006 (0.028)	0.034 (0.029)
$reer_{i,t-1} \times irrerr2_{i,t-1}$	0.013 (0.124)	-0.048** (0.023)	0.009 (0.047)	-0.013 (0.075)	-0.063*** (0.023)
$reer_{i,t-1} \times irrerr3_{i,t-1}$	0.071 (0.068)	-0.008 (0.031)	0.092 (0.058)	0.054 (0.054)	0.025 (0.018)
$reer_{i,t-2} \times irrerr2_{i,t-2}$	0.040 (0.079)	-0.011 (0.033)	-0.019 (0.050)	0.004 (0.052)	-0.006 (0.029)
$reer_{i,t-2} \times irrerr3_{i,t-2}$	-0.035 (0.054)	-0.080* (0.050)	-0.043 (0.057)	-0.070 (0.047)	-0.031 (0.024)
Observations	350	267	129	467	279
No. of countries	23	19	9	31	20
Within R ²	0.65	0.70	0.48	0.69	0.63
Between R ²	0.99	0.98	0.87	0.99	0.95
Overall R ²	0.87	0.83	0.60	0.87	0.76
<i>Long-run coefficients</i>					
$reer$ (fixed)	-0.077 (0.115)	-0.087 (0.067)	-0.006 (0.024)	0.001 (0.079)	-0.076 (0.058)
$reer$ (intermediate)	-0.267 (0.216)	-0.377* (0.214)	-0.023 (0.142)	-0.429 (0.310)	-0.159*** (0.060)
$reer$ (flexible)	0.019 (0.035)	-0.209** (0.086)	0.028*** (0.007)	-0.026 (0.039)	0.021 (0.023)

* significant at 10%; ** significant at 5%; *** significant at 1%

Cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. $irrerr2$ is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. $irrerr3$ is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both $irrerr2$ and $irrerr3$ are based on the de facto nominal exchange rate arrangement classifications of Ilzetzi, Reinhart and Rogoff (2011). Thus we have the label 'irrerr' denoting Ilzetzi, Reinhart and Rogoff exchange rate regime. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Results for euro zone sample not available due to an insufficient number of intermediate and flexible exchange rate regime observations.

Table C4.3.3: Nominal exchange rate regime augmented linear specification results, two-step difference-GMM estimation
(equation 4.8 estimates)

 ca >0.03	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
	(1)	(2)	(3)	(4)	(5)
ca_{i,t-1}	0.641** (0.273)	0.563* (0.338)	0.589* (0.329)	0.971* (0.561)	0.690* (0.410)
ca_{i,t-2}	-0.323 (0.286)	-0.154 (0.171)		0.090 (0.237)	-0.054 (0.241)
ca_{i,t-1} × irrerr2_{i,t-1}	-0.042 (0.315)	-0.319 (0.386)	2.557 (1.584)	-0.441 (0.664)	0.098 (0.659)
ca_{i,t-1} × irrerr3_{i,t-1}	0.044 (1.040)	-0.191 (0.798)	-8.170 (5.436)	-0.109 (1.175)	-0.018 (0.910)
ca_{i,t-2} × irrerr2_{i,t-2}	0.131 (0.565)	-0.100 (0.155)		0.037 (0.294)	0.033 (0.329)
ca_{i,t-2} × irrerr3_{i,t-2}	-0.054 (1.048)	-0.377** (0.157)		-0.769 (1.206)	-0.323 (0.345)
reer_{i,t}	-0.003 (0.177)	-0.101 (0.132)	0.663 (0.409)	-0.724*** (0.216)	-0.352 (0.468)
reer_{i,t-1}	-0.028 (0.277)	-0.009 (0.159)	0.544* (0.270)	0.440* (0.248)	0.202 (0.283)
reer_{i,t-2}	-0.007 (0.108)	0.031 (0.079)		0.126 (0.264)	0.076 (0.093)
reer_{i,t} × irrerr2_{i,t}	-0.082 (0.125)	0.005 (0.063)	0.580 (0.545)	0.253 (0.237)	-0.015 (0.612)
reer_{i,t} × irrerr3_{i,t}	-0.151 (0.344)	0.059 (0.249)	-0.517* (0.271)	0.524** (0.256)	0.255 (0.634)
reer_{i,t-1} × irrerr2_{i,t-1}	-0.067 (0.366)	-0.131 (0.139)	0.390 (0.405)	0.335 (0.264)	0.095 (0.542)
reer_{i,t-1} × irrerr3_{i,t-1}	0.081 (0.330)	-0.089 (0.225)	0.650 (0.474)	-0.228 (0.267)	0.057 (0.236)
reer_{i,t-2} × irrerr2_{i,t-2}	0.124 (0.191)	0.205*** (0.070)		-0.484** (0.237)	-0.090 (0.119)
reer_{i,t-2} × irrerr3_{i,t-2}	-0.007 (0.177)	0.008 (0.048)		-0.186 (0.276)	-0.098* (0.061)
Observations	341	255	129	452	266
No. of countries	23	19	9	31	20
SH test	1.00	0.97	1.00	0.93	0.46
AB(1)	0.00	0.39	0.68	0.03	0.18
AB(2)	0.10	0.44		0.98	0.89
AB(3)	0.40	0.19	0.53	0.72	0.45
<i>Long-run coefficients</i>					
reer (fixed)	-0.055 (0.267)	-0.134 (0.134)	2.935 (2.354)		-0.203 (0.873)
reer (intermediate)	-0.105 (0.147)	-0.000 (0.127)		-0.159 (0.496)	-0.362 (1.422)
reer (flexible)	-0.165 (0.250)	-0.088 (0.320)	0.156*** (0.034)	-0.060 (0.147)	0.199 (0.381)

* significant at 10%; ** significant at 5%; *** significant at 1%
Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t. |ca| > 0.03 indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. irrerr2 is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. irrerr3 is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both irrerr2 and irrerr3 are based on the de facto nominal exchange rate arrangement classifications of Ilzetzi, Reinhart and Rogoff (2011). Thus we have the label 'irrerr' denoting Ilzetzi, Reinhart and Rogoff exchange rate regime. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero mth-order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real effective exchange rate coefficient (reer) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Results for euro zone sample not available due to an insufficient number of intermediate and flexible exchange rate regime observations.

Table C4.3.4: Nominal exchange rate regime augmented linear specification results, two-step system-GMM estimation
(equation 4.8 estimates)

$ ca > 0.03$	Advanced Economies	Emerging Economies	Developing Economies	High Income	Middle & Low Income
	(1)	(2)	(3)	(4)	(5)
$ca_{i,t-1}$	0.744** (0.325)	0.775* (0.403)	1.700** (0.563)	0.786*** (0.119)	0.979* (0.623)
$ca_{i,t-2}$	0.284 (0.250)	0.034 (0.355)		0.179 (0.142)	-0.616* (0.375)
$ca_{i,t-1} \times irrerr2_{i,t-1}$	0.103 (0.585)	-0.022 (0.307)	-0.397 (1.416)	0.059 (0.109)	-0.982 (0.640)
$ca_{i,t-1} \times irrerr3_{i,t-1}$	1.092 (1.665)	0.721 (1.878)	-0.791 (1.504)	0.420 (0.763)	-0.430 (0.767)
$ca_{i,t-2} \times irrerr2_{i,t-2}$	-0.493 (0.546)	-0.407 (0.895)		-0.064 (0.130)	0.980 (1.220)
$ca_{i,t-2} \times irrerr3_{i,t-2}$	-1.593 (2.318)	-0.636 (1.809)		-0.622** (0.304)	-0.346 (0.349)
$reer_{i,t}$	-0.164** (0.083)	0.118 (0.204)	0.335 (0.337)	-0.233* (0.129)	0.375 (0.380)
$reer_{i,t-1}$	0.112 (0.085)	-0.062 (0.188)		0.190 (0.143)	0.007 (0.337)
$reer_{i,t-2}$	-0.001 (0.140)	-0.038 (0.135)		-0.014 (0.054)	0.046 (0.132)
$reer_{i,t} \times irrerr2_{i,t}$	0.296 (0.200)	-0.342* (0.180)	-0.784* (0.436)	0.088 (0.137)	-0.462** (0.233)
$reer_{i,t} \times irrerr3_{i,t}$	-0.231 (0.241)	-0.030 (0.378)	-0.933* (0.503)	0.101 (0.130)	-0.467* (0.288)
$reer_{i,t-1} \times irrerr2_{i,t-1}$	-0.229 (0.304)	0.159 (0.241)	0.224 (0.298)	-0.083 (0.118)	-0.318* (0.172)
$reer_{i,t-1} \times irrerr3_{i,t-1}$	0.056 (0.357)	0.414 (0.354)	0.510 (0.373)	-0.015 (0.117)	-0.216 (0.170)
$reer_{i,t-2} \times irrerr2_{i,t-2}$	0.185 (0.159)	0.037 (0.186)		0.053 (0.071)	0.245 (0.281)
$reer_{i,t-2} \times irrerr3_{i,t-2}$	0.067 (0.224)	0.156 (0.275)		-0.041 (0.055)	-0.043 (0.103)
Observations	350	267	137	467	279
No. of countries	23	19	9	31	20
SH test	0.99	1.00	1.00	0.76	1.00
AB(1)	0.04	0.05	0.01	0.02	0.32
AB(2)	0.95	0.86	0.29	0.82	0.81
AB(3)	0.35	0.52	0.34	0.15	0.44
<i>Long-run coefficients</i>					
$reer$ (fixed)		0.087 (0.493)		-1.617 (3.980)	0.672 (0.797)
$reer$ (intermediate)	0.549 (0.518)	-0.206 (0.339)		0.019 (4.420)	-0.167* (0.090)
$reer$ (flexible)	-0.340 (1.008)	5.254 (140.512)	-0.978 (13.467)	-0.051 (0.135)	-0.211 (0.245)

* significant at 10%; ** significant at 5%; *** significant at 1%

Windmeijer-corrected cluster-robust standard errors in parentheses. The dependent variable is the current account to GDP ratio at time t . $|ca| > 0.03$ indicates that the analysis is executed for the sample of current account balances that are greater than 3 percent in absolute value. Time dummies not included. $irrerr2$ is a dummy variable that equals 1 when country i in period t has an intermediate nominal exchange rate regime, and 0 otherwise. $irrerr3$ is a dummy variable that equals 1 when country i in period t has a flexible nominal exchange rate regime, and 0 otherwise. Both $irrerr2$ and $irrerr3$ are based on the de facto nominal exchange rate arrangement classifications of Ilzetzi, Reinhart and Rogoff (2011). Thus we have the label 'irrerr' denoting Ilzetzi, Reinhart and Rogoff exchange rate regime. SH test refers to the Sargan/Hansen test of valid overidentifying restrictions. AB(m) refers to the Arellano-Bond test for zero m^{th} -order autocorrelation in the first-differenced residuals. P-values are reported for both the SH and AB(m) tests. For each of the nominal exchange rate regimes, fixed, intermediate, and flexible, the long-run real effective exchange rate coefficient ($reer$) is calculated as the sum of the relevant contemporaneous and lagged real effective exchange rate coefficient estimates divided by one minus the sum of the relevant lagged current account coefficient estimates, provided that the current account does not exhibit explosive dynamics in the given regime. Standard errors for long-run real exchange rate coefficients are computed using the delta method. Results for euro zone sample not available due to an insufficient number of intermediate and flexible exchange rate regime observations.

Chapter 5

General Conclusions

This thesis is concerned with topics in the field of international macroeconomics. In particular, it consists of three essays that empirically examine matters related to the dynamics of real exchange rates and external imbalances. Although the three essays are written as separate pieces of work within the same general field, they are all interconnected to varying degrees on a more specific level both through the issues analysed and the estimates that carry over from the first of these essays in chapter 2. Notably, the persistence of variables is a reoccurring theme throughout all three research projects.

Debate surrounding the assessment of real exchange rate dynamics, and more specifically misalignments, has always featured prominently in international macroeconomics, especially in the context of global imbalances. In light of the recent global crisis, understanding how real exchange rates adjust has become particularly important as both academics and policy-makers seek to analyse the degree to which the burden of external adjustment can be shared between “output shifting” and “expenditure switching”. In chapter 2, we focus on the persistence of real exchange rate parity deviations across the globe and document some salient trends. Specifically, in contrast to previous studies of the same variety, our extended global analysis endeavours to more accurately capture real exchange rate dynamics by accounting for structural breaks and adjustment non-linearities in univariate country-by-country time series specifications.

Concerning the results, the adopted empirical models yield real exchange rate convergence rates consistent with the notion of nominal rigidities presiding over the short run, with multilateral exchange rates typically displaying faster mean-reversion. To be exact, the median half-life of real exchange rate disequilibria over the whole sample of countries during post-Bretton Woods is found to be markedly less than 2 years in the case of bilateral exchange rates, and considerably less than 1 year in the case of effective rates. Interestingly, our estimates consistently point to advanced economies as having the slowest rates of adjustment, while, from a geographical

standpoint, they indicate that Latin America and Africa are characterised by the fastest rates of real exchange rate convergence.

Our half-life statistics and findings of significantly different real exchange rate inertia levels across industrial, emerging and developing countries are potentially relevant for both theoretical macro modelling and policy analysis. Indeed, many traditional and dynamic stochastic general equilibrium sticky-price macro models assume relatively swift parity-reversion. Along policy lines, as noted, the persistence of real exchange rate misalignments in developing economies has received special interest given that many of these economies have been adopting World Bank and IMF proposed macroeconomic reform policies with the objective of enhancing external competitiveness. Moreover, Laureti (2001) shows that the integration process between Europe and Mediterranean countries has brought about a convergence in the volatility of prices and exchange rates.¹⁴⁸ Thus, as integration programmes designed to promote monetary integration and financial/trade openness advance in transitional economies, significant discrepancies in real exchange rate dynamics across developed and developing nations may partly diminish.

The analysis we conduct within the univariate framework, however, does not simultaneously consider the origin of real exchange rate disturbances across countries worldwide. Although we cross-sectionally examine the drivers of aggregate rates of persistence in chapter 3, it may also be instructive to investigate the relative roles played by real and monetary shocks using a multivariate time series setup that identifies factors associated with each. In turn, the results of the multivariate framework can be compared to those of the univariate one in order to gauge the contributions of these factors to persistence.

As mentioned, chapter 3 cross-sectionally analyses the covariates of real exchange rate persistence using the half-life estimates of chapter 2. To date, there have been very few cross-sectional studies on real exchange rate inertia and, to the best of our knowledge, virtually none of the global and parametric variety. In particular, we scrutinise a set of macroeconomic and geographic country characteristics in order to

¹⁴⁸ See "Purchasing Power Parity and Integration: Empirical Evidence in the Mediterranean Countries" (2001) by Laureti, L. in *Journal of Policy Modeling* (Vol.23, No.7, pp731-751).

potentially account for the cross-country variation in real exchange rate parity-reversion rates.

Our findings show that economies characterised by higher inflation, nominal exchange rate variability and trade openness tend to display faster real exchange rate mean-reversion. On the other hand, for bilateral exchange rates, geographical distance from the base country imparts a positive effect on inertia levels. The study also posits some modest evidence of a positive relation between productivity growth, as proxied by GDP per capita growth, and persistence. The degree of *de facto* international financial openness is found to only matter at the country group level, with cross-country discrepancies perhaps obscuring results in overall samples. To elaborate, we obtain a positive correlation between persistence and international financial integration for developing economies, while a negative link for more advanced economies. In the case of bilateral exchange rates for the former group of countries, qualitative evidence suggests that the relation may be driven by the debt and reserve components. Further qualitative examination also reveals that foreign exchange reserves are positively correlated with real exchange rate inertia in the non-industrialised world.

Future studies may find it interesting to more systematically evaluate the effects of the different components of external assets and liabilities on real exchange rate persistence. The impact of the debt position on a country's real exchange rate dynamics in particular is one of the less studied issues in the literature. As highlighted by Reinhart and Rogoff (2009), emerging market experiences indicate that high levels of external debt, close to the default threshold, are generally accompanied by sharp real exchange rate adjustment in the form of large depreciations as locals and foreign investors flee the currency. Remarkably, a large number of the sharp speculations and defaults have occurred at external debt to GNP levels below 60 percent, which would seem quite feasible by the standards of advanced economies.

The final essay of chapter 4 contributes to the literature on external imbalances by assessing the bivariate relation between large current account imbalances and the real exchange rate over different levels of nominal exchange rate variability. Proponents of more flexible, or variable, nominal exchange rates in policy circles have often contended that rigid exchange rate arrangements lead to more misaligned real exchange rates than under regimes characterised by greater exchange rate variability, and

therefore result in more prolonged and abrupt adjustments of external imbalances. Indeed, the viability of the euro area as a currency union in recent years has been called into question on the basis of these grounds, particularly during the time of the global crisis. As alluded to in previous chapters, many of the arguments refer back to those of Friedman (1953).

Employing linear and non-linear panel techniques for a large group of industrialised and non-industrialised countries over the post-Bretton Woods period, we find that nominal exchange rate flexibility or volatility plays a significant role in the aforementioned relation. At lower nominal exchange rate rigidity levels, an inverse correlation between large external imbalances and the real exchange rate can be observed. Strikingly, this is in contrast to the often non-existent or positive comovement that prevails under regimes that entail lower nominal exchange rate variability. Subsequently, we infer from our analysis that greater nominal exchange rate adjustment (both in size and frequency) can facilitate a stabilising current account-real exchange rate relation, in the sense that it helps to establish a negative link between the two variables. Overall, the results are interpreted as offering evidence of more effective and immediate expenditure-switching-based adjustment at higher nominal exchange rate flexibility levels.

Controlling for the real exchange rate, we also normally find that current account persistence declines with nominal exchange rate variability in our panel framework. This falls in accordance with the argument that there can be greater scope for interest rate-based output-shifting effects under more flexible exchange rate arrangements. In other words, there may be additional room for the expenditure-shifting channel to act as a further outlet of current account adjustment in such a setting (i.e. adjustment through domestic economic activity).

The latter section of the chapter finally tenders some new evidence along the cross section. The most prominent findings are a) the strong positive relation between current account inertia and real exchange rate inertia based on country-specific half-life estimates, and b) the inverse correlation between persistence in either the current account or real exchange rate and nominal exchange rate volatility.

This study has exclusively focused on the relation between large current account imbalances and the real exchange rate under different levels of nominal exchange rate

variability. A possible avenue for future research would be to investigate the most relevant triggers of current account reversals along varying degrees of nominal exchange rate rigidity using a diverse range of countries. To the best of our knowledge, no work has systematically conducted such an exercise. One comment that we wish to make in relation to our study is that more flexible exchange rate arrangements are not necessarily akin to unstable nominal exchange rates. As Friedman (1953) notes, nominal exchange rate instability actually stems from instability in the underlying economic and political structure. Thus a ‘fear of floating’ should not be validated on the basis of such contentions. What our analysis has achieved is to empirically demonstrate that less rigid nominal exchange rates can aid in external adjustment and prevent explosive or highly persistent large global imbalances.