# Real Exchange Rates and Foreign Assets: Three Essays

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To my father (1958-2004)

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# Abstract

This thesis consists of three self-contained papers, which contribute to the debates surrounding global imbalances and financial globalization. The papers are unified by their featuring of foreign assets and real exchange rates (RERs) as the central themes.

Following the introductory chapter, the first paper revisits the growth impact of RER distortions. The Washington Consensus emphasizes the economic costs of RER misalignment. However, a sizable recent empirical literature finds that undervalued RERs help countries achieve faster economic growth. The study shows that these findings are driven by inappropriate homogeneity assumptions imposed on long-run RER behavior across countries and/or misspecification of the growth equation. When these problems are redressed, the empirical results for a sample of 63 developing countries over the period 1970-2007 suggest that misalignment of the RER, in either direction from the level consistent with external and internal equilibrium reduces economic growth. However, deviations from Balassa-Samuelson adjusted purchasing power parity do not seem to affect growth. The RER should thus be consistent with external and internal balance, irrespective of the purchasing power parity benchmark.

The second paper is motivated by the popular view that the surge in China's foreign exchange reserves is due to a distortionary exchange rate policy aimed at keeping the RER undervalued in order to support export-led growth. It undertakes an in-depth empirical investigation to quantify how much "mercantilist" and "precautionary" motives have contributed to the reserve build-up in China during the period 1998Q4–2011Q4. A substantial problem is that theory is consistent with employing two vastly differing approaches to defining and estimating the role of mercantilist reserve accumulation. *A priori*, either method could generate misleading results. The study shows, however, that the distinction between the two approaches is immaterial in China's case. The results suggest that mercantilism accounts for less than 10 percent of the reserve accumulation. Precautionary motives and other factors seem to be the dominant determinants of the surge in China's international reserves.

The third paper studies the macroeconomic impact of valuation effects (changes in net external assets of a country arising from movements in exchange rates or asset returns). In theory, valuation effects are an important

channel of international risk sharing through their facilitation of external adjustment. However, the effects can also be economically destabilizing in the presence of frictions in the international financial system. Despite the growing significance of valuation effects in an era of financial globalization, the nature and extent of their macroeconomic effect has not yet been systematically examined, especially in relation to emerging market economies (EMEs). The study examines the macroeconomic impact of valuation effects for 53 countries over 1980-2010. Valuation effects seem to operate as a risk sharing channel in high income countries. For EMEs the results depend on how valuation effects correlate with domestic consumption growth. There is weak evidence that valuation effects act as a risk sharing channel only if the correlation is negative, and are destabilizing otherwise. In the latter case, the welfare loss may well exceed one percent of permanent consumption.

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# Acronyms

**ADF** Augmented Dickey-Fuller

**AR** Autoregressive

**CA** Current account balance

**CAP** Capital account balance

**CD** Cross-section dependence

**CFA** Communauté financière d'Afrique ("Financial Community of Africa")

**CPI** Consumer price index

**CRRA** Constant relative risk aversion

**DGP** Data generating process

**DOLS** Dynamic ordinary least squares

**EME** Emerging market economy

**EMU** European Monetary Union

**EOM** Errors and omissions

**EU** European Union

**ERER** Equilibrium real exchange rate

**EWNII** External Wealth of Nations mark II database (Lane and Milesi-Ferretti, 2007)

**FDI** Foreign direct investment

**FMOLS** Fully-modified ordinary least squares

**GDP** Gross domestic product

**GMM** Generalized method of moments

| | |
|---|---|
| **IC** | Information criteria |
| **IFS** | International Financial Statistics |
| **IMF** | International Monetary Fund |
| **MNE** | Multinational enterprise |
| **NFA** | Net foreign asset position |
| **OECD** | Organisation for Economic Co-operation and Development |
| **OLS** | Ordinary least squares |
| **PPP** | Purchasing power parity |
| **PWT** | Penn World Table |
| **RAI** | Reserve adequacy index |
| **RER** | Real exchange rate |
| **RMB** | Renminbi |
| **SEA** | Single-equation approach |
| **SOLS** | Static ordinary least squares |
| **TOT** | Terms of trade |
| **2SLS** | Two-stage least squares |
| **UK** | United Kingdom |
| **UN** | United Nations |
| **US** | United States |
| **WDI** | World Development Indicators |
| **WPI** | Wholesale price index |
| **WTO** | World Trade Organization |

Chapter 1

# Introduction

## 1.1 Context

The international economic landscape has changed substantially following the string of financial crises in emerging market economies (EMEs) in the 1990s. Many EMEs, in particular China and the East Asian countries affected by the 1997-98 financial crisis, have been building up foreign exchange reserves at unprecedented levels by running sizable and persistent current account surpluses.[1] This has been mirrored in widening current account deficits in the US. There is an ongoing debate about the causes of these "global imbalances" and their implications for structural adjustment policies in both surplus and deficit countries.

The influential "Bretton Woods II-view" holds that global imbalances are due to government policy interventions in emerging countries, especially in East Asia, in that they follow mercantilist policies to support a development

[1]For instance, China's reserves (US$ 3.2 trillion) amounted to a staggering 44 percent of annual gross domestic product (GDP) in 2011.

strategy based on export-led growth (Dooley et al., 2004, 2005). According to this view, the key ingredient to fostering economic development is real exchange rate (RER) undervaluation. To maintain real undervaluation, the authorities engage in distortionary exchange rate policies by hoarding foreign exchange reserves in order to resist the equilibrating forces that would appreciate the nominal exchange rate. The underlying logic of the Bretton Woods II model is that real undervaluation is good for economic growth since positive externalities such as learning-by-doing effects or technology spillovers are more pronounced in export-linked industries than in the nontradable sector. Rodrik (2008) and a number of other studies such as Aguirre and Calderón (2005), Béreau et al. (2009), and MacDonald and Vieira (2010) provide empirical evidence that RER undervaluation does indeed foster economic growth in developing countries. The proponents of Bretton Woods II thus highlight how the system benefits emerging countries through export-led growth, and the US through high domestic absorption.

There are, however, concerns about the sustainability of global imbalances. The intertemporal budget constraint determines that net external indebtedness cannot exceed the present value of future trade balances. Therefore, the US's persistent current account deficits cannot continue forever. Eventually some adjustment will be needed. Under conventional theory, this adjustment needs to be in the form of a reversal in the trade balance. How-

ever, a sizable recent literature shows that it is not only the current account driving the change in the net foreign asset position but also "valuation effects" (Lane and Milesi-Ferretti, 2007; Gourinchas and Rey, 2007; Gourinchas, 2008). The latter arise from market value variations in the stock of foreign assets or liabilities due to movements in exchange rates or asset prices.

Theoretically, valuation effects play an important role in international consumption risk sharing by opening up a channel of external adjustment (Devereux and Sutherland, 2010). Valuation effects can be decomposed into "unpredictable" and "predictable" components (Devereux and Sutherland, 2010; Gourinchas, 2008). The unpredictable part reflects the flow payment associated with the sharing of consumption risk across countries. The predictable component arises from the excess return of a country's international portfolio due to differences in country risk premiums. Excess returns thus allow a "safe haven-country" to operate under a persistent current account deficit.

Gourinchas et al. (2010) and Forbes (2010) show that the US indeed is a beneficiary of predicable valuation effects in the sense that foreign assets generate substantial excess returns over recorded gross liabilities. This phenomenon underpins the curious situation of the US earning positive returns even though its net foreign asset position is negative. In addition, the US balance sheet is unique because the bulk of its liabilities is denominated in dollars. Dollar depreciation could therefore help external adjustment through:

(1) a positive wealth transfer and (2) an improvement in the trade balance. Gourinchas and Rey (2007) show that up to 27 percent of the cyclical external adjustment is due to valuation effects. Thus the valuation channel may allow global imbalances to continue over a long time horizon.

However, the empirical relevance of valuation effects is not confined to the US. The magnitude of valuation effects is proportional to gross asset and liability positions. The importance of valuation effects as a driver of the net external asset position has therefore also increased substantially due to financial integration in other developed and emerging economies. In emerging countries, however, the valuation channel need not necessarily be a facilitator of external adjustment. It may well be that valuation effects are economically destabilizing in these countries, which would be the case if they are procyclical with output shocks. A well-known example for this is "original sin" in the sense of Eichengreen and Hausmann (1999): the inability of emerging countries to borrow in their own currencies. Under original sin, a currency depreciation, triggered by a negative demand shock for example, generates a capital loss in the net external asset position, which, despite the shock, requires a surplus in future trade balances to reduce net debt to its long-run value.

There is some empirical evidence that valuation effects have indeed become an important channel of risk sharing for countries that are part of the

European Monetary Union (EMU), EU, and the OECD (Balli et al., 2012). So far, less is known about their nature in emerging economies. The only study that empirically investigates the valuation channel in emerging countries is that of Bracke and Schmitz (2011). They examine the risk sharing properties of valuation adjustments that emanate from portfolio equity, which, however, only represents a small share of a typical emerging country's international portfolio.

## 1.2 Purpose and preview

This thesis consists of three self-contained papers, which contribute to the debates surrounding global imbalances and financial globalization. Foreign assets and real exchange rates are the two key themes running though the three chapters. The first paper (Chapter 2) revisits the claim that RER undervaluation fosters economic growth. The second study (Chapter 3) analyzes whether mercantilist policies explain the surge in foreign exchange rate reserves in China. The third paper (Chapter 4) aims at broadening our understanding of the nature of valuation effects through an in-depth empirical investigation.

The purpose of the first paper (Chapter 2) is to shed light on the contemporary debate on the impact of real exchange rate misalignment on

economic growth. The cornerstone of the Bretton Woods II school of thought is the notion that undervalued RERs help developing countries to achieve faster economic growth (Rodrik, 2008; Aguirre and Calderón, 2005; Béreau et al., 2009; MacDonald and Vieira, 2010). This view, however, runs counter to the "Washington Consensus" (Williamson, 1990) which postulates that real-exchange rate misalignment (both overvaluation and undervaluation) hinders economic growth. A RER that is depreciated relative to its equilibrium level (that is, the value that is consistent with the simultaneous attainment of internal and external balances) would fuel inflation and reduce investment, thereby hampering growth. On the other hand RER overvaluation hinders efficient resource allocation between tradable and non-tradable production in the economy.

The paper identifies two sources of inconsistencies in the recent empirical evidence in support of the view that RER undervaluation spurs growth. The first source is the homogeneity assumption imposed across all countries on long-run RER behavior, which is not in accordance with the theory of RER misalignment. The second is the failure in model specification. The models used in these studies represent both RER overvaluation and undervaluation by a single variable ("RER misalignment"), thereby ignoring the possible differential impact of real overvaluation and undervaluation.

To redress these issues, the study estimates RER misalignments on a

country-by-country basis over the period 1970-2007 using the single-equation methodology as developed by Edwards (1989), Elbadawi (1994), and Baffes et al. (1999). This approach allows for heterogeneity in long-run RER behavior across countries as suggested by economic theory. In the second stage, the paper empirically investigates how real over- and undervaluation impact on growth. Robust inference is achieved by using various measures of RER misalignment.

The empirical results suggest that any deviation of the RER from the equilibrium real exchange rate (i.e. both RER undervaluation and overvaluation) impedes economic growth. The RER should thus be consistent with external and internal balances. This finding is consistent with the Washington Consensus.

The second paper (Chapter 3) is a case study of the role of exchange rate management in China's surge in foreign exchange reserves. It revisits the claim that Chinese reserve hoarding is a by-product of mercantilist policies that seek to maintain the RER undervalued in order to support export-led growth. Following the string of financial crises in the 1990s it is now widely acknowledged that stockpiling reserves as self-insurance against volatile capital flows is prudential policy (Aizenman and Marion, 2003; Aizenman and Lee, 2007; Obstfeld et al., 2010; IMF, 2011). However, the general perception is that China's reserve holdings are too large to be justified by precautionary

motives.

The purpose of this paper is to estimate the extent to which mercantilist policies account for the accumulation of China's foreign exchange reserves. A substantial problem in assessing the role of mercantilism in China's reserve build-up is that, theoretically, reserve accumulation in conjunction with real undervaluation is consistent with both precautionary and mercantilist motives. There are two ways to deal with this problem. The first defines any reserve accumulation in the context of RER undervaluation as mercantilist. Previous studies unanimously use this approach (Aizenman and Lee, 2007; Delatte and Fouquau, 2012; Ghosh et al., 2012, 2014). The problem with this method is that it is arbitrary and tends to overemphasize the mercantilist motive relative to the precautionary one by entirely ruling out the latter, especially in light of the widely-held view that China has undergone a long period of sustained real undervaluation.

The second uses a two-stage procedure, which, first, determines the level of reserves needed for precautionary purposes and then calculates the cumulative contribution of mercantilism to the hoarding of reserves. To this end reserve accumulation in relation to RER undervaluation is considered as mercantilist only if reserve holdings are in excess of precautionary needs. The shortcoming of this approach is the imposed assumption that the precautionary and mercantilist motives are never simultaneously at play, which may

overstate the relevance of the former over the latter. There is no obvious advantage between the two approaches. Therefore, I adopt both methods with the objective of testing the sensitivity of the estimation results in favoring one definition of mercantilist reserve accumulation over the other. The empirical results suggest that in China's case, both of the above discussed approaches yield similar estimates of the importance of mercantilist motives as a determinant of China's surge in foreign exchange reserves. In particular, the central message of the paper is that mercantilist motives cannot account for China's extraordinary demand for foreign exchange reserves. The mercantilist motive accounts for only US$ 200-500 billion (or 3-7 percent of GDP) of total reserve accumulation in China during 1998Q4-2011Q4, depending on the alternative versions of model specification. Precautionary motive and other factors yet to be explored, such as China's emerging role as the premier assembly centre within global production networks, seem to be the dominant determinants of the surge in China's foreign exchange reserves.

Despite the growing significance of valuation effects in an era of financial globalization, the nature and extent of their macroeconomic effect has not yet been systematically examined, especially in relation to EMEs.

The third paper (Chapter 4) examines whether valuation effects (changes in net external assets of a country arising from movements in exchange rates or asset returns) are an operative channel of international consumption risk

sharing or, instead, whether they are are economically destabilizing. If the former is the case then, all else equal, an increase in the magnitude of valuation adjustments should be associated with improved risk sharing outcomes across countries (Gourinchas, 2008). For the purpose of this analysis, risk sharing is measured as the extent of co-movement between idiosyncratic consumption and output growth rates (Lewis, 1996; Sørensen et al., 2007; Kose et al., 2009). The smaller the covariance between the latter variables, the higher is the degree of risk sharing.

The study tests the above hypothesis using a newly constructed panel data set covering 18 high income and 35 emerging economies over the period 1980-2010. The results suggest that an increase in the size of valuation effects is associated with better risk sharing in high income countries, but there is no significant evidence that this relationship holds for the group of EMEs.

In order to explore the nature of valuation effects further, the study then subdivides emerging economies into two groups on the basis of the sign of the correlation between valuation effects and domestic consumption growth. Theory suggests that the sign of this correlation indicates whether valuation effects are a channel of external adjustment (negative correlation) or are economically destabilizing (positive correlation). The correlation is negative for 21 of the 35 emerging countries, but not statistically significant in most cases, providing at best weak evidence of a functioning valuation channel in

these countries. For the remaining 14 countries, an increase in the magnitude of the valuation channel is significantly associated with lower risk sharing. For this group of countries, the extent of risk sharing has substantially deteriorated during the era of financial globalization.

Based on these findings, the study then proceeds to examine if valuation effects inflict welfare costs through volatility in consumption in those emerging countries where the correlation between valuation effects and consumption growth is positive. The econometric results suggest that a doubling of the magnitude of valuation effects amplifies consumption volatility by about 10 percent in those economies. The last section of the paper undertakes a welfare analysis in the spirit of Lucas (1987), Obstfeld (1994b), and Pallage and Robe (2003) to quantify the welfare loss due to the additional consumption uncertainty brought about by valuation-effect volatility. The results suggest that the welfare cost may well exceed one percent of permanent consumption. In some countries, the cost estimates are much higher, ranging up to 92 percent of permanent consumption.

Chapter 2

# Should developing countries undervalue their currencies?


*Summary*

This chapter revisits the growth impact of real exchange rate distortions. The Washington Consensus emphasizes the economic costs of real exchange rate misalignment. However, a sizable recent empirical literature finds that undervalued real exchange rates help countries to achieve faster economic growth. The study shows that these findings are driven by inappropriate homogeneity assumptions imposed on long-run rēal exchange rate behavior across countries and/or misspecification of the growth equation. When these problems are redressed, the empirical results for a sample of 63 developing countries over the period 1970-2007 suggest that misalignment of the real exchange rate in either direction from the level consistent with external and internal equilibrium reduces economic growth. However, deviations from Balassa-Samuelson adjusted purchasing power parity do not seem to affect growth. The real exchange rate should thus be consistent with external and internal balance, irrespective of the purchasing power parity benchmark.

## 2.1 Introduction

The real exchange rate (RER) does not play a central role in traditional growth theory. Both the canonical Solow-Swan growth model and endogenous growth models feature closed economies. However, Ricardo's and Lewis's theories of economic growth suggest a more important role for the RER. As nations develop, the "modern" manufacturing sector absorbs "surplus labor", which directly translates into higher national output. The RER, which creates an incentive to allocate resources to the modern manufacturing sector, is therefore of first-order importance to economic growth. The question of what is the optimal relative price of traded goods arises. There are two opposing views on the answer to that question. The aim of this paper is to shed more light on this debate.

The "Washington Consensus", articulated by Williamson (1990), acknowledges a crucial role of the RER in the growth process. According to this view, an appropriate real exchange rate should be consistent with macroeconomic objectives in the medium run and "sufficiently competitive" such that exports grow at a rate consistent with external balance. However, an overly competitive RER is not appropriate because it would fuel inflation and curb resources available for investment. Underlying this view is the notion that there exists an equilibrium real exchange rate (ERER) that satisfies external and internal balance (Nurkse, 1945). Seen in this light, any deviation from

the ERER will hamper economic growth.

The opposing view, with Rodrik (2008) at the forefront, maintains that RER overvaluation harms growth and undervaluation promotes it. This stance is in part due to the success story of export-led growth in conjunction with apparently undervalued currencies in East-Asian countries. But there are also other plausible explanations for why real undervaluation is good for growth. In the export-oriented growth literature it is often argued that the manufacturing sector is special because positive externalities (learning-by-doing effects, technology spillovers) are more pronounced for export-linked activities than other sectors of the economy. Another explanation is that an undervalued RER encourages higher savings and investment (Levy-Yeyati and Sturzenegger, 2007). Finally, Rodrik's (2008) conjecture is that the manufacturing sector in developing countries is disproportionately subject to distortions and hence below its optimal size in equilibrium. Because removing those distortions proves difficult in practice, an undervalued RER serves as a "more practical" second-best mechanism to optimally reallocate resources toward the manufacturing sector (Rodrik, 2008).

However, there is little systematic evidence supporting any of these views. The nature and prevalence of those positive externalities associated with exporting remain obscured (Eichengreen, 2008; Harrison and Rodríguez-Clare, 2009). Rodrik (2008) was unable to empirically verify that the manu-

facturing sector is disproportionately subjected to distortions in developing countries. In addition, all of these propositions seem to ignore the distortion cost associated with real undervaluation in the form of reduced aggregate demand (Corden, 1981). It is therefore not clear if the gain in exports outweighs the loss in absorption, especially over longer time horizons. Finally, according to Edwards (1989), RER distortions can lead to resource misallocation across sectors as economic agents base their investment decisions on a relative price in disequilibrium. Because the RER tends to adjust to equilibrium over time, real undervaluation may induce investments in short-lived projects.

The early empirical literature identifies a negative impact of RER overvaluation on growth but does not address RER undervaluation (Cottani et al., 1990; Ghura and Grennes, 1993).[1] However, recent empirical studies unanimously reject the Washington Consensus view in the sense that they find a positive effect of RER undervaluation on economic growth.[2] The most prominent example is Rodrik (2008), whose empirical findings suggest that higher medium-term growth is systematically associated with undervalued exchange rates in developing countries. While Rodrik (2008) defines purchasing power parity (PPP) adjusted for the Balassa-Samuelson effect as the ERER, there is also a sizable number of empirical studies estimating ERERs

[1]The term undervaluation only appears once in a footnote in Cottani et al. (1990) and not at all in Ghura and Grennes (1993).

[2]The only exception is Nouira and Sekkat (2012) whose empirical results are inconclusive regarding the impact of real undervaluation on growth.

consistent with internal and external balance that broadly reach the same conclusion (Aguirre and Calderón, 2005; Béreau et al., 2009; Berg and Miao, 2010; MacDonald and Vieira, 2010; Razin and Collins, 1997).[3] Since these two concepts vastly differ from one another and are not directly comparable, this paper considers both ERER definitions, but with the prime focus being on RER misalignment in the sense of Nurkse (1945).

There are two important sources of inconsistencies driving previous results and the bulk of the literature suffers from at least one of these. First, relying on conventional panel data techniques to estimate ERERs imposes strong homogeneity assumptions on cross-country long-run RER behavior. This approach does not conform to the economic theory underlying the ERER and therefore generates misleading results. Second, the objective to infer the effect on growth of two variables (real over- and undervaluation) from a single continuous variable (RER misalignment) introduces a number of pitfalls, which can lead to growth regression misspecification.

This paper explicitly takes into account heterogeneity in long-run RER behavior across countries by individually estimating RER misalignments for 63 developing countries over the period 1970-2007. It then empirically analyzes how RER over- and undervaluation affect economic growth. To this end, the study employs the system generalized method of moments (SGMM)

[3]See Table 2A.1 in the Appendix for a list of previous empirical studies.

estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). To ensure robust inference, various measures of RER misalignment are used.

The empirical results provide evidence in favor of the Washington Consensus view and reject the notion that RER undervaluation is an expedient development policy tool. This means that the optimal growth promoting relative price of traded goods is the value of the equilibrium real exchange rate. The study also shows that the identified inconsistencies rather than differences in estimation methods or data sets drive previous results.

As for deviations from adjusted PPP, using the same data set and estimation methods as Rodrik (2008), but redressing the above problems, generates results which suggest that adjusted PPP misalignment does not matter for the growth performance of developing countries.

The rest of the chapter is organized as follows. Section 2.2 defines the Nurksian ERER and estimates RER misalignments. Section 2.3 empirically analyzes the effects of RER distortions and adjusted PPP deviations on growth. Section 2.4 concludes.

## 2.2 Estimation of real exchange rate misalignment

Before the relationship between RER distortions and economic growth can be analyzed, deviations of the actual RER from its equilibrium value need to be estimated. The problem any empirical study on this subject faces is that the ERER is not directly observable. The starting point to resolve this issue is to define the RER and the ERER.

### 2.2.1 The equilibrium real exchange rate

The real exchange rate is defined as the domestic relative price of traded to nontraded goods. That is, $RER = EP_T/P_N$, where $E$ denotes the nominal exchange rate (measured as domestic currency per foreign currency). $P_T$ and $P_N$ refer to the price of tradables and nontradables, respectively. Note that an increase in RER indicates depreciation.

The equilibrium real exchange rate (ERER) in the sense of Nurkse (1945) is defined as that value of the RER that results in the simultaneous attainment of both internal and external equilibrium, given sustainable values of relevant variables achieving this objective.[4]

Nurkse's definition directly implies that the ERER is determined by

[4]Internal equilibrium implies that the nontraded goods market clears and that the unemployment rate is at its "natural" level. External equilibrium means that the current account deficit can be financed through "sustainable" levels of capital inflows.

a set of macroeconomic fundamentals. Based on Edwards (1989), Montiel (1999b), and Faruqee (1995), the ERER is a function of the following variables:

**Terms of trade** The external terms of trade of a country (the relative price of exportables to importables) is among the key fundamentals explaining long-run RER behavior. The general argument is that an improvement in the terms of trade increases real income thus resulting in excess demand for nontradables. To restore equilibrium, the price of nontraded goods would have to rise, meaning ERER appreciation. However, Edwards (1989) shows that this income effect can be more than offset by substitution effects such that improved terms of trade would lead to depreciation. It is therefore not possible to determine *a priori* which of these two effects dominates (Edwards, 1989).

**Trade policy** Under the assumption that nontradables and importable goods are substitutes, a reduction in tariffs on imported goods decreases (increases) the demand for nontradables (importables), causing the ERER to depreciate.[5]

**Productivity of tradable production** According to the Balassa-Samuelson theorem (Balassa, 1964; Samuelson, 1964), productivity gains in traded goods production are positively related to the growth rate and tend to be higher

[5]See Edwards (1989) for more details. Montiel (1999b) considers the case of export subsidies. ERER depreciation associated with a decline in export subsidies is then brought about through resource reallocation from the exportable to the nontradable sector, resulting in excess supply for nontradable goods.

in the tradable sector than in the nontradable sector. Since tradable goods prices tend to be uniform across countries (law-of-one price), productivity improvements relative to trading partners result ERER appreciation. Under the assumption of full employment and perfect labor mobility, the price adjustment is brought about by higher real wages in both sectors (income effect) and labor absorption in the traded goods sector away from the nontradable sector (supply effect).

**Government consumption** Altering government spending patterns on traded or nontraded goods will have an immediate impact on the ERER. The rationale behind this intuition is straightforward. Increased or shifted government spending towards traded goods results in an increase of the trade deficit requiring real depreciation such that the external balance continues to hold (Montiel, 1999b). In the case where government spending increases or tilts towards nontradables, the effect on the ERER is the opposite as it results in excess demand for nontradables. The relative price of nontradables then has to rise to restore internal equilibrium (Montiel, 1999b).

**Investment** An increase in the investment level has an ambiguous effect on the ERER (Edwards, 1989). Whether the ERER appreciates or depreciates depends on whether it takes place in the tradable or nontradable sector and on factor intensities (Edwards, 1989).

**Net foreign asset position** Intuitively, an increase in a country's net international indebtedness should result in a larger trade surplus in order to service the debt, hence requiring real depreciation (and vice versa). Alternatively, it is possible for the "target level" of the net foreign asset position to rise "permanently" during the adjustment process towards equilibrium, implying current account surpluses and ERER depreciation (Faruqee, 1995). The obverse of this is that it may be desirable for a country to move to a net debtor position thus leading to current account deficits accompanied by an ERER appreciation (Égert et al., 2005). However, based on previous empirical results, an improvement in the net creditor position tends to be associated with ERER appreciation (Aguirre and Calderón, 2005; MacDonald and Ricci, 2003; Montiel, 2007).

The following equation summarizes the long-run relationship between the ERER and the fundamentals:

$$ERER = ERER(\underset{(+/-)}{TOT}, \underset{(+)}{\phi}, \underset{(-)}{\zeta}, \underset{(-)}{G_N}, \underset{(+)}{G_T}, \underset{(+/-)}{I}, \underset{(+/-)}{NFA}), \tag{2.1}$$

where $TOT$ refers to the terms of trade, $\phi$ is a measure of trade policy, $\zeta$ captures productivity differentials (Balassa-Samuelson effect), $G_N$ and $G_T$ are government consumption on nontradables and tradables, $I$ refers to investment, and $NFA$ to the net foreign asset position. Importantly, theoretical priors point to an ambiguous effect of some fundamentals on the ERER, as

shown by the signs of the partial derivatives below.[6,7]

In case a country faces a binding credit constraint, the trade surplus will depend on exogenous foreign aid flows (Baffes et al., 1999). Therefore, Eq. 2.1 takes a modified form:

$$ERER = ERER(\underset{(+/-)}{TOT}, \underset{(+)}{\phi}, \underset{(-)}{\zeta}, \underset{(-)}{G_N}, \underset{(+)}{G_T}, \underset{(+/-)}{I}, \underset{(+)}{TS}), \tag{2.1a}$$

where the net foreign asset position has been replaced with the trade surplus, $TS$.[8]

These two specifications differ fundamentally with regard to the underlying assumption of how the stock of net international indebtedness feeds back on net capital inflows and the ERER. The former conditions the ERER on given (sustainable) values of the stock of net international indebtedness, which also affects the non-exogenous component of net capital inflows (Montiel, 1999a). The latter, on the other hand, specifies the ERER as a function

[6]For details on the relationship between the ERER and its fundamentals, see the Appendix.

[7]In theory, international real interest rate differentials and the extent of capital controls also form part of the ERER fundamentals as permanent changes in both variables affect foreign borrowing decisions and therefore the path of the ERER (Edwards, 1989). Unfortunately, severe data limitations prevent including these variables in the ERER equation. This caveat should not worry us, however, since the stock of international indebtedness will capture any adjustment in foreign borrowing and lending that is brought about by capital account liberalizations or changes in real interest rates. Additionally, as pointed out below, misalignment estimates are similar across alternative specifications. Finally, note that the ERER depends on real variables only (Edwards, 1989).

[8]Notice that this ERER specification may be among the sources that introduce endogeneity in the estimation of the growth model since the level of development may affect credit constraints. As will be shown, however, the data favor the inclusion of binding credit ceilings for only four countries.

of exogenous (sustainable) net capital inflows only, with no feedback from the accumulated stock of net foreign assets. Therefore, the concept of external balance is a "stock-flow" approach in Eq. 2.1 (Faruqee, 1995), and a "flow" approach in Eq. 2.1a (Montiel, 1999a).[9] Which of the two specifications is relevant for a given country will depend on its economic structure. Intuitively, the flow approach is suitable in foreign aid-receiving low income countries, whereas the stock-flow approach fits better for middle income countries. However, rather than imposing possibly restrictive assumptions, in what follows, the approach will be to let the data "choose" the appropriate specification.

The approach adopted to empirically estimate ERERs in this paper is the single-equation approach developed by Edwards (1989), Elbadawi (1994), and Baffes et al. (1999). It comprises three steps. The first involves estimating the long-run equilibrium relationship between the ERER and its fundamentals. The second is to derive sustainable values of those fundamentals that explain long-run RER behavior. The ERER and the degree of misalignment are calculated in the final step.

According to this approach, the empirical equivalent of Eq. 2.1 or 2.1a

[9]Another possibility would be a pure "stock" approach. The net foreign asset position would then be required to have fully adjusted to steady state such that net capital inflows equal the amount needed to sustain the steady state value of the net creditor position. *NFA* and *TS* would then not be part of the ERER function. However, the stock approach is unlikely to be appropriate in the context of developing countries, where the adjustment process of the net foreign asset position may be a matter of several decades – a horizon too long to be of exchange rate policy relevance. See Montiel (1999a) for more details.

under the assumption of linearity in the theorized long-run relationship takes the following form:

$$ln\ ERER_{it} = \beta_i' F_{it}^S, \tag{2.2}$$

where subscript $i$ refers to the country in question, $F^S$ is the vector of the set of fundamentals at sustainable values, and vector $\beta$ contains the to-be-estimated long-run parameters. Uncovering $\beta$ thus involves estimating some form of the empirical model in Eq. 3.5, except that $ERER$ and $F^S$ have to be replaced with their observable counterparts, that is the actual RER and actual values of the fundamentals:

$$ln\ RER_{it} = \beta_i' F_{it} + \nu_{it}. \tag{2.3}$$

The error term $\nu_{it}$ is assumed to be stationary with zero mean.[10]

Once $\beta$ and $F^S$ are derived, the degree of misalignment ($mis_{it}$) can be calculated with the following formula:

$$mis_{it} = \frac{ERER_{it} - RER_{it}}{RER_{it}}, \tag{2.4}$$

where positive (negative) values of $mis_{it}$ indicate overvaluation (undervaluation).

[10]Eq. 3.5 follows from Eq. 2.3 under the assumption that the ERER and sustainable fundamentals are the long-run conditional expected values of their actual counterparts (Baffes et al., 1997).

### 2.2.2 Data

The absence of readily available indices for the actual RER and some of the fundamentals imposes a considerable obstacle to the empirical estimation of ERERs. The fundamentals for which reliable time series are available are investment, the terms of trade, the net foreign asset position, and the trade balance. Proxies have to be used for the actual RER and the other fundamentals.

The RER is an incentive measure for both producing and consuming tradable and nontradable goods. Constructing corresponding indexes is unfeasible due to conceptual problems and data constraints in low income countries (Hinkle and Nsengiyumva, 1999). Therefore, the RER is measured as the ratio of trade-weighted foreign consumer price indexes (CPI) converted at official exchange rates relative to the domestic CPI.[11]

There is also no direct measure for trade policy. The bulk of the empirical literature proxies this variable through the ratio of total exports plus imports to GDP, under the assumption that countries with more liberal trade regimes have higher trade volumes, *ceteris paribus*. Three proxies are considered: the ratio of total exports plus imports to GDP at current (OPEN) and constant (OPEN1) prices, as well as the ratio of current imports relative to

[11] An alternative proxy for tradable goods would be the wholesale price index (WPI). However, for many countries' main trading partners, WPIs are either unavailable or only cover a few years.

current GDP (OPEN2). To capture the Balassa-Samuelson-effect, the variable PROD is constructed, which equals the ratio of the home country's GDP per capita to the OECD average GDP per capita. This proxy directly incorporates Balassa's (1964) assumption that productivity gains are associated with higher growth rates.

Finally, there are no data on the composition of government consumption. Data are, however, available on total government consumption as a share of GDP (GEXP). Empirically, government consumption tends to disproportionately fall on nontraded goods (Edwards, 1989). Therefore, GEXP serves as a proxy for $G_N$. However, this need not be true for all countries (Elbadawi and Soto, 1997). Thus, to avoid imposing more restrictions than necessary, the approach will be to let the data decide whether GEXP proxies $G_N$ or $G_T$.[12]

Under the criterion of at least 20 consecutive yearly observations within the time span 1970-2007, the final sample consists of 63 developing countries, excluding outliers. Table 2A.2 provides a description and the sources of the data.

[12]While this is the least restrictive approach, the downside is an implicit equality restriction on the parameters of $G_T$ and $G_N$.

### 2.2.3 Method

Previous studies that estimate RER misalignment for a large set of countries commonly employ panel data techniques to estimate a single cointegrating vector, which is then used to calculate RER misalignment for the countries in question. There are four major problems with imposing such strong homogeneity assumptions on cross-country long-run RER behavior.

First, assuming homogenous $\beta$ is inconsistent with the theoretical models used to derive the empirical equation of the ERER. On theoretical grounds it is not possible to determine *a priori* the effect of changes in the terms of trade, the investment rate, or the net foreign asset position on the ERER. This implies non-trivial cross-country heterogeneity, something which panel estimators that derive a single cointegrating vector do not account for because they impose the same long-run relationship across groups.[13] Second, even if one is willing to assume that the relationship between the ERER and its fundamentals is the same across countries in the (ultra) long run, the question then becomes what time horizon this constitutes.[14] Results of empirical studies that estimate ERER long-run relationships over several decades for many countries individually suggest considerable parameter heterogeneity

[13]In their concluding remarks Baffes et al. (1999) also appear to be skeptical about $\beta$ homogeneity.

[14]This is the common assumption in empirical studies employing the panel approach as outlined.

across countries over many decades.[15] However, this adjustment process is too long for these ERERs to be of interest for policymakers or analysts (Montiel, 1999a). Third, another (more serious) problem associated with such long time-horizons over multiple decades is that the ERER should then be conditioned on steady state values of the predetermined variables such as sectoral capital stocks. But this would represent a violation of the Nurksian definition of the ERER, as it rules out this scenario (Montiel, 2007). Finally, while theoretical models of the ERER provide a guideline as to which variables determine long-run RER behavior, empirical regularity tells us that, when estimated individually, not all of these fundamentals turn out to be statistically significant drivers of long-run RER movements, although they usually are for the pooled sample. Thus, using the homogeneity assumption may inappropriately condition the ERER on one or more fundamentals that are not part of the true data generating process (DGP) for individual countries.

The risk of ignoring these concerns can be illustrated using some of the estimation results in Mongardini and Rayner (2009). They use the pooled mean group (PMG) estimator to derive RER misalignments for Sub-Saharan African countries. Their results show considerably undervalued RERs in Senegal and Togo, both members of the CFA-franc zone, before the devaluation in 1994. However, during that period, the RER was in fact overvalued

[15] For example, see the estimation results in Aguirre and Calderón (2005).

in these countries according to almost every observer or empirical study.[16] Another illuminating example is the study of Roudet et al. (2007) who estimate RER misalignments for a number of African countries both individually and through panel data. Their panel estimates often suggest real undervaluation, whereas their country-by-country estimates indicate overvaluation. In addition, their panel RER misalignment measures tend to be significantly greater in magnitude which is consistent with the view that panel data techniques estimate ultra-long-run ERERs at best. Roudet et al. (2007) conclude that panel data estimators often do not yield accurate ERER estimates and should therefore be supplemented with single-country estimates.

**Estimation** The approach in this study is to estimate ERERs for each country individually, although panel data imposing the homogeneity assumption will also be employed for comparison purposes.

The first step is to determine the order of integration of the variables using Augmented Dickey-Fuller (ADF) as well as Phillips-Perron (PP) tests. In case the unit root null is rejected, the RER follows a stationary process, providing evidence that relative PPP holds. The ERER can then be set at the sample mean.[17]

[16] See for instance Devarajan (1997) and Coleman (2008).

[17] RERs for all countries turn out to be I(1) at the five percent level except for Mozambique. The tests for Korea, Malawi, and South Africa are somewhat inconclusive but point towards nonstationarity. Argentina's RER is marginally stationary but treated as nonstationary since RER misalignment estimates are not plausible if the ERER is set at the sample mean. The results are not reported for brevity but available upon request.

The second step is to estimate the long-run parameters ($\beta_i$). Estimating the full joint distribution of the RER and its fundamentals would be desirable, but small samples with at most 38 observations and 6 possible fundamentals render system estimation practically unfeasible (Baffes et al., 1999). This motivates a single-equation setting. In principle, the static OLS estimator (SOLS) can be used to estimate $\beta$ in Eq. 2.3. While SOLS is superconsistent (the rate of convergence is proportional to the sample size) and there is no asymptotic bias from simultaneous equations or measurement error (Phillips and Durlauf, 1986), SOLS performs poorly for small samples (Banerjee et al., 1993) and the non-standard distribution of the t-statistics prevents valid inference. Phillips and Loretan (1991), Saikkonen (1991), and Stock and Watson (1993) independently propose a dynamic OLS (DOLS) estimator which can handle these issues.[18] The DOLS estimator is asymptotically equivalent to the Johansen (1988) vector error-correction method (Saikkonen, 1991), performs well in small samples (Stock and Watson, 1993; Montalvo, 1995), and Newey and West (1987) standard errors allow for statistical inference. The DOLS method adds first differenced leads and lags of the I(1) regressors to the static cointegrating regression. Lead and lag lengths can be selected such

[18]Other options would be the fully modified OLS estimator (FMOLS) proposed by Phillips and Hansen (1990) or a single-equation error correction model approach (SEECM). The issue with SEECM is that weakly exogenous regressors for the parameters of interest are essential for valid inference on the long-run parameters. If this condition is satisfied, SEECM is superior to FMOLS (Phillips and Loretan, 1991). However, the assumption that all of the fundamentals are weakly exogenous for the ERER parameters in all 63 countries is unlikely to hold. Furthermore, testing for weak exogeneity requires system estimation. Finally, the Monte Carlo experiments in Stock and Watson (1993) suggest that DOLS tends to outperform FMOLS.

that information criteria (IC) are minimized (Kejriwal and Perron, 2008).[19]

The augmented version of Eq. 2.3 with $m_1$ leads and $m_2$ lags takes the following form:

$$ln\ RER_{it} = \beta'_{i1} F_{it} + \beta'_{i2} Z_{it} + \sum_{s=-m_2}^{s=m_1} \gamma'_{is} \Delta F_{it+s} + \nu_{it}, \tag{2.5}$$

where the vectors $F$ and $Z$ contain the fundamentals that are I(1) and I(0) respectively.[20]

To test for cointegration, I employ the ADF-cointegration test and the Johansen (1988, 1992) method.[21] Since shocks such as trade or capital account liberalizations may shift the equilibrium relationship between the ERER and its fundamentals, I also test for parameter stability relying on Hansen's (1992) $L_c$ and Andrews's (1993) parameter stability tests.[22]

It is sometimes possible to find multiple subsets of the fundamentals that form a long-run relationship with the RER. There is no well-established approach to deal with this issue (Montiel, 2007).

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[19]This encompasses the inclusion of a constant and a trend if it is statistically significant and reduces the ICs.

[20]In a panel setting, the following variant of Eq. 2.3 is estimated: $ln\ RER_{it} = \mu_i + \beta'\ F_{it} + \sum_{s=-m_2}^{s=m_1} \gamma'_{is} \Delta F_{it+s} + \nu_{it}$, where $\mu_i$ is a country-specific constant. This is the (fixed effects) panel DOLS estimator due to Mark and Sul (2003).

[21]The latter allows testing for uniqueness of the estimated cointegrating vector. I restrict the lag length of the underlying VAR system to two. Due to the small sample problem, however, the Johansen (1988, 1992) method is perhaps best viewed as complementary.

[22]Test results are available upon request. $L_c$ can also be viewed as testing for cointegration over the sample period under the null that the variables are cointegrated (Hansen, 1992).

Since one of the possibilities has to be chosen, I use the following selection algorithm, which is similar to Montiel (2007). Strict preference is given to the most inclusive specification provided there is evidence for cointegration, and that the estimated parameters are stable, statistically significant, *and* bear signs consistent with economic theory (see Eqs. 2.1 and 2.1a). Otherwise the specification is disregarded. If there are multiple long-run relationships fulfilling these requirements, choice is given to the one that minimizes the information criteria.[23]

The results of the estimated long-run equilibrium relationships are encouraging: there are cointegrating relationships consistent with economic theory for 63 countries.[24] This outcome is not predetermined by the described selection process.[25] In some cases, the coefficient attached to government consumption turns out to be positive, corroborating the previously stated concern that total government consumption is not necessarily tilted towards nontraded goods in all countries. In addition, somewhat surprisingly, the empirical specification incorporating binding credit ceilings performed poorly, in that it is not the appropriate model specification to explain long-run RER behavior in all but four countries.

[23]This selection process does not affect the main results as the RER misalignment estimates tend to be similar across possible cointegrating equations.

[24]Table 2A.3 in the Appendix reports the results.

[25]The cases of Egypt and the Democratic Republic of the Congo underline this notion as it is not possible to obtain plausible estimates for these countries. They are thus dropped from the sample.

**Sustainable fundamentals** The next step in estimating ERERs involves deriving sustainable values of the fundamentals that form a long-run equilibrium relationship with the RER. The conventional approach is to decompose the relevant time series into cyclical and trend components using the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997).[26] Movements in the trend component are permanent and therefore interpreted as sustainable in the Nurksian sense. [27]

**Results** The RER misalignment estimates in this study are similar to previous ones (Ades et al., 1999; Montiel, 2007; Kinkyo, 2008; MacDonald and Ricci, 2003; Coleman, 2008; Roudet et al., 2007).[28] Figure 2.1 shows country-by-country and panel RER misalignment estimates for China, Korea, and Indonesia. It underlines how the homogeneity assumption can lead to very misleading results. In the case of Korea and Indonesia, the panel estimates suggest significant undervaluation on the eve of the Asian Financial Crisis, whereas any other previous study identifies significant overvaluation. More-

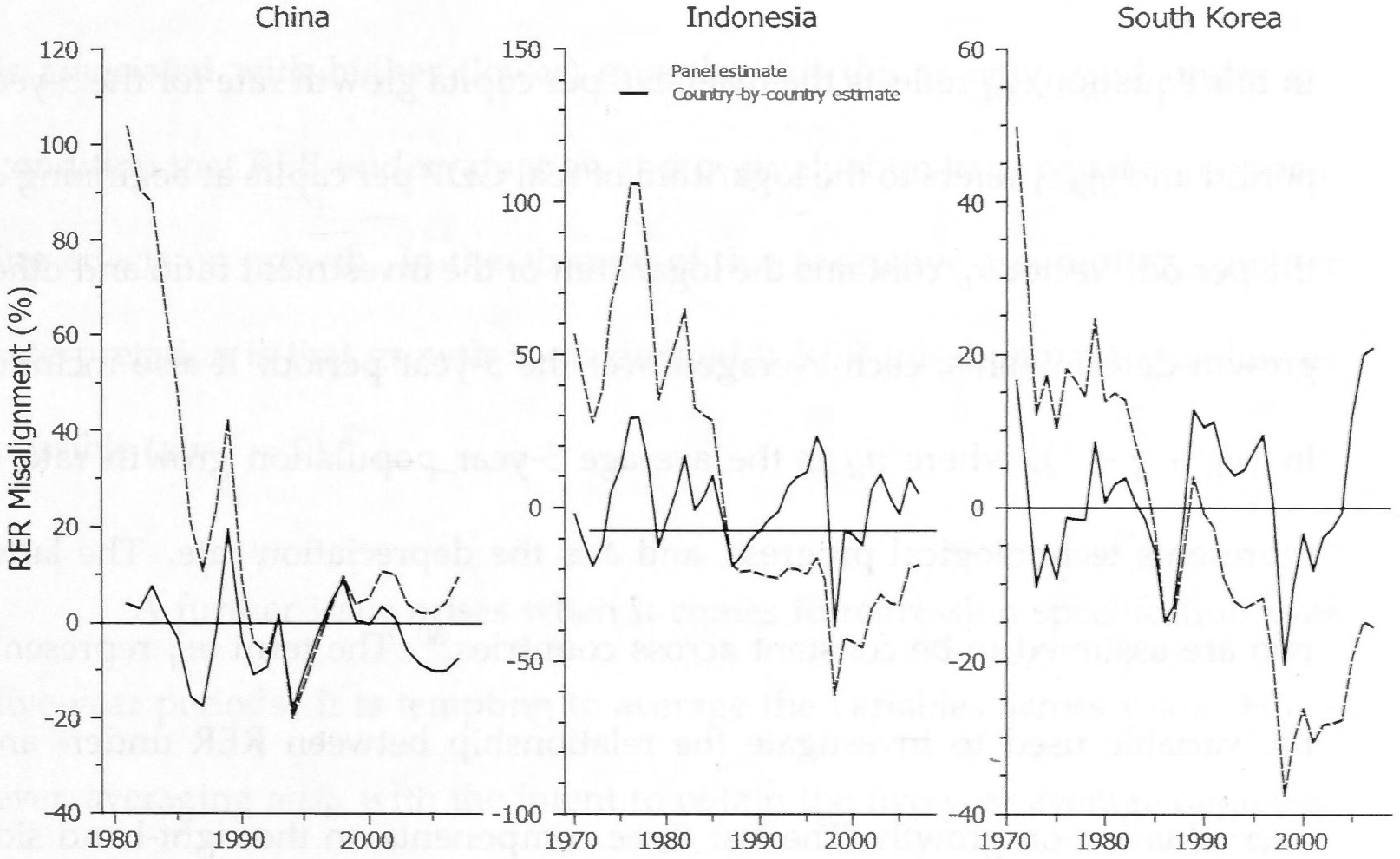
[26] I follow previous studies and set the smoothing parameter at the conventional value of $\lambda = 100$.

[27] Such decomposition techniques are not without caveats. In many developing countries, particularly in Sub-Saharan-Africa and Latin America, fundamentals such as government consumption or the net foreign asset position are likely to have been persistent but unsustainable (Baffes et al., 1999). In these cases, unsustainable changes would be passed through to the trend component. Unfortunately, there are no better alternatives. Baffes et al. (1999) advocate using counterfactual simulations but point out that this requires the unlikely condition that the ERER fundamentals are super-exogeneous for the ERER parameters. In addition, counterfactual simulations are not feasible in this study as detailed knowledge about all 63 countries would be needed. I also considered five-year moving averages but this resulted in some implausible estimates. In summary, the trend component is best thought of as an imperfect approximation for the sustainable values of underlying ERER fundamentals.

[28] They are available in Figure 2A.1 in the Appendix.

over, China's RER was apparently overvalued by about 10 percent in 2007. This is not consistent with the general consensus that the renminbi has become undervalued in recent years. My econometric results use the country-by-country estimates.

Figure 2.1: RER misalignment estimates for China, Indonesia, and South Korea, by year.




## 2.3 Growth regressions

This section examines the impact of RER over- and undervaluation on economic growth. To control for cyclical variations, I split the sample period

1970-2007 into non-overlapping five-year periods.[29]

The empirical growth equation is derived from the Solow-Swan growth model:

$$g_{it} = y_{it} - y_{i,t-1} = \alpha + \beta\, y_{i,t-1} + \gamma' x_{it} + \psi\, m^{\dagger}_{it} + \mu_i + \lambda_t + \epsilon_{it}. \qquad (2.6)$$

In this equation, $g_{it}$ reflects the real GDP per capita growth rate for the 5-year period and $y_{i,t-1}$ refers to the logarithm of real GDP per capita at beginning of the period. Vector $x_{it}$ contains the logarithm of the investment ratio and other growth determinants, each averaged over the 5-year period. It also includes $\ln\,(n_{it} + g + \delta)$, where $n_{it}$ is the average 5-year population growth rate, $g$ represents technological progress, and $\delta$ is the depreciation rate. The latter two are assumed to be constant across countries.[30] The term $m^{\dagger}_{it}$ represents the variable used to investigate the relationship between RER under- and overvaluation on growth. The last three components on the right-hand side represent unobserved country fixed effects ($\mu_i$), time specific effects ($\lambda_t$), and the idiosyncratic error term ($\epsilon_{it}$), respectively.[31]

It is worth pausing here to discuss model specification in more detail

[29] This results in eight non-overlapping five-year periods except for the last one which comprises only three years.

[30] I follow Mankiw et al. (1992) and assume that $g$ equals two percent. As for the depreciation rate, Whelan and McQuinn (2006) convincingly argue that $\delta$ should be set to six percent. The reason is that capital comprises structures and equipment, each depreciating at a different rate. They base the six percent figure on the empirical weight of each type of capital in the production function. See their paper for more details.

[31] See Table 2A.2 for details on data sources.

as there are hidden pitfalls. At first, it seems straightforward to include $mis_{it}$ (Eq. 2.4) in the model. This is the approach the bulk of the literature follows. However, this makes it difficult to infer the respective impact of over- and undervaluation on growth. Given that $mis_{it}$ is negative (positive) when the RER is undervalued (overvalued), a negative sign of the coefficient attached to $mis_{it}$ commonly leads to the inference that undervaluation (overvaluation) is associated with higher (lower) growth. But this is only valid under the condition that RER undervaluation and overvaluation have equal and opposing effects on growth. In the absence of this restrictive assumption, another interpretation is that growth is maximized if RER misalignment is as low as possible ($mis_{it} = 0$).[32]

A further issue arises when it comes to regression specification over five-year periods. It is tempting to average the variables across years. However, averaging $mis_{it}$ with the intent to obtain the five-year average degree of misalignment generates a misleading time series. For illustration, consider the following example. Say the RER was overvalued by 50 percent in the first year and undervalued by 25, 10, 10, and 5 percent in subsequent years. Averaging would produce $mis_{it} = 0$, or perfect alignment when (in accordance with the definition of RER misalignment) the average RER misalignment is 20 percent in this case. Averaging is valid only if there are no fluctuations be-

[32]This interpretation follows directly from applying the definition of RER misalignment as *any* deviation of the RER from its equilibrium level.

tween undervaluation and overvaluation during the time interval of interest, or if their effects on growth are equal but of opposite sign.

To deal with these problems, the approach is to split $mis_{it}$ into two variables: one taking negative values when the RER is undervalued, zero otherwise, and another taking positive values when the RER is overvalued, and zero otherwise. I then average these two variables over the five-year periods. A negative signed coefficient on both variables supports the hypothesis that RER undervaluation (RER overvaluation) fosters (harms) economic growth. In an additional analysis, I also identify RER over- and undervaluation episodes to test their impact on growth.

The last consideration relates to the inclusion of other variables in the model. Importantly, since each ERER fundamental may directly or indirectly affect growth, the model includes each of the ERER fundamentals to properly channel out the impact of RER distortions on growth. I also consider human capital (average years of schooling) and the "rule of law", which proxies institutional quality. Unfortunately, these variables are not available for all countries in the sample. In addition, the rule of law index only starts in 1984. In order to avoid losing too many observations, a number of regression specifications will be reported.[33]

[33] Admittedly, there is a whole host of other variables that may be included. So far the empirical growth literature has identified more than 145 growth determinants, but there is no consensus on which of these variables should be included in growth models (Durlauf et al., 2005). Given the humble objective of this paper, which is to investigate the hypothesis that

### 2.3.1 Estimation

While the model is initially estimated by ordinary least squares (OLS), this procedure does not address the issue of endogeneity. Nickell (1981) shows that the standard fixed-effects estimator of a dynamic panel data model is inconsistent when $T$ (the number of time-series observations) is fixed, even as $N \to \infty$ (the number of cross-sectional units). In addition, growth is likely to affect the independent variables, which gives rise to inconsistent estimates. To address these problems, I resort to system generalized method of moments (SGMM).[34] SGMM involves estimating the growth model both in levels and first differences through as a system of equations. This estimation technique uses internal lagged first differences as instruments for the endogenous variables in the level equation. The differences equation is instrumented with lagged levels. The validity of the SGMM moment conditions requires that the instruments are uncorrelated with the error term and that the latter do not display serial correlation.

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RER undervaluation promotes growth, attempting the latest state of the art model averaging techniques to account for model uncertainty would be beyond the scope of this study.

[34]See Arellano and Bover (1995), Blundell and Bond (1998), and Roodman (2009a) for details.

### 2.3.2 Results

Table 2.1 reports OLS and SGMM results of the impact of RER under- and overvaluation on growth.[35] While OLS and SGMM estimates differ in magnitude, they are qualitatively the same, regardless of model specification. They suggest that the effect of RER undervaluation on growth is negative and statistically significant at least at the 10 percent level. For instance, according to the SGMM results for the baseline growth model (Column 1b), an RER that is on average undervalued by five percentage points (about one standard deviation) would lead to a lower average annual growth rate of 1.3 percentage points. An augmentation with human capital and/or institutional quality leads to virtually the same result (Columns 2b, 3, and 4). Variation in the size of coefficients and standard errors appears to be mainly driven by changes in the sample. The results also corroborate the notion of an adverse impact

[35]The baseline SGMM results use all available lags as "collapsed" instruments to contain "instrument proliferation" (Roodman, 2009b). Standard errors incorporate Windmeijer's (2005) finite-sample correction for two-step SGMM. The second order test for autocorrelation and the Hansen test for overidentifying restrictions suggest that the validity of the SGMM moment conditions cannot be rejected at conventional levels. Furthermore, SGMM assumes that the idiosyncratic disturbances are independent across countries. The cross-sectional independence test of Pesaran (2004) reveals that the null of cross-section independence cannot be rejected at the 10 percent level.

of RER overvaluation on growth.[36,37] However, the negative relationship between RER undervaluation and growth is in contrast to Rodrik (2008) and other recent studies such as Abida (2011) and MacDonald and Vieira (2010).

[36] Aguirre and Calderón (2005) and Razin and Collins (1997) find that RER distortions impact on growth in a nonlinear fashion. I have also included squared terms of RER under-and overvaluation in the model but there is no evidence of a nonlinear relationship, implying that the optimal level of misalignment is zero. The result for this regression is available in Table 2A.4 in the Appendix. For comparison purposes, the table also reports results for the baseline model (Table 2.1, Column 1), but using the same samples as in Columns 2-4 (Table 2.1) and for models that only include either the ERER fundamentals or RER distortions. Overall, these do not add much, except the result for the latter specification where the coefficient on RER undervaluation shrinks to half of its previous size which underlines the importance of controlling for all ERER fundamentals in order to properly channel out the growth effect of RER distortions.

[37] I have also tried using crude RER over- and undervaluation five-year dummies which are the sum of their yearly values. However, this approach does not yield plausible results.

Table 2.1: Growth regressions – Main results.

| Independent variable | (1a) OLS | (1b) SGMM | (2a) OLS | (2b) SGMM | (3) SGMM | (4) SGMM |
|---|---|---|---|---|---|---|
| Initial Income | -0.25 (8.4)*** | -0.01 (0.1) | -0.24 (7.4)*** | -0.02 (0.4) | -0.02 (0.6) | -0.02 (0.6) |
| Investment | 0.22 (3.2)*** | 0.19 (2.7)*** | 0.15 (5.7)*** | 0.13 (2.0)** | 0.07 (1.1) | 0.08 (1.3) |
| ln $(n+g+\delta)$ | -0.09 (0.7) | -0.50 (1.4) | -0.11 (0.9) | -0.32 (0.9) | -0.67 (1.7)* | -0.48 (1.8)* |
| Terms of Trade | 0.002 (0.1) | 0.01 (0.4) | -0.01 (0.6) | -0.02 (0.7) | 0.02 (0.3) | 0.08 (1.2) |
| Trade Openness | 0.02 (0.7) | 0.1 (1.4) | 0.004 (0.1) | 0.01 (0.3) | -0.02 (0.5) | -0.06 (1.6) |
| Government Consumption | -0.14 (2.0)** | -0.09 (0.9) | -0.05 (1.3) | -0.05 (0.7) | -0.03 (0.5) | 0.01 (0.1) |
| Net Foreign Asset Position | 0.04 (1.6) | -0.13 (2.4)** | 0.04 (1.7)* | -0.03 (0.7) | -0.02 (0.5) | 0.01 (0.4) |
| Human Capital | | | -0.07 (1.6) | 0.06 (0.9) | | 0.01 (0.2) |
| Rule of Law | | | | | 0.12 (2.9)*** | 0.12 (3.0)*** |
| RER Undervaluation | 0.27 (1.8)* | 1.29 (3.3)*** | 0.32 (2.2)** | 1.16 (2.6)** | 0.82 (1.8)* | 1.08 (2.2)** |
| RER Overvaluation | -0.65 (3.6)*** | -2.01 (4.7)*** | -0.60 (3.2)*** | -1.06 (1.5) | -0.80 (1.8)* | -1.18 (3.0)*** |
| Observations | 469 | 469 | 430 | 430 | 216 | 210 |
| N | 63 | 63 | 57 | 57 | 55 | 53 |
| AR(2) (p-value) | | 0.71 | | 0.21 | 0.72 | 0.92 |
| Hansen test (p-value) | | 0.81 | | 0.83 | 0.68 | 0.88 |
| Instruments | | 69 | | 77 | 67 | 74 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of robust clustered standard errors for OLS and the Windmeijer (2005) correction for two-step SGMM standard errors). Each regression includes country and time fixed effects. SGMM results use all available lags as "collapsed" instruments in Columns 1b and 2b. In Columns 3 and 4, the instrument set is restricted to lag 1. The terms of trade is treated as strictly exogenous; initial income, the rule of law, and human capital as predetermined; and the rest as endogenous. Observations are averages over five-year periods. The value of the variable RER Undervaluation (Overvaluation) is less (greater) than or equal to zero. Initial income, investment, population growth, government consumption, the terms of trade, the rule of law, and human capital (average years of schooling) are measured in natural logarithms.

### 2.3.3 Robustness

There may be concerns relating to consistency. In particular, RER misalignment estimates may be subject to measurement error, thus introducing attenuation bias. Notice that while first-stage estimates of the long-run RER parameters are superconsistent, the problem is that each method used to derive the sustainable values of the ERER fundamentals has its caveats (cf. Eq. 3.5) and that the actual RER is a proxy. It is thus likely that RER misalignment estimates are measured with error. Even so, SGMM estimates are consistent provided there is no correlation between the instruments and the measurement errors, for example if the latter are serially uncorrelated (Bond et al., 2001; Hauk and Wacziarg, 2009). Where this is not the case, consistent estimates can be obtained by excluding recent lags from the instrument set (Bond et al., 2001). Doing so, however, does not significantly change the results (see Table 2.2, Columns 3-5). Furthermore, basing RER misalignment estimates on alternative values of "sustainable" variables derived with the Butterworth-filter (Pollock, 2000) does not make a marked difference (see Table 2.2, Columns 1 and 2).

Table 2.2: Growth regressions – Robustness.

| Independent variable | (1a) OLS | (1b) SGMM | (2a) OLS | (2b) SGMM | (3) SGMM | (4) SGMM | (5) SGMM |
|---|---|---|---|---|---|---|---|
| Initial Income | -0.25 (8.3)*** | -0.001 (0.0) | -0.25 (7.5)*** | 0.01 (0.1) | 0.04 (0.6) | -0.05 (0.5) | -0.02 (0.2) |
| Investment | 0.23 (3.3)*** | 0.22 (2.4)** | 0.16 (5.6)*** | 0.18 (3.4)*** | 0.28 (2.6)*** | 0.26 (2.3)** | 0.27 (2.5)** |
| ln $(n+g+\delta)$ | -0.05 (0.4) | -0.29 (1.0) | -0.08 (0.6) | -0.15 (0.4) | -0.64 (1.6) | -0.46 (1.1) | -0.52 (1.3) |
| Terms of Trade | 0.01 (0.4) | 0.01 (0.3) | -0.01 (0.5) | -0.03 (1.0) | 0.00 (0.1) | 0.02 (0.6) | 0.01 (0.1) |
| Trade Openness | 0.03 (0.9) | 0.08 (1.0) | 0.01 (0.3) | -0.01 (0.2) | 0.07 (0.7) | 0.15 (1.1) | 0.05 (0.6) |
| Government Consumption | -0.15 (2.0)** | -0.09 (1.1) | -0.06 (1.4) | 0.04 (0.4) | -0.02 (0.1) | -0.09 (0.9) | -0.09 (0.5) |
| Net Foreign Asset Position | 0.05 (1.7)* | -0.10 (1.8)* | 0.05 (1.9)* | -0.02 (0.5) | -0.23 (2.8)*** | -0.19 (2.4)** | -0.15 (1.2) |
| Human Capital | | | -0.07 (1.4) | 0.04 (0.7) | | | |
| RER Undervaluation | 0.25 (1.9)* | 0.97 (2.9)*** | 0.29 (2.1)** | 0.74 (2.5)** | 1.26 (2.2)** | 0.91 (1.8)* | 1.26 (2.2)** |
| RER Overvaluation | -0.54 (3.2)*** | -1.42 (3.1)*** | -0.49 (3.0)*** | -0.73 (1.6) | -1.63 (2.6)*** | -2.09 (3.8)*** | -1.85 (2.8)*** |
| Observations | 456 | 456 | 422 | 422 | 469 | 469 | 469 |
| N | 61 | 61 | 56 | 56 | 63 | 63 | 63 |
| AR(2) test | | 0.99 | | 0.11 | 0.65 | 0.63 | 0.69 |
| Hansen test (p-value) | | 0.72 | | 0.89 | 0.44 | 0.43 | 0.29 |
| Instruments | | 69 | | 77 | 61 | 53 | 45 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of robust clustered standard errors for OLS and the Windmeijer (2005) correction for two-step SGMM standard errors). Each regression includes country and time fixed effects. In Columns 1a-2b RER misalignment estimates are based on alternative values of "sustainable" variables derived with the Butterworth-filter. Tanzania and Nigeria are dropped from the sample as both are classed as outliers. In Columns 1a and 2b SGMM results use all available lags as "collapsed" instruments. Columns 3-5 exlude instruments up to lag 1, 2, and 3, respectively. The terms of trade is treated as strictly exogenous; initial income and human capital as predetermined; and the rest as endogenous. The value of the variable RER Undervaluation (Overvaluation) is less (greater) than or equal to zero.

Table 2.3: Growth regressions – Robustness: Bootstrapped standard errors.

| | (1a) | (1b) | (2a) | (2b) |
|---|---|---|---|---|
| Independent variable | OLS | OLS | OLS | OLS |
| Initial Income | -0.25 (0.03)*** | -0.25 (0.031)*** | -0.24 (0.033)*** | -0.24 (0.035)*** |
| Investment | 0.22 (0.068)*** | 0.22 (0.066)*** | 0.15 (0.027)*** | 0.15 (0.03)*** |
| ln $(n+g+\delta)$ | -0.09 (0.128) | -0.09 (0.131) | -0.11 (0.135) | -0.11 (0.136) |
| Terms of Trade | 0.002 (0.028) | 0.002 (0.03) | -0.01 (0.026) | -0.01 (0.026) |
| Trade Openness | 0.02 (0.032) | 0.02 (0.034) | 0.004 (0.031) | 0.004 (0.032) |
| Government Consumption | -0.14 (0.068)** | -0.14 (0.068)** | -0.05 (0.038) | -0.05 (0.041) |
| Net Foreign Asset Position | 0.04 (0.024) | 0.04 (0.025) | 0.04 (0.024)* | 0.04 (0.026) |
| Human Capital | | | -0.07 (0.046) | -0.07 (0.053) |
| RER Undervaluation | 0.27 (0.147)* | 0.27 (0.150)* | 0.32 (0.147)** | 0.32 (0.149)** |
| RER Overvaluation | -0.65 (0.183)*** | -0.65 (0.180)*** | -0.60 (0.189)*** | -0.65 (0.188)*** |
| Observations | 469 | 469 | 430 | 430 |
| N | 63 | 63 | 57 | 57 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Robust clustered standard errors in parentheses in Columns 1a and 2a. Bootstrapped standard errors (1000 replications) are in parentheses in Columns 1b and 2b.

Another issue is that statistical inference might be misleading due to a "generated regressor problem" (Pagan, 1984). While RER over- and undervaluation are not classical generated regressors in the sense of Pagan (1984) (they are neither the first stage prediction nor the error term) the possibility that standard errors are downward biased here cannot be ruled out due to the lack of a theoretical treatment of the present case. Therefore, to adjust for the potential extra variation stemming from RER over- and undervaluation, I re-estimate the OLS results with bootstrapped standard errors. As it turns out, the latter remain virtually unchanged, thus alleviating the concern that inference based on the main results is misleading (bootstrapped standard errors are at most 2 percent higher for the variables of interest (see Table 2.3)).

Bootstrapping for SGMM, on the other hand, is problematic since the population moment conditions do not hold in the bootstrap samples

(Bond and Windmeijer, 2005). Hall and Horowitz (1996) and Brown and Newey (2002) develop methods to deal with this issue but Bond and Windmeijer (2005) show that bootstrapped two-step standard errors are similar to asymptotic two-step standard errors in terms of unreliability, and that (bootstrapped) Wald tests based on the inefficient one-step GMM estimator have less power relative to the Windmeijer (2005) corrected two-step test. In light of this and the fact that bootstrapped OLS standard errors provide no evidence of misleading inference, I abstain from attempting the Hall and Horowitz (1996) or Brown and Newey (2002) bootstrapping procedure for SGMM. In view of this discussion, the remainder of the paper leaves both issues untreated.

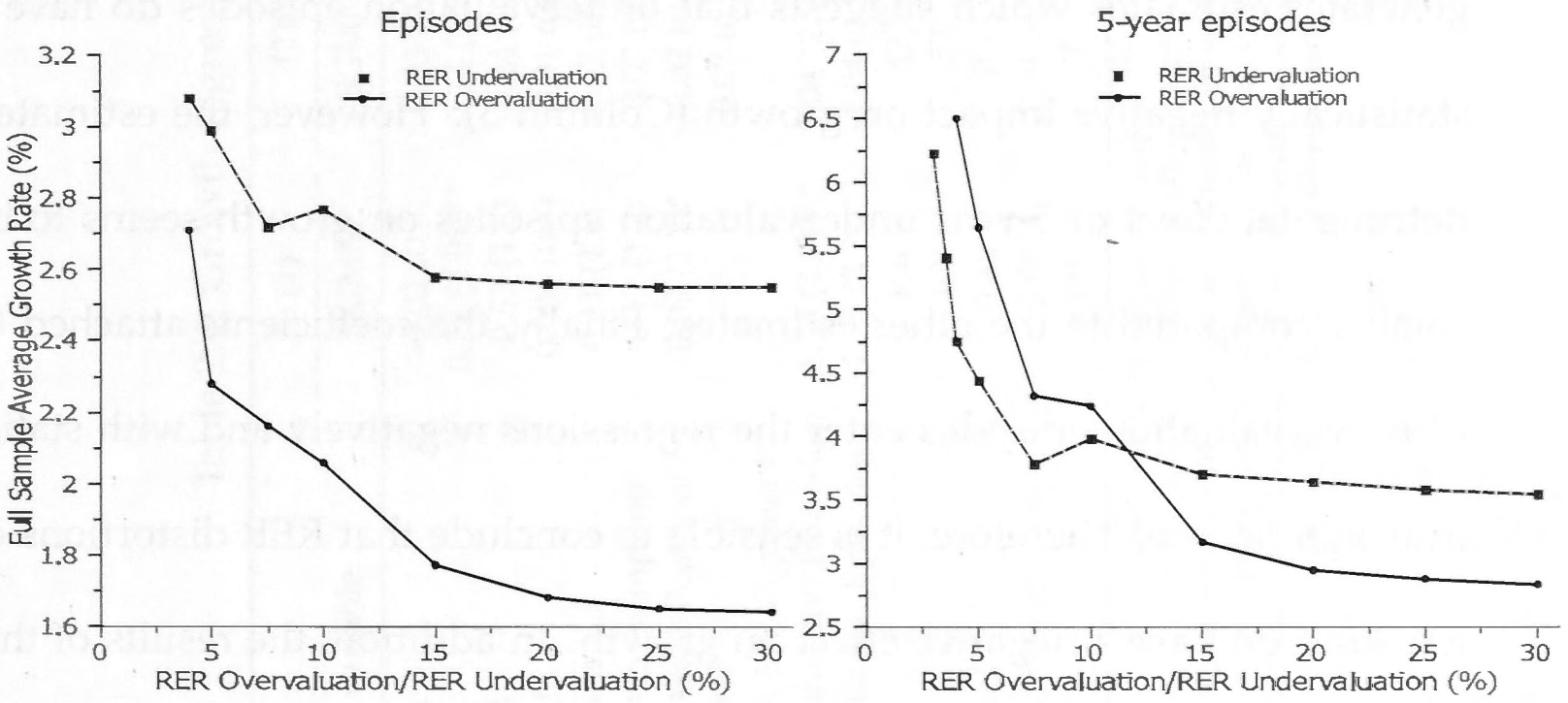
### 2.3.4 Episodes

This section identifies over- and undervaluation episodes to better understand the impact of RER misalignment on growth. To this end, I define two types of episodes. The first occurs if the RER is over-/undervalued during the majority of years over the five-year period. The resulting measure takes the value of the average degree of RER over- or undervaluation during the five-year interval, and zero otherwise. The second type is defined as taking place if there is real over- or undervaluation in each of the five years. As before, the value of these variables equals the five-year average degree of misalignment,

and zero otherwise. A third variable measures non-episodic RER distortions as the average degree of absolute misalignment. Given this procedure, a coefficient with a positive (negative) sign on RER undervaluation (overvaluation) episodes would corroborate the main results.

Figure 2.2 plots the full sample average growth rate together with the maximum value of RER over- and undervaluation episodes. There is an unambiguous negative relationship between growth and episodes of RER distortions. Regardless of episode type, the plots suggest that growth is, on average, higher the closer the RER is to equilibrium.

Figure 2.2: RER distortions-growth nexus.




Note: Each scatter represents the full sample average growth rate for values of RER over- or undervaluation (absolute RER misalignment) less than or equal to the corresponding value on the x-axis in the left panel (right panel).

Table 2.4 presents growth regression results. Irrespective of the type of RER undervaluation episode and model specification, there is strong evidence against the hypothesis that RER undervaluation promotes growth. The point estimates of real undervaluation episodes are unanimously positive. They are also statistically significant at conventional levels in all but one model specification (Column 4). However, this result should not be overemphasized. The best outcome that RER undervaluation may achieve is having a zero effect on growth if and only if real undervaluation persists for a sufficiently long period. Also notice that the coefficient in that regression is still positive and statistically significant at the 20 percent level. In addition, merging RER overvaluation episodes and absolute misalignment to one regressor generates estimates which suggests that undervaluation episodes do have a statistically negative impact on growth (Column 3). However, the estimated detrimental effect of 5-year undervaluation episodes on growth seems to be smaller compared to the other estimates. Finally, the coefficients attached to RER overvaluation episodes enter the regressions negatively and with statistical significance. Therefore, it is sensible to conclude that RER distortions of any kind do have a negative effect on growth. In addition, the results of this section and the last one suggest that absolute ERER deviations are the best measure to analyze the growth effect of RER distortions (Column 6).[38]

[38]For all specifications in Tables 2.1 and 2.4, the hypothesis that under- and overvaluation affect growth equally cannot be rejected at the 10 percent level.

Table 2.4: Growth regressions – Misalignment episodes.

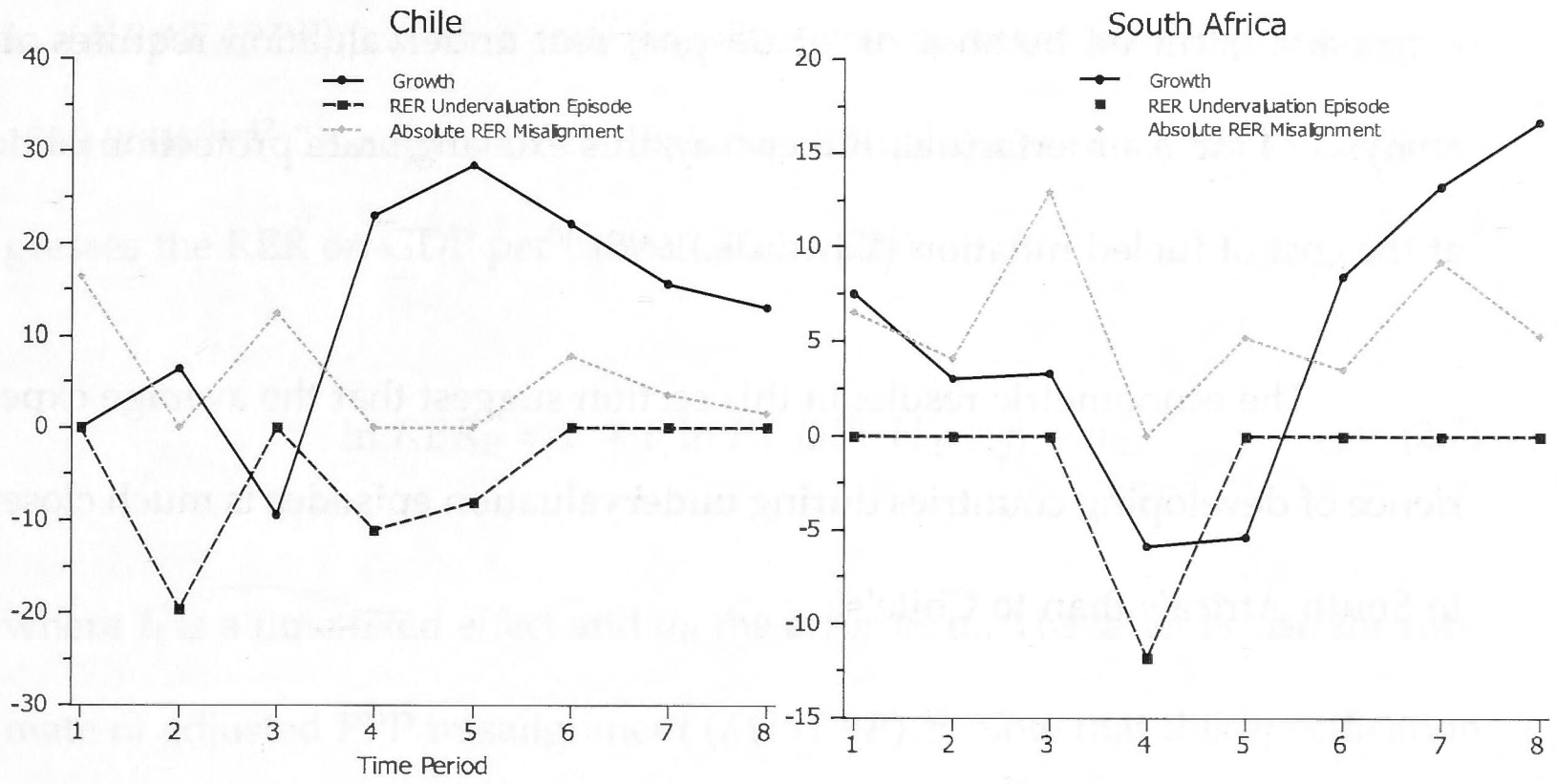
| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Independent variable | SGMM | SGMM | SGMM | SGMM | SGMM | SGMM |
| Initial Income | -0.02 (0.5) | -0.03 (0.6) | -0.002 (0.0) | -0.02 (0.4) | -0.03 (0.7) | 0.002 (0.1) |
| Investment | 0.22 (3.0)*** | 0.14 (1.8)* | 0.20 (2.9)*** | 0.20 (3.1)*** | 0.13 (2.0)** | 0.20 (2.7)*** |
| ln $(n+g+\delta)$ | -0.53 (1.5) | -0.24 (0.7) | -0.42 (1.4) | -0.44 (1.5) | -0.45 (1.5) | -0.48 (1.4) |
| Terms of Trade | 0.004 (0.1) | -0.01 (0.4) | -0.01 (0.2) | 0.001 (0.1) | -0.01 (0.4) | -0.01 (0.3) |
| Trade Openness | 0.11 (1.1) | 0.02 (0.5) | 0.08 (1.1) | 0.1 (1.2) | 0.03 (0.6) | 0.09 (1.3) |
| Government Consumption | -0.12 (1.2) | -0.07 (0.8) | -0.06 (0.7) | -0.11 (1.3) | -0.08 (1.1) | -0.06 (0.8) |
| Net Foreign Asset Position | -0.09 (1.7)* | -0.02 (0.4) | -0.12 (1.9)* | -0.10 (1.6) | -0.03 (0.6) | -0.13 (1.9)* |
| Human Capital | | 0.07 (0.9) | | | 0.05 (0.9) | |
| Absolute RER Misalignment | | | -1.80 (2.7)*** | -1.52 (2.6)*** | -1.37 (2.6)*** | -1.68 (3.2)*** |
| RER Undervaluation Episodes | 1.35 (2.7)*** | 1.04 (2.5)** | 0.84 (1.9)* | 0.58 (1.4) | 0.66 (2.0)** | |
| RER Overvaluation Episodes | -1.75 (2.7)*** | -1.04 (1.9)* | | -1.97 (3.3)*** | -1.44 (2.2)** | |
| Observations | 466 | 427 | 469 | 469 | 430 | 469 |
| N | 63 | 57 | 63 | 63 | 57 | 63 |
| AR(2) (p-value) | 0.83 | 0.15 | 0.69 | 0.69 | 0.21 | 0.58 |
| Hansen test (p-value) | 0.68 | 0.90 | 0.79 | 0.92 | 0.99 | 0.44 |
| Instruments | 69 | 77 | 69 | 76 | 84 | 62 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of the Windmeijer (2005) correction for two-step SGMM standard errors). Each regression includes country and time fixed effects. SGMM results use all available lags as "collapsed" instruments. The terms of trade is treated as strictly exogenous; initial income and human capital as predetermined; and the rest as endogenous. The value of the variable RER Undervaluation (Overvaluation) Episodes is less (greater) than or equal to zero. In Columns 3-5, absolute RER misalignment equals zero during RER over- and undervaluation episodes. Initial income, investment, population growth, government consumption, the terms of trade, and human capital (average years of schooling) are measured in natural logarithms.

To conclude this section, it is illustrative to provide the narrative behind the experiences of some countries during undervaluation episodes. Figure 2.3 shows the evolution of RER distortions and growth over five-year periods for South Africa and Chile. There is a negative relationship between real undervaluation and growth for South Africa, where economic difficulties began to emerge in the 1970s following the oil price crisis and the Soweto uprising. The continued deterioration of South Africa's net international creditor position essentially put in place a credit ceiling in the early 1980s (Hirsch, 1989). The required current account surplus to service the debt stifled economic expansion, a common situation for developing countries dependent on capital goods imports. Because of the adoption of a floating exchange rate system, further loss in confidence in the economy, falling gold prices, and high inflation in industrialized countries coming to an end, the rand depreciated continuously (Hirsch, 1989). This resulted in an RER undervaluation episode ending only in 1991. Due to excessive short-term debt, the rand's depreciation required higher repayments (in domestic currency terms), which in turn exacerbated South Africa's economic woes. [39]

[39]South Africa was not the only country with such an experience. A similar situation took place in Algeria in the early 1990s. After a decade of sluggish growth and high international indebtedness, in part due to falling oil prices, the Algerian dinar was significantly overvalued. In 1991, a more than 100 percent depreciation vis-à-vis the US dollar generated a real undervaluation episode that lasted until 1997. Economic performance improved from the mid 1990s onwards after debt restructuring and a series of reforms that aimed for macroeconomic stability and greater trade openness.

Figure 2.3: RER distortions-growth nexus for selected countries.




An interesting counterexample is the case of Chile. Following the debt crisis in 1982, Chile underwent trade liberalization reforms between 1985 and 1992, which included an average tariff reduction from 36 to 12 percent (Li, 2004). Since tariff removals cause the ERER to depreciate (Edwards, 1989), the actual RER needs to depreciate as well in order to restore equilibrium. The trade policy reforms were therefore accompanied by a (large) nominal devaluation which caused the RER to become undervalued in 1985. The RER did not appreciate back to equilibrium for 10 consecutive years (the longest undervaluation episode in the sample). Real undervaluation was sustained for such a long period because the crawling band exchange rate system leveled

off the impact of inflation on the RER (Edwards, 1995). Nonetheless, Chile experienced rapid economic growth during that period. Whether this growth expansion occurred because of, or despite, real undervaluation requires an analysis of the counterfactual. Either way, this exchange rate protection came at the cost of fueled inflation (Edwards, 1995).[40]

The econometric results in this section suggest that the average experience of developing countries during undervaluation episodes is much closer to South Africa's than to Chile's.

### 2.3.5 PPP misalignment

So far this study has examined the growth effect of deviations of RER from the level consistent with internal and external balance. Thus the results are not comparable with those of studies by Rodrik (2008) and others that have measured RER misalignment following the (Balassa-Samuelson adjusted) PPP approach. It could well be that RER undervaluation from the point of view of internal and external equilibrium retards growth, whereas undervaluation relative to PPP is growth promoting. Rather than further discussing the relative merits of the two approaches to measuring RER misalignment, in this sub-section I probe whether the Rodrik (2008) results stand up to scrutiny.

[40]The narrative behind the first RER undervaluation episode (1975-1980) is very similar. Tariff removals accompanied by a large nominal devaluation resulted in a significant real undervaluation.

Rodrik (2008) uses Penn World Table 6.2 (PWT) data on the exchange rate ($XRAT$) and PPP conversion factors to compute the RER as $\ln RER_{it} = \ln (XRAT/PPP)_{it}$, with $t$ indexing five-year averages covering the period 1950-2004.[41,42] To adjust for the Balassa-Samuelson effect, Rodrik (2008) regresses the RER on GDP per capita ($RGDPCH$):

$$\ln RER_{it} = \alpha + \beta \ln RGDPCH_{it} + f_t + u_{it}, \tag{2.7}$$

where $f_t$ is a time fixed effect and $u_{it}$ the error term. The latter is also the estimate of adjusted PPP misalignment ($MISPPP$).[43] Note that this specification implicitly assesses that the magnitude of the impact of productivity gains on RER (operating via wages) is uniform across countries. Thus it ignores differences in labor market distortions or "surplus labor" situations across countries.

To examine the sensitivity of the Rodrik (2008) results to this restrictive assumption, I first follow his approach to estimate $MISPPP$ and re-estimate Eq. 2.7 by adding country slope dummies to obtain $MISPPP$ measures that account for parameter heterogeneity.[44] I then compare the growth effects of the two alternative misalignment indicators by estimating Rodrik's

[41] To avoid confusion, I use the same notation as Rodrik (2008) whenever it is suitable.

[42] A ratio greater than one means that the RER is further depreciated relative to the PPP benchmark. It follows that an increase in $\ln RER_{it}$ refers to depreciation.

[43] Under this approach, $MISPPP$ is positive (negative) when the RER is undervalued (overvalued). Rodrik (2008) names this variable $UNDERVAL$.

[44] Indeed, the homogeneity restriction on $\beta$ is rejected at the 1 percent level.

(2008) baseline growth specification:

$$g_{it} = \alpha + \beta \ln RGDPCH_{i,t-1} + \delta\, MISPPP_{it} + f_i + f_t + u_{it}, \qquad (2.8)$$

where $g_{it}$ is annual growth and $f_i$ are country specific effects.

Table 2.5 reports the results. They match Rodrik's (2008) for the full and developing country sample (Columns 1 and 2).[45] In particular, the point estimate of $\delta = 0.026$ for the developing country subsample implies that a 10 percent undervaluation spurs growth by 0.26 percentage points in these countries. Splitting $MISPPP$ into positive and negative values still yields estimates that suggest a significantly positive impact of undervaluation on growth (Column 3). Including my measure of RER misalignment in the growth model also leads at first to the conclusion that PPP undervaluation promotes growth (Column 4). However, distinguishing between undervaluation and overvaluation changes the results. The coefficient of RER undervaluation is close to zero and fails to achieve statistical significance. This suggests that countries do not gain from RERs that are undervalued relative to Balassa-Samuelson adjusted PPP. Interestingly, the point estimate of PPP overvaluations is the same across $MISPPP$ measures (0.022) and this implies a negative and statistically significant impact on growth. But this negative effect also disappears when employing SGMM to control for endogeneity (Column 6).[46] There-

[45] Only the t-stats are trivially different.

[46] The instrument set contains all available lags resulting in 172 instruments. Initial income

fore, in contrast to Nurksian ERER deviations, adjusted PPP misalignment does not seem to affect growth.[47] This is, in fact, good news for developing countries, as otherwise a terms of trade boom leading to a long-lasting Nurksian ERER appreciation above the PPP benchmark (assuming the actual RER follows suit) would stifle growth, even though the appreciation is an equilibrium phenomenon. In summary, my alternative estimates suggest that Rodrik's (2008) inference that RER undervaluation promotes growth is driven by the questionable parameter homogeneity restriction in the first stage.

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is treated as predetermined and under-and overvaluation as endogenous. The AR(2) test is rejected at the 5 percent level, suggesting a violation of the SGMM moment conditions, but this is not an issue since no causal claim is being made here.

[47] I have also used annual observations in the first stage and then five-year averages in the second. This procedure yields very similar results.

Table 2.5: Growth regressions – Adjusted PPP misalignment.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Independent variable | All countries | Developing | Developing | Developing | Developing | Developing (SGMM) |
| Initial Income | -0.030 (5.4)*** | -0.039 (4.8) *** | -0.039 (4.9)*** | -0.033 (3.8)*** | -0.033*** | 0.014 (4.6)*** |
| RER Misalignment | 0.017 (3.4) *** | 0.026 (4.1) *** | | 0.015 (2.5)** | | |
| RER Undervaluation | | | 0.031 (3.4)*** | | 0.006 (0.6) | 0.010 (0.7) |
| RER Overvaluation | | | 0.022 (2.3) ** | | 0.022 (2.9)*** | 0.005 (0.4) |
| Observations | 1303 | 790 | 790 | 790 | 790 | 790 |

Notes:The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of robust clustered standard errors for OLS and the Windmeijer (2005) correction for two-step SGMM standard errors). Each regression includes country and time fixed effects. Developing country observations are those with real GDP per capita below $6,000. Iraq, Laos, and North Korea have been excluded from the sample.

### 2.3.6 Reconciliation with previous results

This section demonstrates that the driving force behind the finding in this study that Nurksian undervaluation reduces growth is the combination of estimating RER misalignments on a country-by-country basis and the way the study distinguishes between RER over- and undervaluation in the second stage.

To this end, let's see what happens when I use annual and 5-year panels in the first stage to estimate "panel misalignment" measures ($mis_{it}$, Eq. 2.4).[48] Using as regressor $mis_{it}$ that is estimated through the annual panel and then averaged over five years generates a coefficient on this variable which is equal to $-0.11$ and significant at the 5 percent level (Table 2.6, Column 1). This suggests that a 10 percent undervaluation increases annual growth by 0.22 percentage points. Interestingly, this effect is similar to Rodrik's (2008) baseline result for the developing country subsample. Even when a distinction is made between positive and negative values of $mis_{it}$ using the same approach as in this paper, the coefficient attached to RER undervaluation is insignificant (Column 2). The results are virtually the same when I use a five-year panel in the first stage to estimate $mis_{it}$ (Columns 3 and 4). In summary, panel measures as opposed to the country-by-country misalignment estimates only identify a negative growth impact of RER overvaluation

[48] For simplicity, I continue to use Rodrik's (2008) above specification. Including more regressors does not significantly affect the results.

but not undervaluation.

However, it is still possible to obtain results suggesting a positive instead of a negative effect of RER undervaluation on growth using country-by-country RER misalignment measures. This happens when the previously mentioned pitfalls associated with model specification are ignored. For instance, using five-year averaged $mis_{it}$ as a covariate yields a negative coefficient that is statistically and economically significant (Column 5). In addition, splitting five-year averaged $mis_{it}$ (as opposed to first splitting, then averaging) and then including RER over- and undervaluation along with their squares in the model, generates results that suggest a positive impact of RER undervaluation of up to 21 percent on growth, before it turns negative (Column 5). This is similar to Aguirre and Calderón's (2005) finding.

Table 2.6: Growth regressions – Panel RER misalignment.

| Independent variable | (1) Annual | (2) Annual | (3) 5-year panel | (4) 5-year panel | (5) Country-by-country | (6) Country-by-country |
|---|---|---|---|---|---|---|
| Initial Income | -0.22 (7.5)*** | -0.22 (6.7) *** | -0.19 (6.6)*** | -0.20 (6.7)*** | -0.19 (6.4)*** | -0.19 (6.5)*** |
| RER Misalignment | -0.11 (2.5) ** | | -0.09 (2.2)** | | -0.31 (2.5)** | |
| RER Undervaluation | | 0.05 (0.3) | | -0.01 (0.2) | | -0.84 (2.5)** |
| RER Undervaluation Squared | | | | | | -4.00 (2.7)*** |
| RER Overvaluation | | -0.19 (2.6)** | | -0.16 (2.1)** | | 0.37 (1.5) |
| RER Overvaluation Squared | | | | | | -3.16 (4.2)*** |
| Observations | 463 | 463 | 473 | 473 | 471 | 471 |
| N | 63 | 63 | 63 | 63 | 63 | 63 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of robust clustered standard errors). Each regression includes country and time fixed effects.

## 2.4 Conclusion

The purpose of this paper has been to contribute to the debate on the impact of real exchange rate misalignment on economic growth, with particular emphasis on the inference of some recent studies that real undervaluation promotes growth. While the traditional position on this issue (the "Washington Consensus") advocates for the RER being close to its equilibrium level, the recent theoretical and empirical literature emphasizes the economic benefits of real undervaluation. This study has estimated RER misalignments for 63 developing countries and analyzed the impact of RER over- and undervaluation on economic growth. In accordance with the Washington Consensus, the results suggest that any deviation of the RER from the level that is consistent with external and internal equilibrium lowers economic growth. Previous results appear to be driven by two inconsistencies. First, the strong homogeneity assumption on long-run RER behavior across countries produces misleading results and is inconsistent with economic theory. Second, the objective to infer the effect on growth of two variables (real over- and undervaluation) from a single continuous variable (RER misalignment) can lead to model misspecification. The paper has also revisited the claim that PPP undervaluation promotes growth in developing countries. Again, when the two problems are taken into account, the results suggest that deviations from adjusted PPP do not impact on developing countries' growth performance.

Thus, despite recent criticisms, the Washington Consensus still has valuable policy guidelines to offer. Developing countries should aim to keep the RER close to its equilibrium level in the sense of Nurkse (1945), which reinforces another policy guideline of the Washington Consensus: sound macroeconomic policies. In addition, countries with fixed but adjustable exchange rate regimes should closely review their current pegs if there are movements in anchor currencies. However, while it is true that the fastest-growing countries tend to have avoided excessive RER distortions in either direction, it is not a sufficient condition for growth take-off. For example, the RER rarely diverged from equilibrium in the Central African Republic but the country did not experience fast growth. Therefore, "the real exchange rate is best thought of as a facilitating condition" (Eichengreen, 2008, p. 20).

# Appendix

Table 2A.1: Empirical studies on the RER undervaluation-growth nexus.

| Author | Countries & Period | Econometric Methodology[1] | Finding |
|---|---|---|---|
| Razin and Collins (1997) | 93 countries<br>1975-1992 | SEA, panel data, FE | (+) (nonlinear) |
| Aguirre and Calderón (2005) | 60 countries<br>1965-2003 | SEA, DOLS<br>and panel DOLS | (+) (nonlinear) |
| Gala and Lucinda (2006) | 58 developing countries<br>1960-1999 | PPP adjusted | (+) |
| Rodrik (2008) | 188 countries<br>1950-2004 | PPP adjusted | (+) |
| Béreau et al. (2009) | 31 countries + EU<br>1980-2007 | SEA, panel data,<br>PMG & FM-OLS | (+) |
| Berg and Miao (2010) | 181 countries<br>1950-2004 | SEA, panel data, FE | (+) |
| MacDonald and Vieira (2010) | 90 countries<br>1980-2004 | SEA, panel data,<br>FE & RE | (+) |
| Abida (2011) | 3 MENA countries<br>1980-2008 | SEA,panel data,<br>FM-OLS | (+) |
| Nouira and Sekkat (2012) | 52 developing countries<br>1980-2005 | SEA, panel DOLS | inconclusive, mostly 0 |

Notes: Contains information about the ERER definition and the econometric methodology to derive RER misalignment. SEA refers to the single-equation-approach developed by Edwards (1989), Elbadawi (1994), and Baffes et al. (1999), implying an ERER definition consistent with internal and external balance. PPP adjusted means the ERER in these studies is defined as absolute PPP adjusted for the Balassa-Samuelson effect.

Table 2A.2: Data Appendix Table – Data sources and definitions.

| Variable | Description | Source |
|---|---|---|
| **RER misalignment estimation** | | |
| Real exchange rate (RER) | Constructed with the formula: $RER = (NER \cdot CPI_T)/CPI_D$. $NER$, $CPI_T$, and $CPI_D$ are the multilateral official nominal exchange rate, the multilateral foreign consumer price index, and the domestic consumer price index respectively. $NER$ and $CPI_T$ are calculated as geometric averages weighted by total official trade shares of the largest trading partners. The total trade shares are calculated for the time period under consideration. | Compiled from: WDI, UN Comtrade, DOT (IMF), and WDI |
| Terms of trade (TOT) | The ratio of the export price index to the import price index. | Compiled from: WDI and WT |
| Trade policy (OPEN) | Constructed as the ratio of the sum of the total value of exports (X) plus the total value of imports (M) relative to GDP at current prices. OPEN1=(X+M)/GDP at constant prices. OPEN2=M/GDP at current prices. | PWT 7.0 (OPEN & OPEN1) WDI (OPEN2) |
| Balassa-Samuelson-effect (PROD) | Proxied with the ratio of GDP per capita (home country) to the OECD average of GDP per capita income at current (PROD) and constant (PROD1) prices. | WDI |
| Government consumption (GEXP) | GDP share of total government consumption expenditure at current prices (GEXP). GEXP1: Government consumption share of PPP converted GDP per capita at current prices. | WDI (GEXP) PWT 7.0 (GEXP1) |
| Net foreign asset position (NFA) | The ratio of net foreign assets relative to GDP at current prices. Net foreign assets are defined as the sum of net holdings of portfolio equity assets, foreign direct investment assets, debt assets, financial derivatives assets, and foreign exchange reserves minus gold. | Lane and Milesi-Ferretti (2007) |
| Investment (INV) | The investment share of PPP converted GDP per capita at current prices. | PWT 7.0 |
| Trade surplus (TS) | Net exports relative to GDP: TS=(X-M)/GDP. | WDI |

Table 2A.2: Data Appendix Table – Data sources and definitions (ctd.).

| Variable | Description | Source |
|---|---|---|
| **General** | | |
| Sample size and outliers | The data set for estimating RER misalignment in the sense of Nurkse (1945) is constructed with the objective of maximizing sample size. Any country is included for which the above data is available for at least 20 consecutive years within the period 1970-2007. This study defines each country as "developing" except Japan, European countries, and Western Offshoots. Observations with RER misalignment in excess of 100 percent are excluded, as well as their adjacents provided a time-series of at least 20 consecutive observations is retained. Otherwise the country's observations are dropped altogether. In addition, civil war-torn countries are excluded from the sample as well as those countries for which it was not possible to estimate plausible ERERs. | |
| **Growth regressions** | | |
| GDP per capita | Real GDP per capita at constant prices (chain series) | PWT 7.0 |
| ln $(n+g+\delta)$ | Average growth of the population ($n$). | PWT 7.0 |
| | Technological progress ($g = 0.02$) and depreciation rate ($\delta = 0.06$). | |
| Investment | Log of the investment share of GDP at constant prices. | PWT 7.0 |
| ERER fundamentals | See above. | |
| Human capital | Average years of schooling of population over age 15. | Barro and Lee (2010) |
| Rule of law | The strength and impartiality of the legal system. Measured from 0 (lowest) to 6 (highest). | International Country Risk Guide (ICRG) |

Table 2A.3: Long-run equilibrium relationships.

| COUNTRY | ln TOT | OPEN | PROD | GEXP | NFA | INV | TS | [leads,lags] |
|---|---|---|---|---|---|---|---|---|
| Algeria | 0.55 (33.0)*** | | -0.08 (45.1)*** | | | | | [1,0] |
| Argentina | -1.19 (2.5) ** | 0.04 (6.5)*** | | | | | | [1,0] |
| Bangladesh | | 0.02 (9.6)*** | | | -0.016 (6.3)*** | | | [1,2] |
| Bolivia | -0.51 (2.5)** | 0.01 (3.0)*** | -0.05 (3.2)*** | | | | | [2,2] |
| Botswana | | 0.007 (6.5)*** | | 0.006 (2.3)** | 0.003 (11.2)** | | | [1,0] |
| Brazil | -0.24 (3.5)*** | | -0.02 (6.4)*** | | -0.01 (4.8)*** | | | [2,1] |
| Burkina Faso | | 0.02 (6.4)*** | -0.39 (12.7)*** | -0.01 (2.4)** | | -0.02 (5.7)*** | | [2,0] |
| Cabo Verde | | | -0.11[1] (8.6)*** | | | 0.004 (4.2)*** | | [1,0] |
| Cameroon | -0.32 (3.5)*** | 0.04[2] (6.9)*** | -0.11 (9.2)*** | -0.05 (3.9)*** | | | | [3,0] |
| Central African Republic | -0.12 (3.0)*** | | | -0.03[1] (5.8)*** | | | 0.04 (6.8)*** | [2,0] |
| Chile | -0.46 (8.1)*** | 0.01 (11.3)*** | -0.02 (7.6)*** | | | | | [1,0] |
| China | | 0.02 (8.3)*** | | | -0.03 (7.6)*** | | | [3,1] |
| Colombia | | 0.02 (8.5)*** | -0.05 (17.1)*** | -0.01 (3.1)*** | -0.004 (2.3)** | | | [3,0] |
| Costa Rica | | | -0.04 (8.2)*** | 0.08[1] (4.9)*** | | 0.01 (3.4)*** | 0.02 (7.4)*** | [1,2] |
| Côte d'Ivoire | | 0.02 (7.5)*** | -0.02 (3.5)*** | -0.07 (16.6)*** | -0.005 (6.5)*** | | | [2,0] |
| Dominican Republic | -0.14 (2.2)** | 0.01[2](1.8)** | -0.05 (3.8)*** | | | | | [1,2] |
| Ecuador | | 0.007 (4.2)*** | -0.03 (4.3)*** | -0.02 (2.3)** | -0.003 (3.9)*** | | | [1,0] |
| El Salvador | | | -0.07 (2.9)*** | -0.12[1] (5.0)*** | | | | [2,2] |
| Equatorial Guinea | 0.42 (4.2)*** | 0.003 (13.6)*** | | | -0.004 (4.8)*** | | | [1,0] |
| Gabon | | | -0.02 (13.5)*** | | | 0.03 (10.8)*** | 0.02 (17.0)*** | [2,0] |
| The Gambia | | | | -0.04[1] (4.9)*** | -0.001 (3.7)*** | 0.01 (2.6)** | | [0,1] |
| Guatemala | -0.40 (5.4)*** | 0.009 (4.0)*** | -0.26[1] (15.2)*** | | | | | [2,2] |
| Haiti | | 0.01 (3.9)*** | | | -0.005 (2.9)** | -0.06 (2.5)** | | [2,2] |
| Honduras | | | -0.06 (6.7)*** | -0.03 (4.3)*** | | 0.01 (4.3)*** | | [1,1] |
| Hong Kong | | 0.005 (5.2)*** | -0.02[1] (7.8)*** | -0.17 (6.3)*** | | | | [1,1] |
| India | | 0.01 (9.6)*** | -0.30 (29.2)*** | | -0.003 (2.8)** | | | [1,0] |
| Indonesia | | 0.007 (3.8)*** | -0.19 (16.2)*** | | | 0.009 (3.2)*** | | [1,0] |
| Israel | | 0.006 (13.5)*** | -0.007 (8.0)*** | -0.006 (3.7)*** | | | | [1,1] |
| Jordan | 0.33(3.3)*** | 0.003[2] (2.7)** | -0.02 (13.5)*** | | | 0.003 (3.4)*** | | [1,0] |
| Kenya | | | -0.10 (3.2)*** | | -0.003 (2.8)*** | | | [1,0] |
| Madagascar | | 0.02 (8.3)*** | -0.27 (4.6)*** | | -0.003 (1.8)* | | | [2,2] |
| Malawi | -0.42 (5.2)*** | 0.01 (6.8)*** | | -0.04[1] (4.1)*** | | -0.01 (2.5)** | | [0,2] |

*Continued on next page*

Notes: The dependent variable is log RER. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Numbers in parentheses are the absolute values of the t-ratio. The last column reports the number of leads and lags that minimized the information criteria. [1] or [2] on top of the coefficients refer to the alternative proxies (OPEN1, OPEN2, PROD1, GEXP1) as set out in Table 2A.2.

Table 2A.3: Long-run equilibrium relationships (ctd.).

| COUNTRY | ln TOT | OPEN | PROD | GEXP | NFA | INV | TS | [leads,lags] |
|---|---|---|---|---|---|---|---|---|
| Malaysia | 0.28 (4.3)*** | 0.003 (11.9)*** | -0.01 (3.5)*** | | | | | [3,1] |
| Mali | | | -0.98 (21.0)*** | | 0.006 (8.5)*** | | | [2,0] |
| Mauritania | | | -0.33 (8.9)*** | -0.007 (3.2)*** | | | | [1,0] |
| Mauritius | | 0.002 (2.3)** | -0.04 (3.1)** | | 0.004 (3.2)*** | | | [2,2] |
| Mexico | 0.14 (9.6)*** | | -0.02 (10.3)*** | -0.04 (7.5)*** | -0.008 (15.3)*** | | | [1,0] |
| Morocco | | 0.003 (3.0)*** | -0.08 (10.5)*** | | | | | [1,0] |
| Niger | -1.0 (5.9)*** | | -0.11 (3.1)*** | -0.06 (4.5)*** | | | | [2,0] |
| Nigeria | -0.47 (7.9)*** | 0.02 (10.5)*** | | | -0.001 (2.8)** | -0.06 (5.5)*** | | [0,1] |
| Pakistan | | 0.03 (5.3)*** | | 0.06 (5.3)*** | | -0.10 (8.3)*** | | [0,2] |
| Panama | | | -0.01 (4.4)*** | | 0.001 (4.8)*** | 0.002 (4.5)*** | | [3,0] |
| Paraguay | 0.74 (14.6)*** | | -0.05 (4.9)*** | 0.06 (3.6)*** | | 0.03 (4.6)*** | | [1,0] |
| Peru | | 0.03 (8.3)*** | -0.06 (10.6)*** | 0.13 (8.5)*** | | | 0.02 (4.5)*** | [2,2] |
| Philippines | | 0.004 (5.8)*** | -0.11 (12.7)*** | -0.04 (5.0)*** | | 0.01 (4.0)*** | | [1,1] |
| Sénégal | -0.88 (5.5)*** | | -0.12 (2.3)** | -0.04 (3.4)*** | | | | [2,2] |
| Seychelles | | 0.004[2] (3.0)*** | | -0.01[1] (4.2)*** | | | | [2,0] |
| Singapore | -0.79 (6.1)*** | 0.001 (10.5)*** | -0.003 (7.5)*** | | -0.002 (7.4)*** | | | [2,0] |
| South Africa | -0.36 (5.0)*** | 0.01 (8.7)*** | -0.02 (18.0)*** | | | | | [1,3] |
| South Korea | | | -0.003 (1.8)* | 0.03 (2.3)** | 0.004 (2.1)** | | | [2,2] |
| Sri Lanka | | 0.004 (2.3)** | -0.30 (16.0)*** | | | | | [2,2] |
| Swaziland | | | | -0.01 (2.4)** | 0.0005 (2.8)*** | 0.06 (2.2)** | | [2,0] |
| Tanzania | -0.34 (4.0)*** | 0.03 (9.8)*** | | | 0.002 (3.2)*** | 0.02 (2.2)** | | [2,2] |
| Thailand | | 0.004 (15.1)*** | -0.03 (3.2)*** | -0.02 (2.6)** | -0.004 (7.3)*** | | | [1,1] |
| Togo | 0.064 (2.3)** | | | -0.02(6.2)*** | -0.002(6.5)*** | | | [1,1] |
| Trinidad & Tobago | -0.48 (3.5)*** | 0.01 (5.5)*** | | -0.01 (2.3)** | 0.002 (2.2)** | | | [1,0] |
| Tunisia | 0.23 (5.4)*** | 0.01 (9.0)*** | -0.04 (3.5)*** | | | -0.01 (2.7)*** | | [1,0] |
| Turkey | | | -0.04 (7.8)*** | -0.04 (2.2)** | 0.02 (3.0)*** | | | [2,1] |
| Uruguay | 0.23 (2.3)** | | | | -0.004 (2.0)** | | | [1,0] |
| Venezuela | | 0.01 (4.2)*** | -0.008 (6.8)*** | -0.07 (4.3)*** | | | | [2,0] |
| Zambia | 0.35 (4.1)*** | | -0.04 (2.5)** | | -0.002 (3.6)*** | | | [2,1] |
| Zimbabwe | | 0.01 (2.7)** | -0.06 (8.3)*** | -0.01 (3.6)*** | | | | [0,1] |
| Panel | -0.13 (2.5)** | 0.004 (5.9)*** | -0.01 (7.3)*** | | -0.001 (2.9)*** | -0.003 (1.9)* | | [1,1] |

Notes: The dependent variable is log RER. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Numbers in parentheses are the absolute values of the t-ratio. The last column reports the number of leads and lags that minimized the information criteria. [1] or [2] on top of the coefficients refer to the alternative proxies (OPEN1, OPEN2, PROD1, GEXP1) as set out in Table 2A.2.

Table 2A.4: Growth regressions – Additional results.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Independent variable | SGMM | SGMM | SGMM | SGMM | SGMM |
| Initial Income | -0.05 (1.0) | 0.01 (0.2) | 0.02 (0.6) | -0.05 (0.9) | -0.02 (0.4) |
| Investment | 0.21 (2.8)*** | 0.11 (1.8)* | 0.12 (2.2)** | 0.19 (3.2)*** | 0.21 (2.4)** |
| ln $(n+g+\delta)$ | -0.54 (1.9)* | -0.42 (1.2) | -0.53 (1.7)* | -0.83 (2.6)*** | -0.50 (1.4) |
| Terms of Trade | -0.01 (0.1) | -0.02 (0.7) | 0.07 (1.7)* | | -0.04 (1.1) |
| Trade Openness | 0.11 (1.5) | 0.02 (0.6) | -0.06 (1.8)* | | 0.11 (1.2) |
| Government Consumption | -0.15 (1.9)* | -0.06 (0.8) | 0.00 (0.0) | | -0.10 (1.1) |
| Net Foreign Asset Position | -0.07 (1.2) | -0.04 (0.8) | -0.02 (0.5) | | -0.09 (1.5) |
| RER Undervaluation | 1.35 (1.3) | 1.00 (1.5) | 1.29 (2.2)** | 0.76 (1.7)* | |
| RER Undervaluation Squared | 4.25 (0.9) | | | | |
| RER Overvaluation | -0.86 (0.7) | -1.35 (1.7)* | -1.43 (3.2)*** | -2.19 (6.3)*** | |
| RER Overvaluation Squared | -2.46 (1.3) | | | | |
| Observations | 469 | 430 | 210 | 469 | 469 |
| N | 63 | 57 | 53 | 63 | 63 |
| AR(2) (p-value) | 0.97 | 0.13 | 0.26 | 0.74 | 0.85 |
| Hansen test (p-value) | 0.93 | 0.65 | 0.87 | 0.43 | 0.21 |
| Instruments | 83 | 69 | 70 | 45 | 55 |

Notes: The dependent variable is real GDP per capita growth. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. t-ratios in parentheses (calculated on the basis of the Windmeijer (2005) correction for two-step SGMM standard errors). Each regression includes country and time fixed effects. SGMM results use all available lags as "collapsed" instruments, except in Column 3 where the first lag is used. The terms of trade is treated as strictly exogenous; initial income as predetermined; and the rest as endogenous. Observations are averages over five-year periods. The value of the variable RER Undervaluation (Overvaluation) is less (greater) than or equal to zero. Initial income, investment, population growth, government consumption, the terms of trade, are measured in natural logarithms.

Figure 2A.1: Estimated RER misalignments.

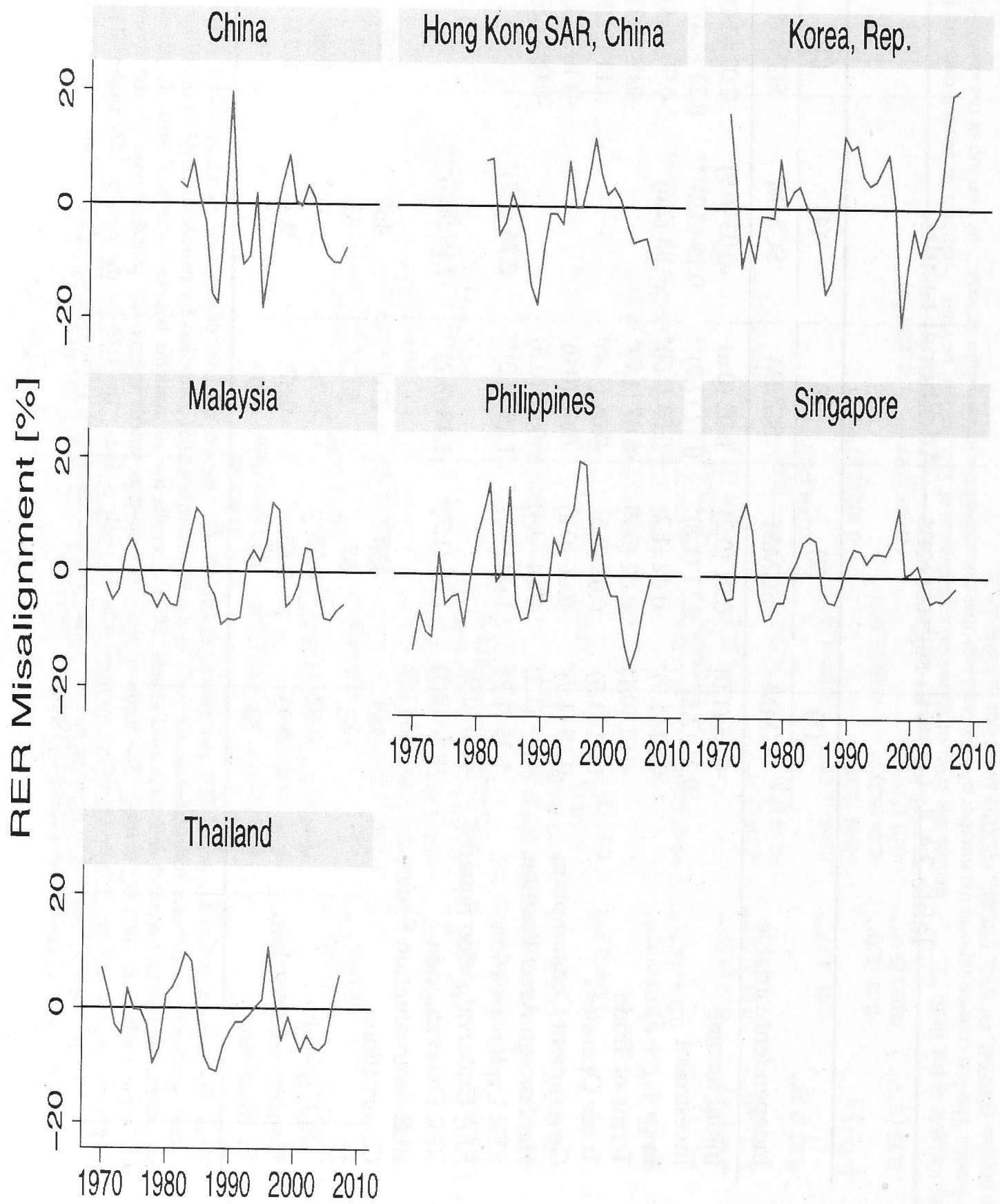


Figure 2A.1: Estimated RER misalignments (ctd.).

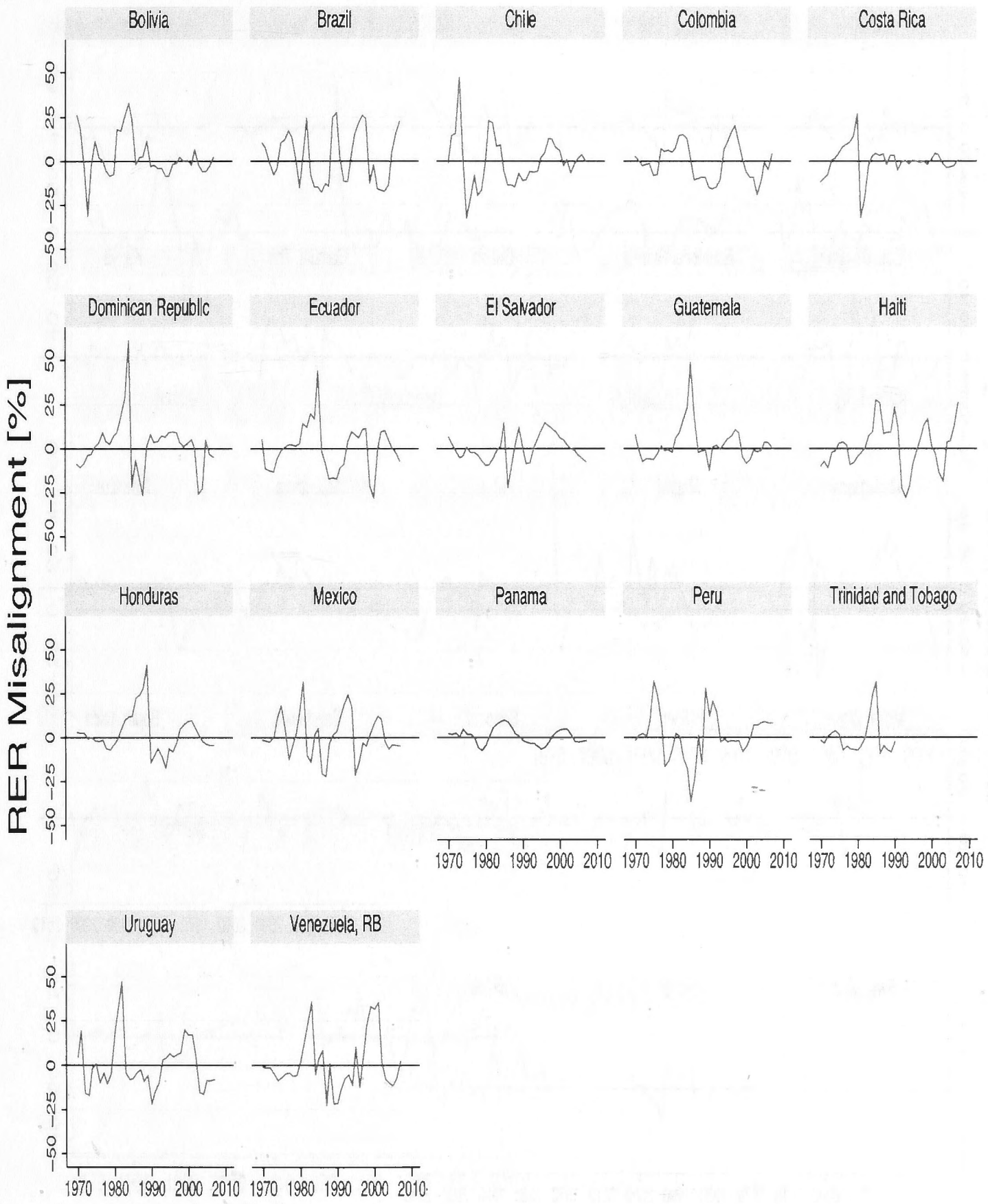


Figure 2A.1: Estimated RER misalignments (ctd.).

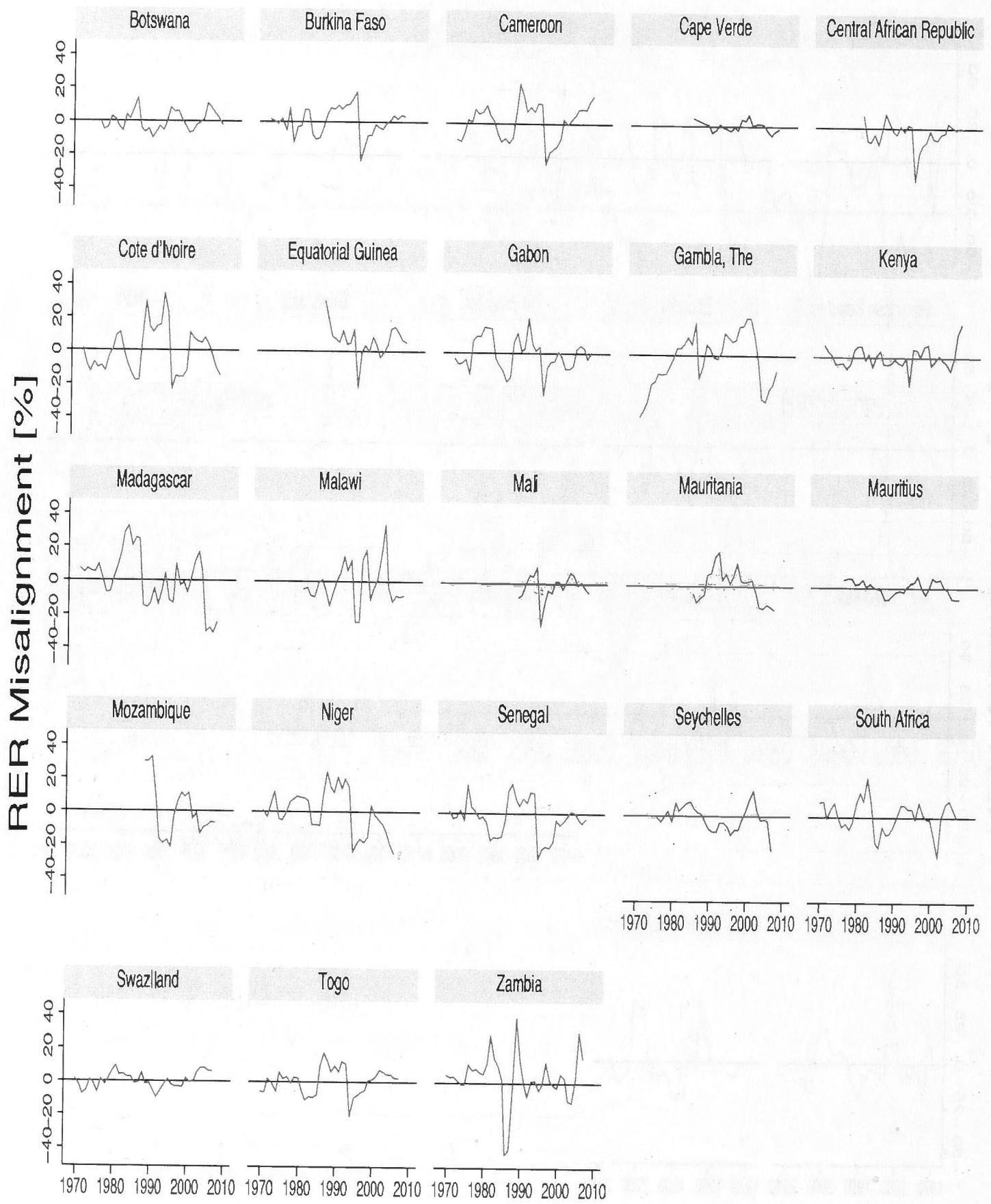


Figure 2A.1: Estimated RER misalignments (ctd.).

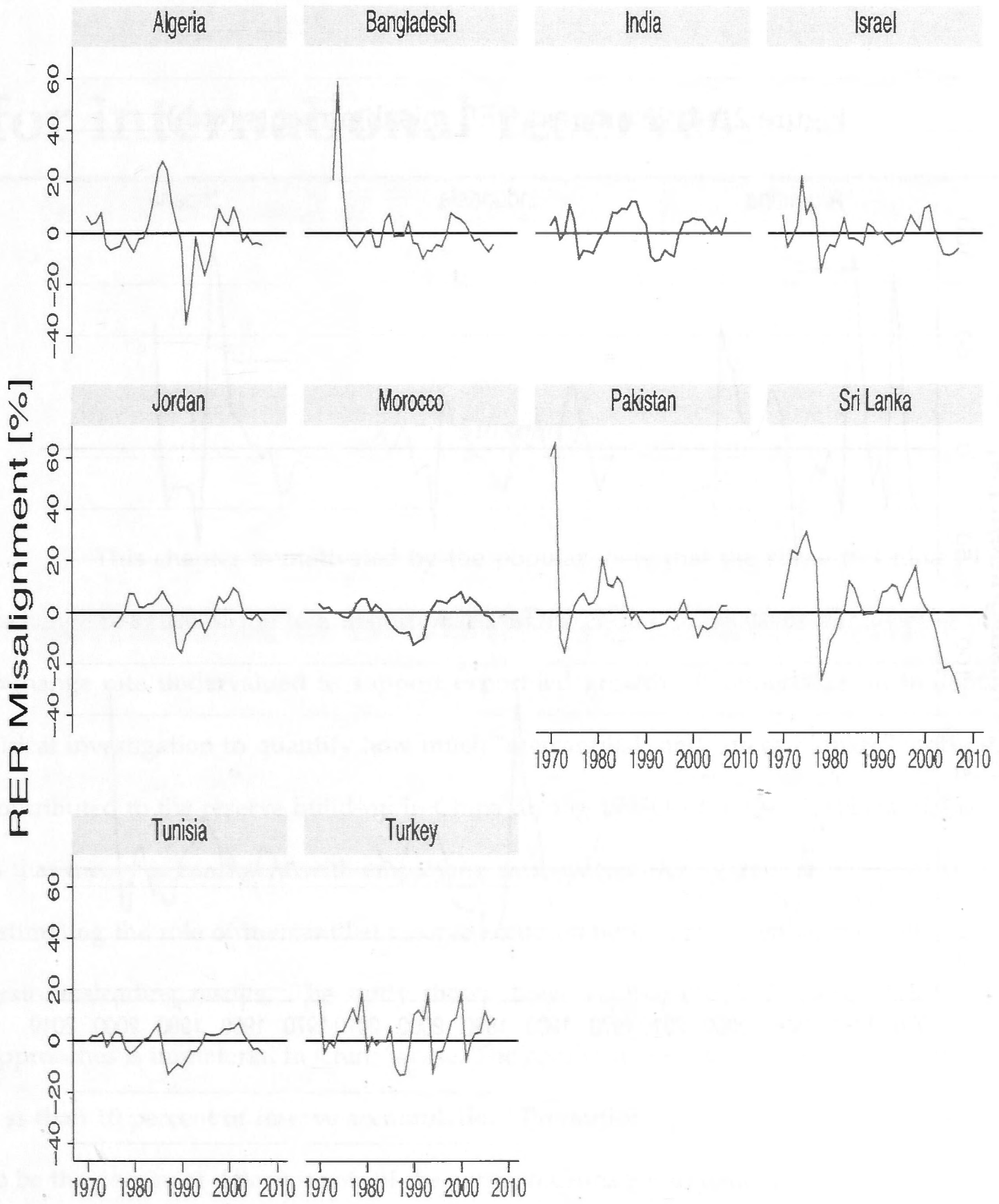
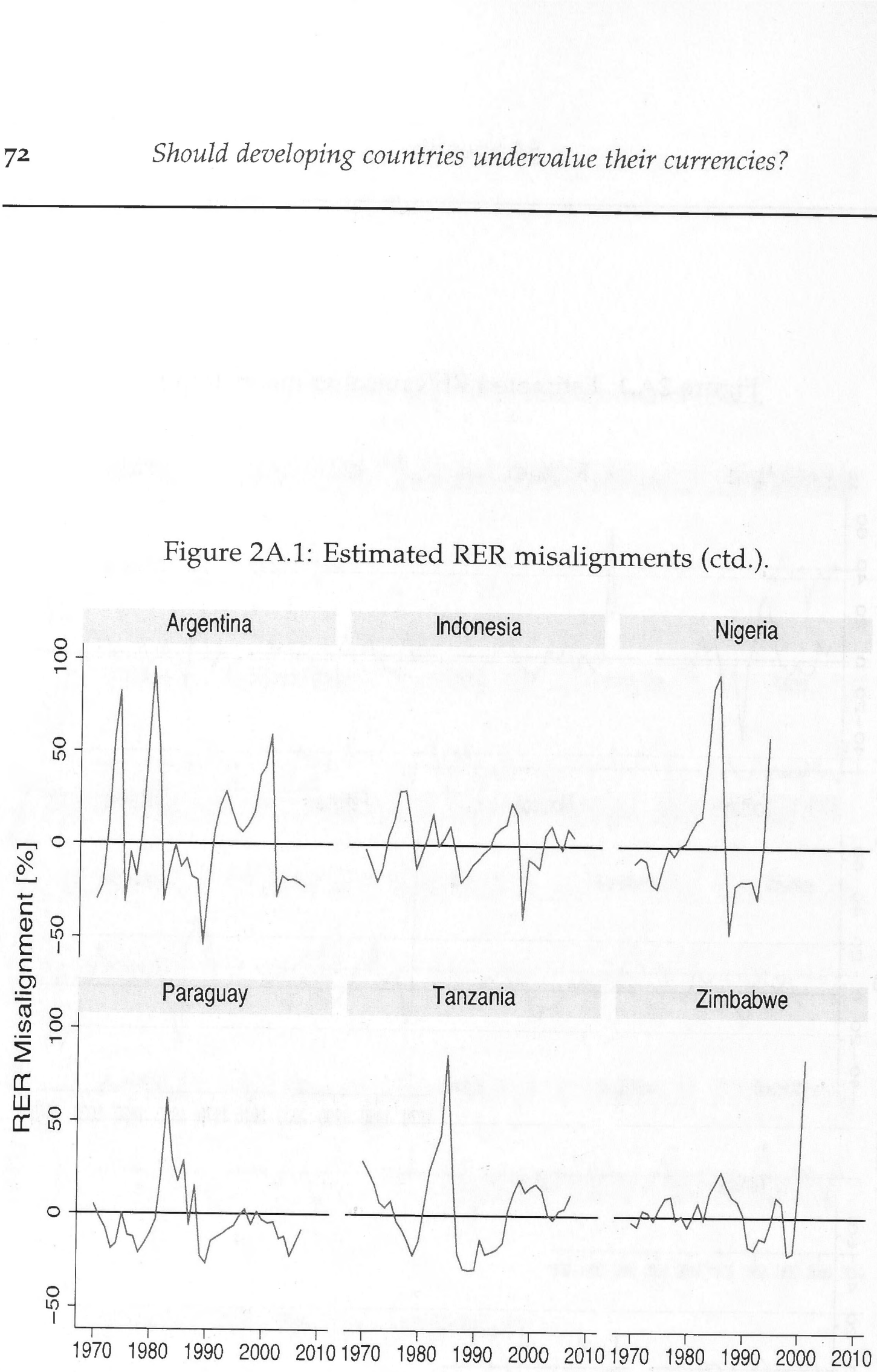


Figure 2A.1: Estimated RER misalignments (ctd.).



Chapter 3

# Mercantilism and China's hunger for international reserves


*Summary*

This chapter is motivated by the popular view that the surge in China's foreign exchange reserves is due to a distortionary exchange rate policy aimed at keeping the real exchange rate undervalued to support export-led growth. It undertakes an in-depth empirical investigation to quantify how much "mercantilist" and "precautionary" motives have contributed to the reserve build-up in China during 1998Q4-2011Q4. A substantial problem is that theory is consistent with employing two vastly differing approaches to defining and estimating the role of mercantilist reserve accumulation. *A priori,* either method could generate misleading results. The study shows, however, that the distinction between the two approaches is immaterial in China's case. The results suggest that mercantilism accounts for less than 10 percent of reserve accumulation. Precautionary motives and other factors seem to be the dominant determinants of the surge in China's international reserves.

## 3.1 Introduction

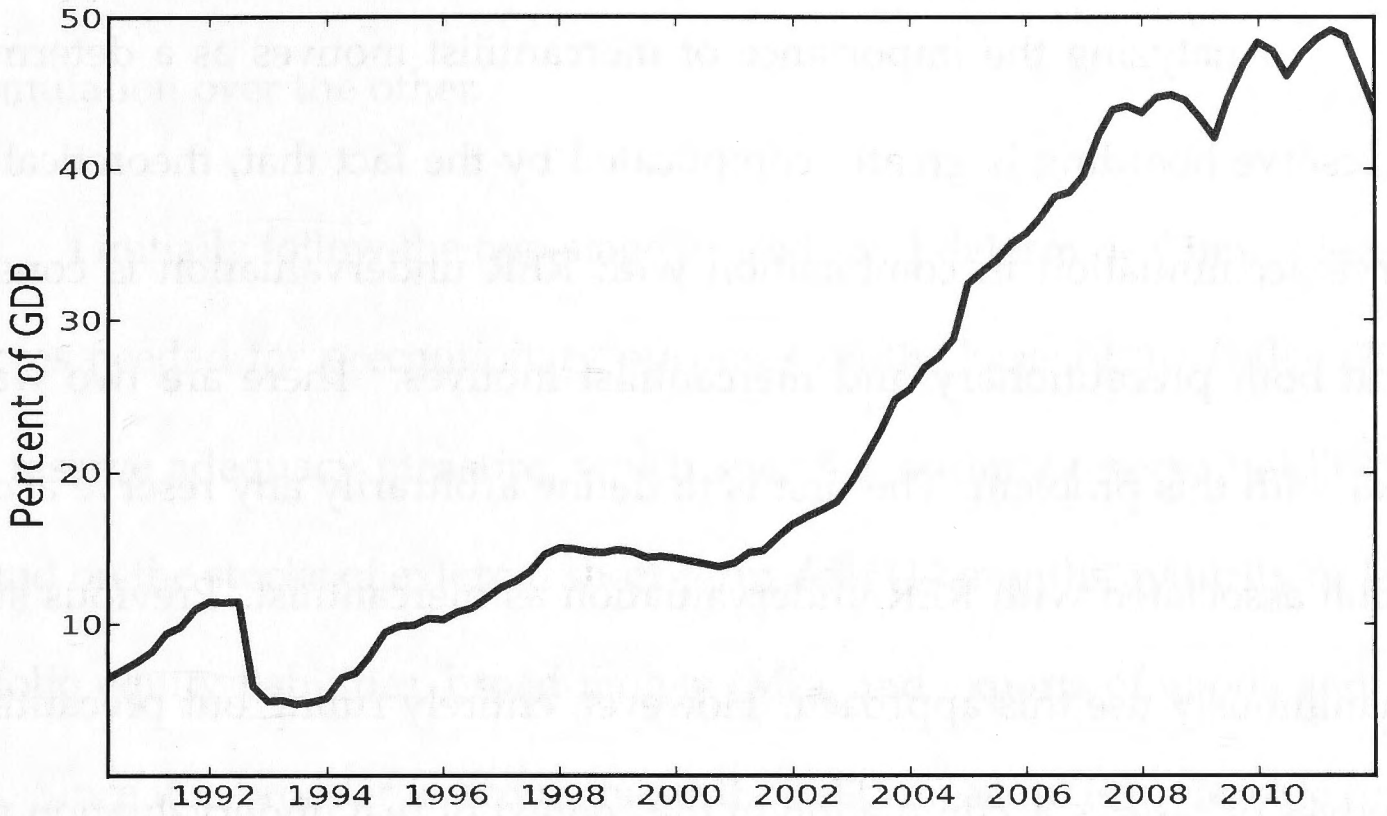
Over the past two decades, China has accumulated foreign exchange reserves at an unprecedented rate and is now by far the world's largest holder of international reserves. While still moderate at 8 percent of GDP (about US$ 30 billion) in 1990, reserve holdings since then have almost sextupled to 44 percent of GDP (about US$ 3.2 trillion) in 2011 (see Figure 3.1). In an increasingly integrated world characterized by volatile capital flows, it is prudent for emerging economies to stockpile reserves as self-insurance against Sudden Stops (Aizenman and Marion, 2003).[1] Yet the general perception is that China's reserve holdings are too large to be justified by precautionary motives. In light of the record trade surpluses and a fixed exchange rate regime, an often stated suspicion is that China accumulates reserves as part of mercantilist policies, which aim at keeping the real exchange rate (RER) undervalued in order to support export-led growth (Dooley et al., 2004). Paul Krugman (2010), for instance, accused China of "the most distortionary exchange rate policy any major nation has ever followed".[2]

The purpose of this study is to examine whether this view about China's exchange rate policy has any merit. A number of empirical papers estimate a reserve demand model for a large group of emerging economies

[1]Sudden Stop refers to the situation of a sudden downturn in capital inflows (Calvo, 1998).

[2]Paul Krugman (14 March, 2010), "Taking on China", *New York Times*, http://www.nytimes.com/2010/03/15/opinion/15krugman.html, April 29.

Figure 3.1: Stock of foreign exchange reserves, 1990-2011.




*Source:* IMF IFS statistics.

in order to analyze the relative significance of precautionary and mercantilist motives in explaining the reserve build-up in those countries (Aizenman and Lee, 2007; Delatte and Fouquau, 2012; Ghosh et al., 2012, 2014). Such cross-country studies are useful for testing the determinants of the surge in average reserve levels in emerging countries or assessing reserve adequacy of an individual economy relative to the average country experience. Howver, this approach is of dubious value for investigating how a particular factor such as mercantilism explains reserve hoarding in a peculiar country such as China, which substantially differs from the average emerging economy in terms of economic size, export performance, and the extent of reserve accumulation.

This motivates an in-depth case study of China's surge in reserves.

Analyzing the importance of mercantilist motives as a determinant of reserve hoarding is greatly complicated by the fact that, theoretically, reserve accumulation in combination with RER undervaluation is consistent with both precautionary and mercantilist motives. There are two ways to deal with this problem. The first is to define arbitrarily any reserve accumulation associated with RER undervaluation as mercantilist. Previous studies unanimously use this approach. However, entirely ruling out precautionary motives of reserve accumulation in the context of real undervaluation would naturally tend to substantially overstate the relevance of mercantilism as a determinant of the surge in China's foreign exchange reserves, especially in light of the general perception that China has undergone a long period of sustained real undervaluation.

The second option is to follow a two-stage approach: the first step assesses China's level of reserves needed for precautionary purposes. The second calculates the cumulative contribution of mercantilism to the hoarding of reserves by defining reserve accumulation in relation to RER undervaluation as mercantilist only if reserve holdings are in excess of precautionary needs. A caveat of this method is the implicit assumption that precautionary and mercantilist motives do not overlap, which could lead to overemphasizing the former over the latter. Since there is no obvious advantage between

the two approaches I adopt both with the objective of testing the sensitivity of the estimation results of favoring one definition of mercantilist reserve accumulation over the other.

I initially follow the two-stage procedure. I determine China's level of reserves needed for precautionary purposes on the basis of the IMF's (2011) new reserve adequacy measure, which specifies optimal reserve holdings to depend on the stocks of external short-term debt (12 months maturity or less), portfolio equity liabilities, broad money (M2), and exports of goods and services. Since it is broader in scope the, IMF (2011) measure is preferable to the existing "traditional" ones such as the 3-months import cover rule, 5-20 percent of broad money (M2), or the "Guidotti-Greenspan" rule.[3] The IMF considers reserve holdings in the range of 100-150 percent of its reserve adequacy measure to be adequate. In this paper, I use both bounds as cut-off points in determining reserve excessiveness for two reasons. The first is to take into account the uncertainty in assessing optimal precautionary reserve levels. The second and more important one is to minimize the danger of underestimating the mercantilist motive as a determinant of China's reserve build-up by selecting too generous a threshold of precautionary reserve needs. The analysis focuses on the period after the Asian Financial Crisis using quarterly data covering 1998Q4-2011Q4. The IMF (2011) measure suggests that reserves crossed

[3]The Guidotti-Greenspan rule recommends that reserve holdings should be the equivalent to the stock of external short-term debt, where short-term refers to a maturity of 12 months or less.

the 100 and 150 percent limit in 2002Q4 and 2005Q1, respectively.

This study uses two approaches to calculate the cumulative contribution of RER undervaluation to reserve hoarding: (1) "Back-of-the-envelope" calculations based on the available estimates of the price elasticity of import and export demand and (2) estimating a reserve demand model which explicitly takes into account the effect of real undervaluation on reserve accumulation. Both methods yield virtually the same results. To estimate RER misalignment I use the single-equation methodology (Edwards, 1989; Elbadawi, 1994; Baffes et al., 1999), which, after carefully weighing the relative merits of various approaches to measuring equilibrium real exchange rates (ERERs), I argue to be the most preferable one. My estimates suggest that China's RER underwent an undervaluation episode from 2002Q2-2008Q2, which almost perfectly coincides with the period during which reserve accumulation was the fastest (see Figure 3.1). In addition, the start date of the real undervaluation episode is only two quarters before reserves cross the IMF (2011) measure's 100 percent benchmark in 2002Q4. This suggests that the distinction between the two above approaches to measuring the quantitative importance of mercantilist policies is immaterial in the particular case of China. Finally, my RER misalignment estimates are similar to previous ones such as those of Qin and He (2011) or Gan et al. (2013) and more generally consistent with the broad consensus that the renminbi has been undervalued during most of the

2000s (Cline and Williamson, 2007).

The main results suggest that mercantilist motives contributed between US$ 200-300 billion (or less than 10 percent) to reserve accumulation in China. The exact number depends on whether reserves are deemed excessive from 2002Q4 or 2005Q1 onwards. Even when taking into account the uncertainty surrounding the estimation of the reserve demand model, the upper bound estimate still does not significantly exceed US$ 500 billion. My estimates translate into 3-7 percent of GDP and are therefore similar to the 4.5 percent of GDP figure of Ghosh et al. (2014), which further corroborates that for China, both approaches to estimating mercantilism's contribution to reserve accumulation generate similar results.[4] Nonetheless, while the above numbers are large, the central message of this paper is that they are too small to fully account for China's hoarding of reserves. The IMF's (2011) reserve adequacy measure would still indicate excessiveness, even in the absence of mercantilist motives. This means that precautionary motives and other factors seem to be the dominant determinants of the surge in China's foreign exchange reserves.

The rest of the chapter is organized as follows. Section 3.2 reviews the precautionary and mercantilist motives for reserve demand and how both are related to the real exchange rate. Section 3.3 assesses China's reserve

[4]The study of Ghosh et al. (2014) is the only preivous one that provides a China-specific estimate of mercantilism's importance in the surge in foreign exchange reserves.

adequacy levels for precautionary purposes, estimates RER misalignment, and then proceeds to undertake the "back-of-the-envelope" calculations. Section 3.4 estimates a reserve demand model for China on the basis of which I compute the cumulative contribution of mercantilism to reserve accumulation. The last section concludes.

## 3.2 Reserve accumulation and the real exchange rate

This section discusses the interplay between the current account, the real exchange rate (RER), and international reserves accumulation. It reviews the mercantilist and the precautionary motive of reserve hoarding and shows that both are consistent with RER undervaluation.

In a series of influential papers, Dooley et al. (2004, 2005) argue that the governments of East Asian countries, and China in particular, have the objective of absorbing unskilled surplus labor in the modern manufacturing sector, while simultaneously building the domestic capital stock along the way. To achieve those goals these countries follow mercantilist policies in that they deliberately undervalue their RERs to support export-led growth.

In this international system, which Dooley et al. (2004) refer to as "Bretton Woods II", the authorities fix the nominal exchange rate to the US dollar such that the RER is undervalued relative to its equilibrium value.

In the absence of intervention, the usual adjustment process would be that the excess supply of foreign exchange, (triggered not only by the increase in exports but potentially also by additional net capital inflows), generates appreciation pressure on the nominal exchange rate. Yet the authorities can interfere with the latter process through reserve accumulation and by imposing capital controls, thereby resisting appreciation of the nominal exchange rate. In addition, since international reserves add to the monetary base, the resulting inflationary effect needs to be sterilized by selling bonds domestically. Therefore, another important ingredient of the policy mix is financial repression, which keeps the fiscal costs of sterilization manageable. As a result, China displays large current account surpluses, rapid international reserve accumulation, and an undervalued RER.

However, reserve accumulation need not necessarily be the outcome of mercantilist policies. A country may increase the stock of international reserves as a precautionary measure to face a sudden exodus of volatile capital triggered by various external shocks such as a currency crisis. Indeed, the string of financial crises in the 1990s has brought the issue of costly sudden exodus into the spotlight (Radelet and Sachs, 1998; Calvo, 1998). Indonesia's output for instance contracted by 15 percent of GDP during the Asian Financial Crisis of 1997/98. There is empirical evidence that emerging countries, especially those in East Asia, have begun to stockpile international reserves

based on the bitter lessons of the 1997/98 financial crisis to insure themselves against both current and capital account shocks (Aizenman and Marion, 2003; Aizenman and Lee, 2007; Obstfeld et al., 2010; Ghosh et al., 2012, 2014).

If a country decides to accumulate international reserves for precautionary purposes, undervaluation in the RER could well be an unintended side effect. In theory, an improvement in the net foreign asset position, brought about by foreign reserve purchases, usually appreciates the equilibrium real exchange rate (ERER). Reserve accumulation is thus associated with real undervaluation. Durdu et al. (2009) formalize the latter notion in their model in which emerging economies go through sustained episodes of reserve accumulation in the face of financial globalization and Sudden Stop risk. In their framework, these periods are characterized by persistent current account surpluses and real undervaluation. The authors note that:

*"[T]he current account surplus and undervalued real exchange rate are by-products of the buildup of precautionary savings in the aftermath of Sudden Stops, or following financial globalization. They do not require intentional exchange rate management by central banks."* (Durdu et al., 2009, p.207).

Reserve accumulation in combination with RER undervaluation is not mercantilist in this case since the authorities' underlying objective is not to boost exports via the RER.[5] In addition, mercantilist policies are defined as

[5]Ghosh et al. (2014) note that this might be a possibility but they do not further investigate the issue.

the deliberate undervaluing of the RER. In contrast, real undervaluation in the context of precautionary reserve accumulation is an unintended consequence of which the authorities may or may not be aware.

A number of studies attempt to analyze empirically whether reserve accumulation in emerging economies is dominated by the precautionary or mercantilist motive (Aizenman and Lee, 2007; Delatte and Fouquau, 2012; Ghosh et al., 2012, 2014). The approach of these papers is to estimate reserve demand for a large number of countries as a function of indicators of current and capital account shocks. The demand function also includes some estimate of RER undervaluation as a measure for mercantilist motives. If there is a positive association between reserve accumulation and the extent of real undervaluation, then this is taken as suggestive evidence of deliberate foreign exchange market intervention to keep the RER undervalued as part of a mercantilist growth strategy (Aizenman and Lee, 2007; Delatte and Fouquau, 2012; Ghosh et al., 2012, 2014). Yet the latter inference is only correct if we are willing to assume that reserve accumulation in combination with an undervalued RER is always mercantilist and never precautionary. This is an overly restrictive assumption, which may bias the results towards giving mercantilism as a determinant of the surge in China's foreign exchange reserves too much importance. This concern is especially relevant in China's case, given the widespread view that the country's RER has been persistently underval-

ued.

Another approach to analyzing the role of mercantilism in China's reserve build-up is to follow a two-stage procedure: the first step assesses China's level of reserves needed for precautionary purposes. The second calculates the cumulative contribution of mercantilist motives by defining reserve accumulation in relation to RER undervaluation as mercantilist only if reserve holdings are in excess of precautionary needs. A major problem with this method is the implicit assumption that precautionary and mercantilist motives are never simultaneously at play. This does not seem to be realistic and may result in overemphasizing the precautionary motive.

Without knowing the Chinese authorities' true motivations for accumulating reserves, neither of the two approaches dominates the other.[6] For lack of a better choice, in this paper I use both approaches with the intention to examine the sensitivity of the estimation results to choosing one definition of mercantilism over the other. I first follow the two-stage procedure.

[6]From a Chinese point of view, the concerns associated with nominal exchange rate revaluation are a significant loss in employment in export-linked industries and an increase in speculative capital flows (Gang, 2008). Notice that these concerns do not directly imply a mercantilist motive of reserve accumulation. Pursuing export-led growth and employment creation in the tradable sector does not require an undervaluation in the RER, as highlighted by Williamson (1990).

## 3.3 Reserve adequacy

This section assesses China's level of reserves needed for precautionary motives. There are several measures of reserve adequacy. A widely used rule-of-thumb for optimal reserve holdings says that the latter should be equivalent to the value of three months of imports. However, this metric does not incorporate a country's exposure to volatile capital flows and seems therefore inappropriate for assessing reserve adequacy during an era of financial globalization (Athukorala and Warr, 2002).[7]

The "Guidotti-Greenspan" rule (GGR) recommends that reserves should not fall below the amount of external short-term debt, where short-term debt is defined as all obligations maturing within 12 months. The idea behind this is that emerging countries should hold enough reserve coverage to withstand a Sudden Stop of short-term capital. In light of its focus on Sudden Stop risk, GGR seems a more appropriate measure of reserve adequacy than the three-months import cover rule. Nonetheless, since China is becoming ever more financially integrated with the rest of the world, an important caveat of GGR is that in its assessment it leaves out other "mobile capital" such as portfolio equity liabilities (Athukorala and Warr, 2002). [8] Finally, the IMF (2011) notes

[7]The import coverage rule dates back to the time of Bretton Woods when a loss of trade credit for three-months was perceived to be the worst possible current account shock (Athukorala, 2014).

[8]Similarly when it comes to the rule-of-thumb that reserve holdings should be equivalent to three months worth of imports.

that the 12 month benchmark of GGR is *ad hoc* since the duration of a crisis or a Sudden Stop of short-term capital may both last significantly longer or less than 12 months. In any case, notice that reserves in China have historically surpassed the short-term debt stock several-fold, even in the 1980s (Figure not shown). This suggests that Chinese authorities have not given short-term debt holdings much emphasis in assessing reserve adequacy.

The reserve adequacy measures discussed so far ignore the possibility that during a crisis foreigners who had invested in financial assets in the country, along with domestic deposit holders who look for a "safe haven", are putting pressure on foreign exchange reserves (Obstfeld et al., 2010). The third conventional measure builds on this latter idea by recommending to central banks that they should hold reserves to the equivalent of 5-20 percent of broad money (M2).

The major shortcomings of the reserve adequacy measures is that they are arbitrary and based on only one particular source of balance of payment pressure. This motivated the IMF (2011) to develop a new measure of reserve adequacy that is based on previous experiences of emerging countries during crisis episodes. It identifes four factors that capture various sources of risk for balance of payments pressures, which are a combination of the ones discussed above: (1) a loss in export earnings due to an adverse terms of trade shock, (2) short-term debt (12 months maturity), (3) medium and long-term debt

and portfolio equity liabilities, and (4) broad money (M2). For countries with a fixed exchange rate regime such as China, the IMF (2011) proposes the following rule-of-thumb metric for adequate international reserve holdings at time $t$:

$$R_t^* = 0.3\,STD_t + 0.15PDL_t + 0.1M2_t + 0.1X_t. \tag{3.1}$$

In this equation, the weights are based on the 10th percentile of respective outflows during balance of payment pressure events (IMF, 2011). The definitions of the variables are as follows:

- $R^*$: adequate stock of foreign exchange reserves by the precautionary motive,
- STD: the stock of short-term debt (12 months maturity or less),
- PDL: gross portfolio equity liabilities, and
- X: exports of goods and services (over 12 months).

Based on the above measure, I construct a reserve adequacy index (RAI). The RAI is defined as as the ratio of actual reserves (R) to the adequate stock of reserves needed for precautionary reasons ($R^*$):

$$RAI_t = \frac{R_t}{R_t^*}100\%. \tag{3.2}$$

To assess the level of reserves needed for precautionary purposes, my analysis relies solely on the RAI rather than the other discussed reserve adequacy measures.

Since R* is a "round number" there is considerable scope when assessing reserve adequacy. The IMF (2011) considers values for the $RAI_t$ within the range 100-150 percent as optimal. In this paper I consider both bounds as reserve adequacy thresholds, to take into account the uncertainty in determining the optimal level of reserve holdings needed for precautionary purposes. More importantly, the practice of also using the lower limit of 100 percent substantially reduces the probability of underestimating mercantilism's contribution to reserve accumulation. This will therefore result in an upper and lower bound estimate of mercantilism's contribution to reserve accumulation.

### 3.3.1 Data

The data on international reserve holdings, broad money (M2), and the value of both imports and exports come from the IMF's International Financial Statistics (IFS) data base. Each of these time series is measured at quarterly frequency. I source the data on portfolio equity liability from the External Wealth of Nations mark II (EWNII) database developed by Lane and Milesi-Ferretti (2007). Observations on the stock of short-term external debt (12 months maturity or less) come from the World Bank's International Debt

Statistics databank. To transform the data series of short-term debt and portfolio equity liabilities from annual to quarterly frequency I use the cubic spline interpolation method.

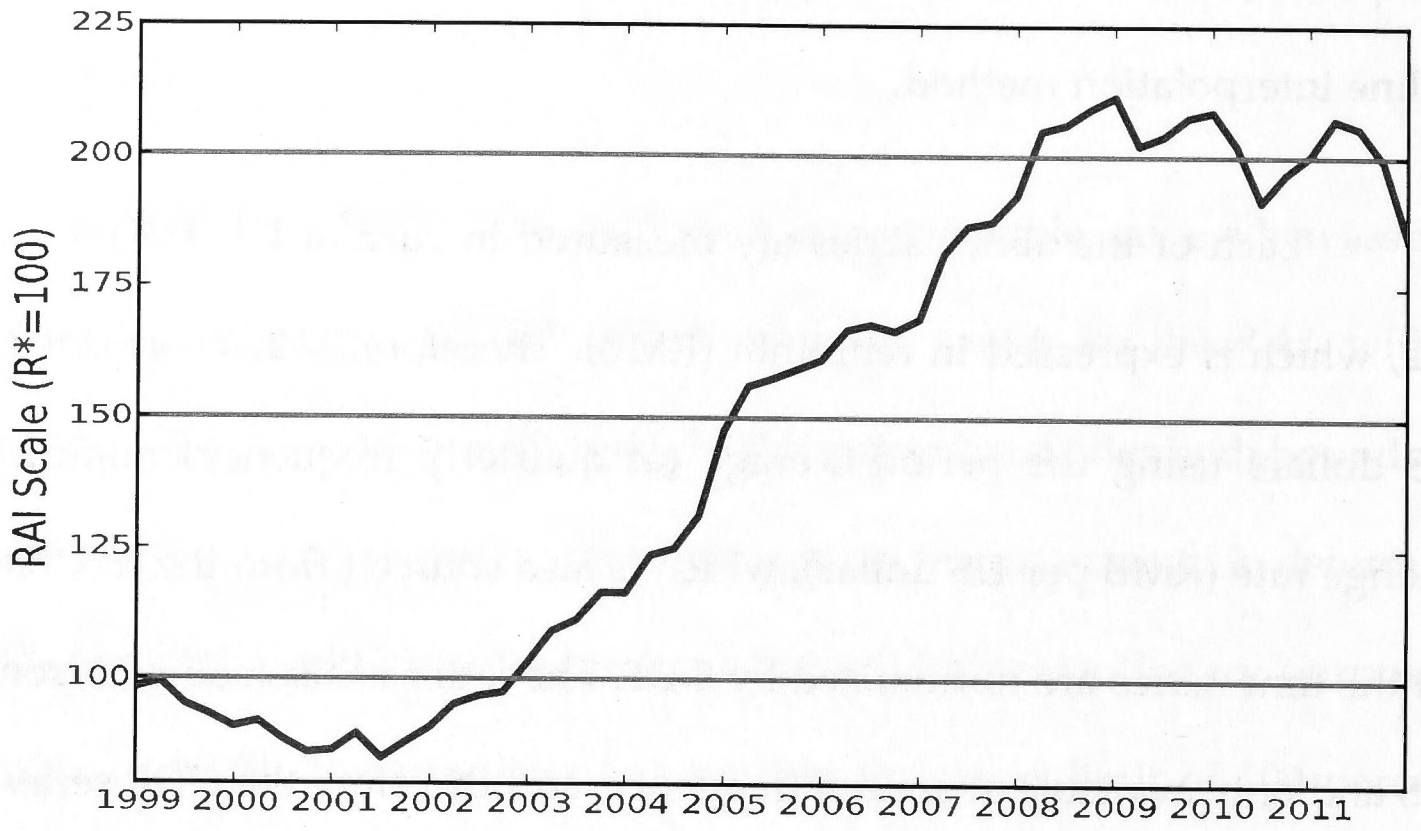
Each of the above series are measured in current US dollars, except M2, which is expressed in renminbi (RMB). Therefore, M2 is converted into US dollars using the period-average (at quarterly frequency) nominal exchange rate (RMB per US dollar), which is also sourced from the IFS. Finally, all the time series are normalized by GDP. The latter is also sourced from the IFS and only available at annual frequency, and therefore the GDP series also needed to be interpolated before normalizing.

The sample period is dictated by data availability of M2 at quarterly frequency, which only starts in 1998Q4. This is not a caveat, however, since the focus of this paper is on China's reserve build-up post the Asian Financial Crisis in 1997. Since the EWNII database ends in 2011 the end of the sample period is 2011Q4.

### 3.3.2 Evolution of the reserve adequacy index

Figure 3.2 plots the RAI over the sample period (1998Q4-2011Q4). An RAI of below 100 percent indicates a reserve inadequacy based on precautionary needs, adequacy within the range 100-150 percent, and excessiveness beyond

Figure 3.2: Reserve adequacy index (RAI), 1998Q4-2011Q4.




*Source:* Compiled from IMF IFS statistics and Lane and Milesi-Ferretti (2007).

this range (IMF, 2011). To better highlight these cut-off points, Figure 3.2 adds horizontal lines at 100, 150, and 200 percent.

In the period after the Asian Financial Crisis, the index has never been significantly below 100 percent, with the sole exception of when it was 85 percent in 2001Q2. From then, the RAI increased sharply between 2002 and 2008, the years when Chinese reserve accumulation was the fastest (see Figure 3.1). Reserve levels exceeded the 100 percent mark in 2002Q4 and the 150 percent threshold in the first quarter of 2005. Between 2008Q1 and 2011Q4 the index stabilized at around 200 percent, despite the accumulation of a staggering US$ 1.5 trillion in reserves during that period. Thus, solely

using the RAI conceals the astounding magnitudes involved in this analysis. For instance, in 2011Q4, the RAI at 100 and 150 percent translates into US$ 1.7 and US$ 2.6 trillion, respectively.

In terms of assessing reserve adequacy, the RAI suggests that China's reserves were slightly below the level needed for precautionary purposes up until the end of 2002. Reserves were then within the "adequacy range" between 2002Q4 and 2004Q4. They became excessive by 2005Q1 at the latest.[9] Consequently, the cut-off dates for indicating reserve excessiveness are both 2002Q4 and 2005Q1.

### 3.3.3 Estimating RER misalignment

The next step in assessing the importance of the mercantilist motive is to quantify how much real undervaluation has contributed to reserve accumulation during the quarters in which reserves are judged excessive by the RAI.[10]

[9]Figure 3A.1 in the Appendix plots the Guidotti-Greenspan rule and 20 percent of M2 (20M2) together with the stock of international reserves (each expressed as GDP ratios). From the figure it is immediately noticeable that Chinese reserve holdings grossly exceed the stock of short-term external debt by several multiples, as mentioned earlier. 20M2 consistently exceeded the stock of international reserves up until the end of 2004. Reserve holdings surpass 20M2 in 2005Q1, which is the same date when RAI exceeds the 150 percent mark. This thus suggests that the chosen cut-off dates are not sensitive to using the RAI.

[10]Notice that it would not be appropriate to define the quantity of foreign exchange market intervention as the difference between actual and adequate reserve holdings (R-R$^*$) and interpret the resulting number as indicative of the mercantilist motive. Even though the authorities keep the RMB-value to the US dollar fixed through foreign exchange market interventions, this does not necessarily imply that the RER is undervalued (cf. Corden (2009) in a different but similar context). There are other factors, mostly exogenous to the policy makers' influence, which contribute to reserve accumulation.

Since RER undervaluation is unobserved it needs to be estimated. However, obtaining reliable RER misalignment estimates is a nontrivial task in the process.

There is a large variety of methods for estimating RER distortions: purchasing power parity adjusted for the Balassa-Samuelson effect (PPP-A); the single equation approach (SEA) using individual-country or panel data; and the macroeconomic balance (MB) methodology. Cline and Williamson (2007) review 18 recent papers that estimate the ERER for China and conclude that the RER misalignment results are highly sensitive to the method used.

None of the approaches is strictly preferable over the other. Each method has its advantages and disadvantages, but for some the latter dominate. The problem with the PPP-A and MB approaches is that they often do not generate consistent misalignment estimates across different papers. Cheung (2012), for instance, shows that PPP-A distortion estimates are sensitive to revisions in China's output and national price level data to the extent that, when also controlling for serial correlation, the previously 2004 undervaluation estimate of 53 percent turns into a 13 percent overvaluation.

In addition,the misalignment literature typically follows Nurkse (1945) and defines the ERER as the value of the RER, which leads to external and internal balances, given all relevant variables at their sustainable values. Consequently, Cline and Williamson (2007) question the usefulness of the PPP-A

approach as an equilibrium exchange rate concept since a number of historical examples show that RER deviations from the PPP-A equilibrium may coincide with external and internal balances.

The greatest strength of the MB methodology is how well it incorporates the concepts of internal and external equilibriums. But on balance, the MB framework is very limited due to its sensitivity.[11] The MB approach uses a two step procedure to determine the ERER. The first step specifies a current account "norm", either in an *ad hoc* fashion, or empirically estimated as a function of a set of macroeconomic fundamentals. The second step uses trade elasticities to calculate RER misalignment as the depreciation or revaluation required to close the gap between the actual and "norm" current account. The fundamental problem of the MB approach, especially in the context of China, is that there is no consensus on either the current account norm or the trade elasticities. Schnatz (2011) shows that even small changes in either the current account norm or trade elasticities can substantially affect the RER distortion estimates.

The single-equation methodology also includes the cornerstones of external and internal balances but, unlike the MB approach, does not require intermediate estimation steps, and this decreases the sensitivity of the misalignment results substantially. Indeed, Qin and He (2011), Peng et al. (2008),

[11] For a detailed discussion about the limitations of the MB approach, see Schnatz (2011).

and Gan et al. (2013) estimate RER misalignment for China and their results are similar, despite differences in data sources, estimation methods, and sample periods. However, the single-equation approach is flawed when pooled panel regressions are used to estimate ERERs because by doing so the implicit assumption is homogeneity in cross-country long-run RER behavior, and this is incompatible with the theory of RER misalignment (see Chapter 2 for more details). Therefore, in what follows, I estimate the ERER for China individually. I use the same estimation procedure as in Chapter 2, which I briefly summarize here again. I discuss potential caveats along the way.

The starting point of the single-equation approach is Nurkse's (1945) definition, which suggests that the ERER is determined by a set of macroeconomic fundamentals. Following Edwards (1989), Montiel (1999b), and Faruqee (1995) the ERER depends on the following variables:

$$ERER = ERER(\underset{(+/-)}{TOT}, \underset{(+)}{\phi}, \underset{(-)}{\zeta}, \underset{(-)}{G_N}, \underset{(+)}{G_T}, \underset{(+/-)}{I}, \underset{(+/-)}{NFA}), \tag{3.3}$$

where $TOT$ refers to the terms of trade, $\phi$ is a measure of trade policy, $\zeta$ captures productivity differentials (Balassa-Samuelson effect), $G_N$ and $G_T$ are government consumption on nontradables and tradables, $I$ refers to investment, and $NFA$ to the net foreign asset position. The signs of the partial derivatives appear below.

According to the single equation approach, in a first step, the long-run equilibrium relationship between the ERER and its fundamentals is estimated using the empirical equivalent of the equation above:

$$ln\ RER_t = \beta' F_t + v_t, \tag{3.4}$$

where $F$ is the vector of the set of fundamentals, $\beta$ describes the long-run relationship between RER and the fundamentals, and $v_t$ is a stationary mean zero error term.

The second step requires the computation of sustainable values of those fundamentals that form a long-run relationship with the actual RER in order to calculate the ERER:

$$ln\ ERER_t = \beta' F_t^S, \tag{3.5}$$

where superscript $S$ indicate the fundamentals at their sustainable values.

In a third and final step the degree of misalignment ($mis_t$) is calculated:

$$mis_t = \frac{RER_t - ERER_t}{RER_t}, \tag{3.6}$$

where positive values of $mis_t$ indicates overvaluation in RER.

**Data** The data sources and definitions are exactly the same as in Chapter 2, with the only difference being that the IFS is the source of the observations on RER. Furthermore, the IMF measures the RER as $RER = P_N / E\,P_T$, where $P_N$, $P_T$, and $E$ refer to the price of nontradables, tradables, and the nominal exchange rate, respectively. This means that appreciation is associated with an increase in RER. Due to data constraints, the ERER needs to be estimated using annual data so that cubic spline interpolation methods are required to obtain observations of the ERER at quarterly frequency. Quarterly data on RER are, however, available in the IFS database. The sample period is entirely determined by the EWNII database. In the case of China, observations on the net foreign asset position are available over the thirty year period 1981-2011.

**Estimation method** Most macroeconomic series are nonstationary in levels and require at least one differencing operation to produce a stationary process, i.e. they are integrated of order $d$ (I($d$), $d > 0$). The possible presence of I($d$) variables on both sides may introduce the problem of a spurious regression (Granger and Newbold, 1974). Therefore, I first determine the order of integration of the RER and the fundamentals using Augmented Dickey-Fuller (ADF) tests. The test results for the variables in levels and first difference are reported in Table 3.1. For each of the fundamentals, the null hypothesis that the series contains a unit root can never be rejected at conventional levels. The RER is also treated as nonstationary, even though the null can be rejected

Table 3.1: RER fundamentals: Unit root tests.

*Panel A: Variables in levels*

| | Test Eq. Includes | Test Statistic | P-Value |
|---|---|---|---|
| Real Exchange Rate (RER) | Constant | -2.8 | 0.07 |
| Terms of Trade (TOT) | None | -1.6 | 0.10 |
| Trade Openness (OPEN) | Constant & Trend | -3.1 | 0.13 |
| Productivity of Tradable Production (PROD) | Constant | 5.7 | 1.00 |
| Government Consumption (GEXP) | Constant | -2.2 | 0.22 |
| Net Foreign Asset Position (NFA) | Constant | 0.0 | 0.68 |
| Investment (INV) | None | 1.2 | 0.94 |

*Panel B: Variables in first differences*

| | Test Eq. Includes | Test Statistic | P-Value |
|---|---|---|---|
| Real Exchange Rate (RER) | None | -4.1 | 0.00 |
| Terms of Trade (TOT) | None | -5.1 | 0.00 |
| Trade Openness (OPEN) | None | -4.0 | 0.00 |
| Productivity of Tradable Production (PROD) | None | 2.6 | 1.00 |
| Government Consumption (GEXP) | None | -4.6 | 0.00 |
| Net Foreign Asset Position (NFA) | None | -3.8 | 0.00 |
| Investment (INV) | None | -4.6 | 0.00 |

Notes: This table reports the ADF-test statistic under the null hypothesis that the series is nonstationary. Sample period: 1981-2011.

at the 10 percent level. The first differences of all variables are stationary, except for the proxy for productivity growth of tradable production (PROD, measured as the ratio of China's GDP per capita to the OECD average GDP per capita). Therefore, PROD is treated as I(2). I use first differences of this proxy in a regression setting.

The next task is to estimate $\beta$, the parameters describing the long-run relationship between the RER and fundamentals. My preferred estimation method is the dynamic OLS (DOLS) estimator (Phillips and Loretan, 1991; Saikkonen, 1991; Stock and Watson, 1993), which is an augmentation of the static OLS estimator with leads and lags of first differenced independent

nonstationary variables. The optimal number of leads and lags are best chosen such that the information criteria are minimized (Kejriwal and Perron, 2008). In the estimation of the cointegrating regression there is no asymptotic bias arising from simultaneous equations or measurement error (Phillips and Durlauf, 1986). Another important feature is that DOLS performs well in small samples (Stock and Watson, 1993; Montalvo, 1995).

Augmenting Eq. 3.4 with $m_1$ leads and $m_2$ yields:

$$ln\ RER_t = \beta' F_t + \sum_{s=-m_2}^{s=m_1} \gamma_s' \Delta F_{t+s} + \nu_t, \tag{3.7}$$

where vector $F$ contains the fundamentals.

Finally, I test for cointegration and stability of the estimated long-run parameters using the ADF-cointegration test for the former and the $L_c$-test as developed by Hansen (1992) for the latter. A substantial problem when it comes to estimating the ERER is that it is not unusual to find various subsets of fundamentals explaining long-run RER behavior. Since theory offers little guidance on this issue, for lack of better alternatives, I use the same selection algorithm as in Chapter 2. In particular, I choose the specification which includes the largest number of fundamentals. Additional requirements are that the variables are cointegrated, the estimated parameters stable, and the signs of the coefficients attached to the fundamentals should be consistent

with theory as shown in Eq. 3.3.

Following this procedure, the estimated long-run equilibrium relationship is:

$$ln\ RER_t = \underset{(0.005)}{0.05}\, NFA + \underset{(0.01)}{0.40}\, GEXP - \underset{(0.003)}{0.03}\, OPEN, \tag{3.8}$$

Observations: 30 ADF (p-value): 0.00 $L_c$ : 0.55.

An improvement in the NFA is associated with ERER appreciation, consistent with Eq. 3.3 and the discussion in Section 3.2. The other fundamentals that matter for ERER determination over the long run in the Chinese case are government consumption and trade openness. An increase in government consumption appreciates the ERER, whereas greater trade openness (proxied as total trade over GDP) leads to ERER depreciation; this is consistent with the underlying theory of ERER determination. Finally, ADF and $L_c$ tests suggest that the requirements of cointegration and parameter stability are satisfied.

To derive sustainable values of the fundamentals I use the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997), setting the smoothing parameter at $\lambda = 100$. The HP-filter decomposes a series into trend and cyclical components. Since the three fundamentals (NFA, GEXP, and OPEN) that describe China's long-run RER movements are nonstationary, movements in

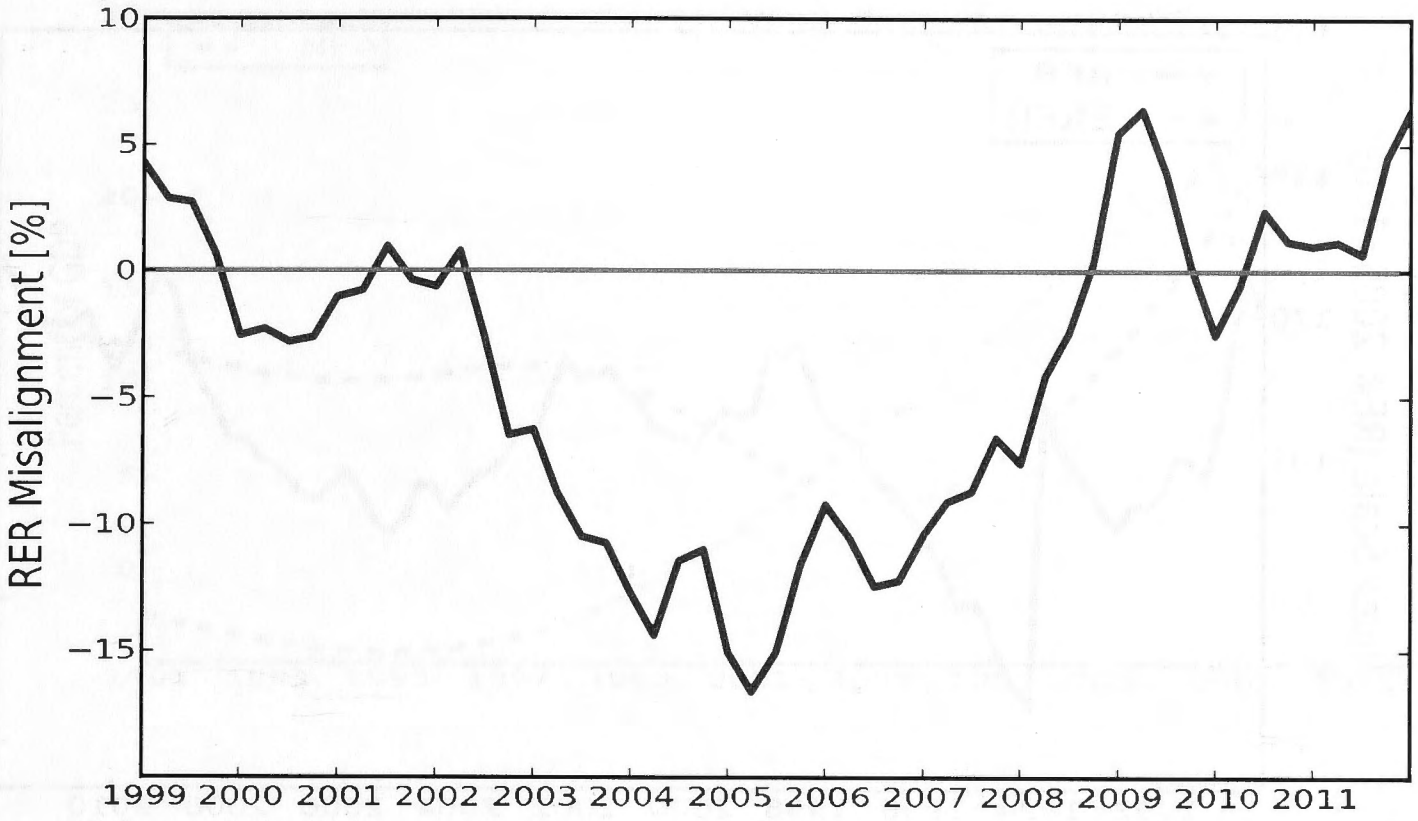
their respective trend components are permanent and therefore used to calculate the ERER given by $\hat{\beta}' F_t^S$.

**Results** Figure 3.3 plots the RER misalignment estimates over the sample period 1998Q4-2011Q4. In the late 1990s the RER was overvalued by about 10 percent, and subsequently hovered around its equilibrium value until the beginning of 2002, before entering a long episode of undervaluation in 2002Q2. The degree of undervaluation was increasing at first and culminated in the first quarter of 2005 at 16.5 percent. From then onwards the RER slowly reverted back to equilibrium. 2008Q2 marks the end of the undervaluation episode, which suggests that mercantilist motives of reserve hoarding only played a role until then. Interestingly, my estimates suggest that the start and end dates of the RER undervaluation and reserve accumulation episodes coincide almost perfectly (cf. Figures 3.1 and 3.2).

Of great importance for this study is the finding that the real undervaluation episode only starts two quarters before the RAI crosses the 100 percent threshold in 2002Q4. This suggests that the two earlier discussed approaches to measuring the contribution of mercantilist motives to reserve accumulation generate very similar results in China's particular case.[12] This finding therefore alleviates the concern that favoring one approach over the

[12]For convenience, in the following analysis I disregard any effect on reserve accumulation that stems from RER undervaluation during the two quarters before 2002Q4. This decision does, however, not affect any of the results in this paper since the RER was only marginally undervalued at the beginning of the episode.

Figure 3.3: RER misalignment, 1998Q4-2011Q4.

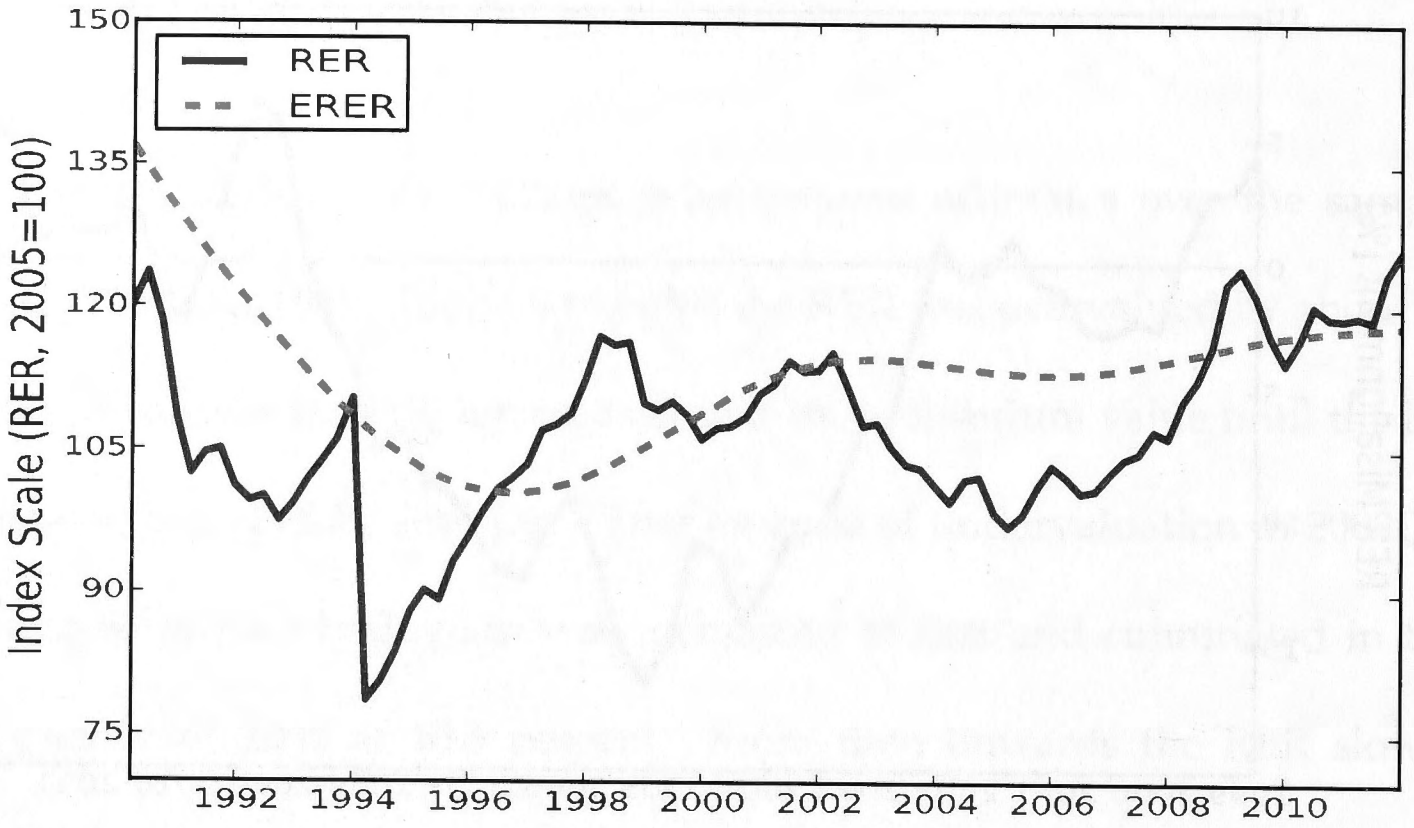



Note: Positive (negative) values refer to RER overvaluation (undervaluation).

other may result in misleading inferences regarding the relative importance of mercantilist versus precautionary motives of reserve accumulation.

It is worthwhile investigating the driving forces behind the misalignment estimates. Figure 3.4 plots the ERER together with the actual RER at quarterly frequency over 1990-2011. The ERER appreciated slowly from the mid 1990s until 2000, but has remained virtually unchanged since then. Figure 3.5 plots the ERER fundamentals: NFA, government consumption, and trade openness at sustainable values. Since the mid 1990s there has been a steady improvement in the NFA. Since 2000, the associated ERER appreciation with the latter development is, however, entirely counteracted by China's

Figure 3.4: RER and ERER, 1990Q1-2011Q4.

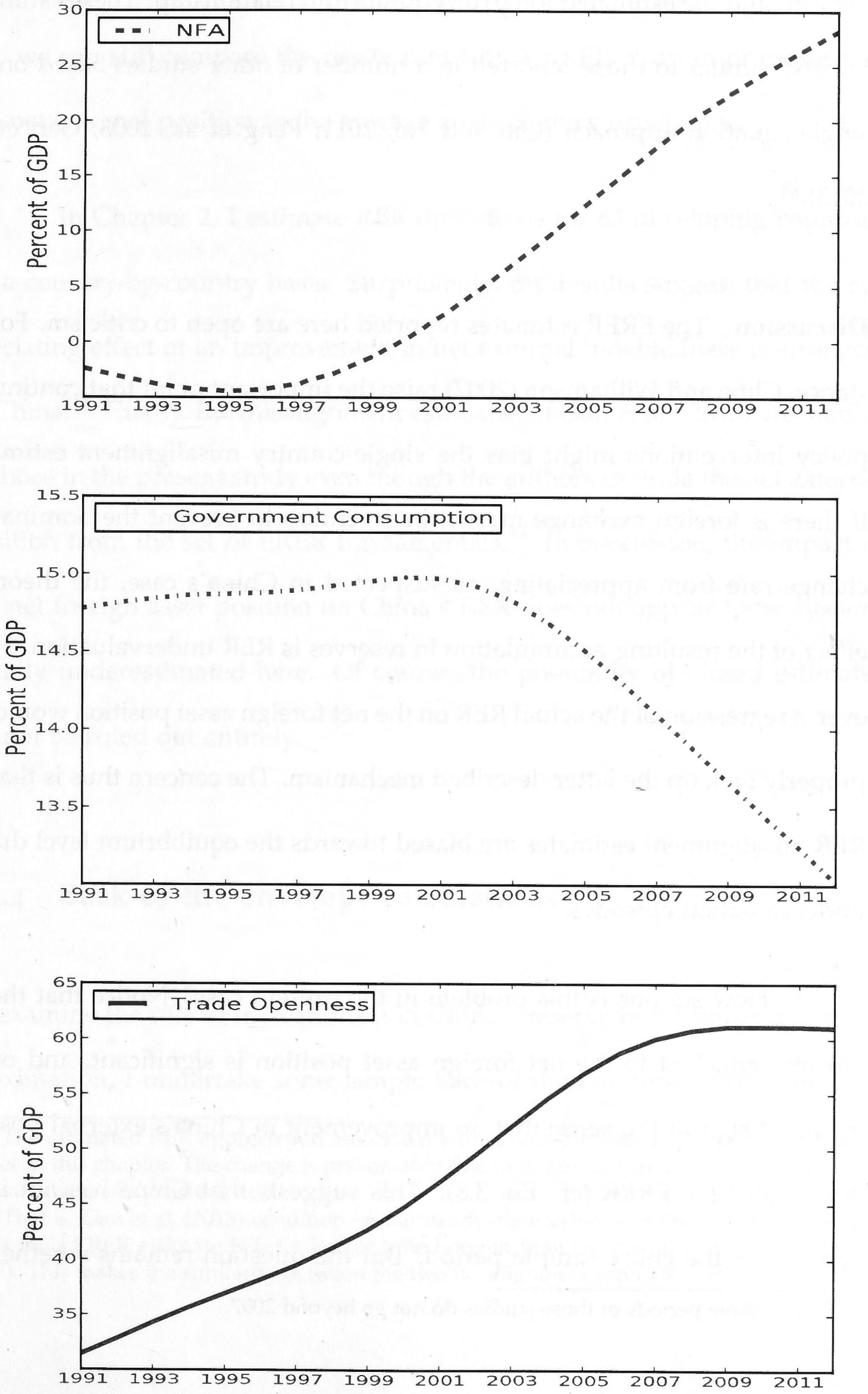



Note: An increase in RER and ERER indicates appreciation. Therefore, ERER>RER denotes real undervaluation.

move towards greater trade openness and the decline in government consumption. It is thus highly misleading to infer a large RMB undervaluation on the basis of China's rapid accumulation of foreign assets alone. The undervaluation episode was thus the result of the RER depreciation between 2002 and 2005, which was due to the US dollar losing its value relative to the currencies of China's trading partners, in particular the Euro. Between 2005 and 2009, China's RER appreciated by 28 percent due to a combination of RMB appreciation vis-à-vis the US dollar and a surge in the inflation rate, which eventually brought the real undervaluation episode to an end.

Finally, interestingly, these estimates of RER misalignment are similar

Figure 3.5: ERER fundamentals (sustainable values), 1990-2011.




Note: The sustainable values of the fundamentals are derived using the Hodrick and Prescott (1997) (HP) filter.

to the ones obtained in Chapter 2, despite differences in the measurement of the RER and the estimated long-run equilibrium relationship. These estimates are also similar to those reported in a number of other studies based on the single-equation approach (Qin and He, 2011; Peng et al., 2008; Gan et al., 2013).[13]

**Discussion** The ERER estimates reported here are open to criticism. For instance, Cline and Williamson (2007) raise the important point that continuous policy interventions might bias the single-country misalignment estimates. If there is foreign exchange market intervention to prevent the nominal exchange rate from appreciating, as suspected in China's case, the theorized effect of the resulting accumulation in reserves is RER undervaluation. However, a regression of the actual RER on the net foreign asset position would not properly pick up the latter described mechanism. The concern thus is that the RER misalignment estimates are biased towards the equilibrium level during undervaluation episodes.

How serious is this problem in the present case? Notice that the coefficient attached to the net foreign asset position is significant, and of the expected sign in the sense that an improvement in China's external position appreciates the ERER (cf. Eq. 3.8). This suggests that China has not intervened over the entire sample period. But the question remains whether the

[13]The sample periods of those studies do not go beyond 2007.

coefficient on the net foreign asset position is significantly smaller in magnitude than it should be. Even though knowing the counterfactual is impossible, we can still compare the reaction of China's RER to an improvement in the net external position to the average cross-country experience.

In Chapter 2, I estimate RER distortions for 63 developing countries on a country-by-country basis. Surprisingly, my results suggest that the appreciating effect of an improvement in net external indebtedness is strongest in China.[14] Finally, the misalignment estimates of Gan et al. (2013) are similar to those in the present study even though the authors exclude the net external position from the set of ERER fundamentals.[15] In conclusion, the impact of the net foreign asset position on China's RER does not appear to be systematically underestimated here. Of course, the possibility of biased estimates cannot be ruled out entirely.

### 3.3.4 Back-of-the-envelope calculations

To examine the role of mercantilism in China's reserve build-up, as a first approximation, I undertake some simple back-of-the-envelope calculations. To

[14]The estimated RER appreciation associated with a reduction in net external debt is even larger in this chapter. The change is presumably due to differences in the sample period and measurement of the actual RER.

[15]That is, Gan et al. (2013) condition on the steady-state value of the net external position. Thus their ERER estimate is for a longer time horizon than the one in this study (Montiel, 2007). This makes the similarity between the two misalignment estimates even more remarkable.

keep the exercise as tractable as possible I impose the simplifying assumption that the RER influences reserve accumulation through the trade balance but not the capital account. As mentioned, there is no consensus on the exact trade elasticites for China. For this reason, I experiment with a variety of different export and import elasticities. In particular I consider the values in the set {0.3,0.5,0.7,1.0}, which are "conventional" ones for China (Cline and Williamson, 2007; Schnatz, 2011; Thorbecke, 2013; Xing, 2012). For convenience, I set the same value for the elasticity of exports and imports, respectively.[16] In addition, I follow Cline and Williamson (2007) and assume that half of China's imports are composed of re-exportable parts and components. For instance, assuming elasticities of 0.7, a 1 percent real appreciation reduces exports by 0.7 percent. The US dollar-value of final good imports increases by 0.7 percent, which is offset by a 0.7 percent reduction in the US dollar value of parts and components imports. Thus the net effect on the trade balance is the loss in exports.

As an example consider the first quarter of 2005, when total exports amounted to 7.8 percent of GDP, or US$ 156 billion. The RER at that time was undervalued by 16.5 percent.[17] Assuming a revaluation of the same magnitude and trade elasticities of 0.7, exports in this case would fall by 0.9 percent

[16]Considering non-overlapping trade elasticities would generate little additional insight. Generally, the estimates are increasing in the magnitude of the export and import elasticities.

[17]Since an increase in RER denotes appreciation, "percent of undervaluation" equals "percent of revaluation" required to close the gap to the ERER.

of GDP. This translates into a reduction of about US$ 22 billion in the trade balance or the accumulation of reserves. In the following, I consider trade elasticities in the set {0.3,0.5,0.7,1.0} and redo the illustrated calculation for every quarter during the RER undervaluation episode in which reserve holdings are deemed excessive on the basis of the RAI. Summing the obtained estimates then yields first approximations of how much mercantilism contributed to the reserve build-up in China.

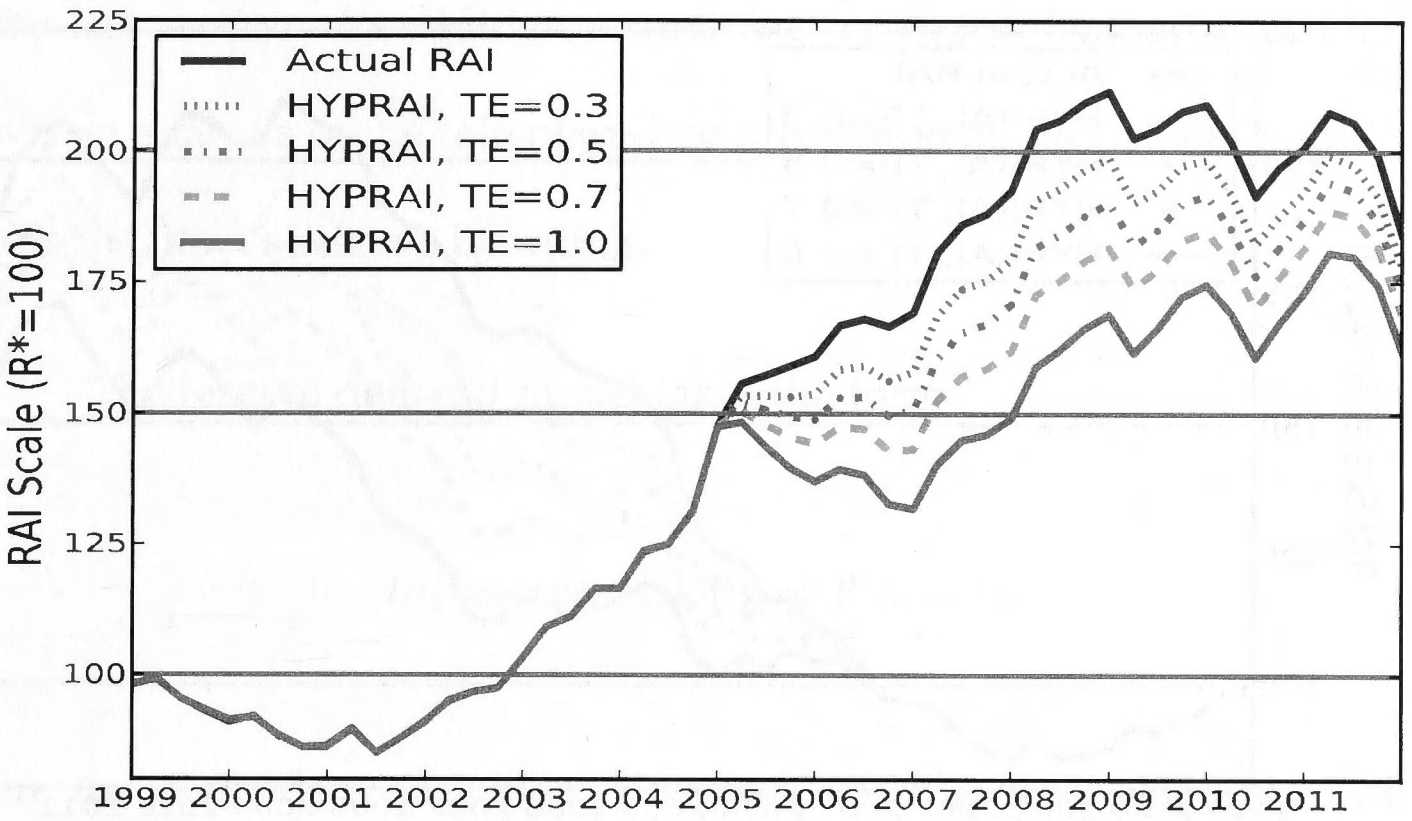
Starting with the lower bound estimates, the first quarter for which the RAI suggests that reserves are excessive is Q1 in 2005. The last quarter of the undervaluation episode is Q2 in 2008, so 14 quarters in total. The estimate of mercantilism's contribution to reserve accumulation (as per the above calculations) is increasing in the value of the trade elasticities. For instance, for export and import elasticities of 0.3, the stock of reserves would be US$ 119 billion lower in the hypothetical case of no RER undervaluation during 2005Q1-2008Q2. The estimate increases substantially to about US$ 400 billion if, instead, we assume unitary trade elasticities. The results for the upper bound estimate are similar, even though in this case reserve excessiveness already began in 2002Q4. The cumulative trade surplus over the 23-quarter period that is attributable to RER undervaluation sums up to US$ 156 billion and about US$ 500 billion for trade elasticities of 0.3 and 1.0, respectively.[18]

[18] As mentioned earlier, disregarding RER undervaluation's contribution to reserve accumulation during the two quarters before 2002Q4 does not significantly affect the above results. At most, only about US$ 2 billion would be added to the US$ 500 billion figure.

These are big numbers by any standard, yet too small to account for China's rapid reserve accumulation. In fact, reserve holdings would still be deemed excessive by a large margin according to the RAI, even in the absence of mercantilist policies. To illustrate this point, Figure 3.6 plots the actual RAI and the respective hypothetical RAI in the absence of RER undervaluation since 2005Q1 for the various export and import elasticities. The dashed vertical line indicates the end of the real undervaluation episode in 2008Q2. Overall, Figure 3.6 suggests that mercantilism alone appears to be a poor candidate to explain China's rapid reserve accumulation during the 2000s. Irrespective of the particular trade elasticities assumed, the gap between the hypothetical RAIs and the reserve adequacy benchmark of 150 percent remains substantial, both in 2008Q2 and at the end of the sample period.

Figure 3.7 plots the actual RAI and the indexes that would prevail in the hypothetical case of no RER undervaluation since 2002Q4. The hypothetical RAIs never stay close to the 100 percent benchmark and also surpass the reserve adequacy threshold of 150 percent by the end of the sample period in 2011Q4, although reserves are not far off the adequacy range when assuming unitary export and import elasticities. Therefore, even in the extreme case of regarding all reserve accumulation in combination with real undervaluation as mercantilist, the point still stands that the surge in China's foreign exchange reserves cannot be explained by distortionary foreign exchange mar-

Figure 3.6: Back-of-the-envelope calculations, RAI and hypothetical RAIs, 2005Q1.

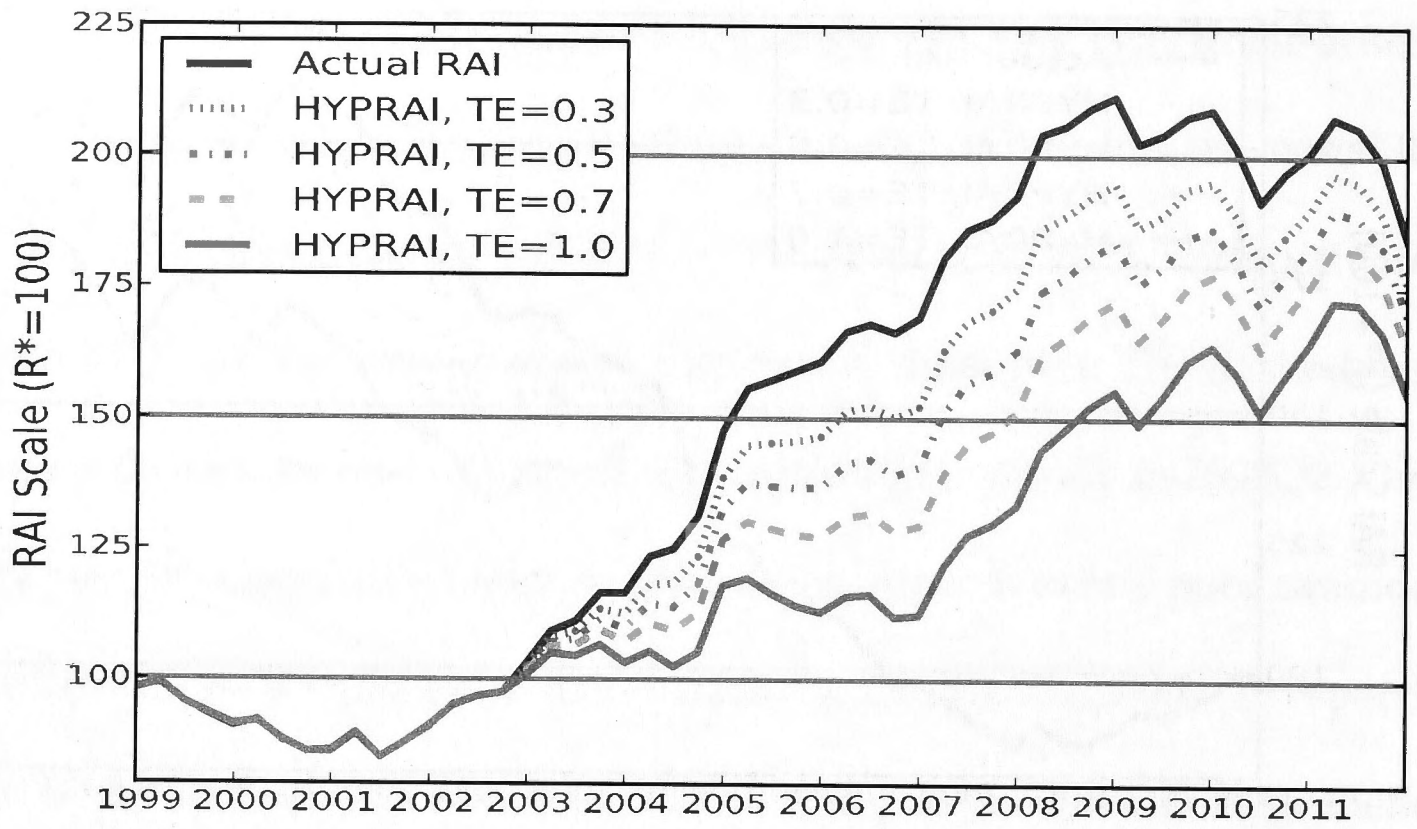



Note: HYPRAI refers to the hypothetical index level in case of no real undervaluation since 2005Q1. TE denotes the export and import elasticities.

ket interventions alone, unless the elasticities of exports and imports are well above 1.0.

While suggestive, there are a number of caveats associated with the back-of-the-envelope calculations in this section. It may well be that real undervaluation spurs reserve accumulation through the capital account and not just the current account. Indeed, Prasad and Wei (2007), for example, argue that much of China's reserve hoarding in the early 2000s can be traced back to "hot money" inflows, as opposed to improvements in the trade balance. In addition, the results are also sensitive with respect to the assumption that

Figure 3.7: Back-of-the-envelope calculations, RAI and hypothetical RAIs, 2002Q4.




Note: HYPRAI refers to the hypothetical index level in case of no real undervaluation since 2002Q4. TE denotes the export and import elasticities.

the price elasticities do not exceed unity.[19] The next section attempts to address these issues by estimating China's reserve demand as a function of real undervaluation and other factors, precautionary ones in particular.

## 3.4 Determinants of reserve demand

In this section I estimate China's demand function for international reserves. The main purpose is to obtain an estimate of the impact of RER undervaluation on reserve accumulation while controlling for other factors driving re-

[19] Ahmed (2009), for example, reports export price elasticities that are greater than unity.

serve demand. The advantage of this approach is that it is free of imposing *ad hoc* assumptions, as has been done for the back-of-the-envelope calculations in the last section. In addition, estimating a reserve demand function also allows an analysis of the role played by precautionary and other "traditional" factors in China's reserve hoarding.

The reserve demand model takes the form:

$$ln(\text{reserves/GDP})_t = \beta' X_t + \varepsilon_t, \tag{3.9}$$

where the dependent variable, $ln(\text{reserves/GDP})_t$, is the logarithm of the reserves to GDP ratio .Vector $X_t$ contains the determinants of reserve demand discussed below. The error term $\varepsilon_t$ is stationary and mean-zero.

I follow Aizenman and Marion (2003), Aizenman and Lee (2007), Ghosh et al. (2012), Ghosh et al. (2014), and Obstfeld et al. (2010) by including the following explanatory variables, where, unless indicated otherwise, the same data sources and definitions apply as laid out in Section 3.3.1:

- the logarithm of the total trade (exports plus imports) to GDP ratio [+],
- the log of the ratio M2 to GDP [+],
- the logarithm of the fraction of portfolio equity liabilities over GDP [+],
- the log of the ratio of short-term debt over GDP [+],

- the logarithm of GDP per capita (WDI, interpolated) [+], and
- RER misalignment as defined in Eq. 3.6 [+/−].

The signs in square brackets represent the partial derivatives. Most of these variables represent precautionary reserve demand to insure against not only a wide range of potential capital account shocks (M2, portfolio equity liabilities, and short-term debt) but also against current account shocks. To proxy the latter, I use total trade to capture both the extent of loss in export earnings and the propensity to import. Other options to control for current account shocks would be to use the log ratio of imports or exports to GDP. Either way, the particular choice of proxy has no material impact on the results.

Since reserve holdings should increase with the exposure to current and capital account shocks, the association between the former and the variables that capture the latter should be positive. The model also includes GDP per capita as a "scale" variable to capture that reserve demand is potentially "non-homogenous" in the size of the economy (Ghosh et al., 2012).

Finally, the model includes RER misalignment in order to estimate the impact of real undervaluation on reserve accumulation. Since undervaluation (overvaluation) in the RER boosts (discourages) exports and may attract (distract) capital inflows, the sign attached to the coefficient on RER misalignment

is expected to be negative. Recall, however, that additional reserve accumulation induced by real undervaluation is not necessarily due to the mercantilist motive. As discussed in Section 3.2, RER undervaluation is also fully consistent with precautionary reserve hoarding. Nonetheless, notice that it is also possible for a country to accumulate foreign exchange reserves at times of RER overvaluation, in which case the association between RER misalignment and reserve accumulation would be positive (Aizenman and Lee, 2007). Yet in China's case this is not an expected outcome since there is a strong overlap between both RER undervaluation and fast reserve accumulation episodes. Nonetheless, *a priori* the sign of the coefficient on RER misalignment is ambiguous.

### 3.4.1 Method

Before turning to the estimation of the reserve demand model, I examine the time series properties of the variables. To this end, I employ ADF tests. The test results are reported in Table 3.2. They suggest that all variables are I(1), except GDP per capita and RER misalignment. The former is I(2) and the latter I(0) by construction. I then difference the GDP per capita variable so that it enters the reserve demand equation as an I(1) variable.

For estimating the reserve demand equation I use the DOLS estima-

Table 3.2: Unit root tests.

*Panel A: Variables in levels*

| | Test Eq. Includes | Test Statistic | P-Value |
|---|---|---|---|
| Reserves | None | -1.2 | 0.21 |
| Trade (Imports plus Exports) | None | -1.4 | 0.16 |
| GDP per capita | Constant & Trend | -3.4 | 0.07 |
| M2 | Constant | -1.7 | 0.43 |
| Portfolio Liabilities | Constant & Trend | -1.9 | 0.64 |
| Short-Term Debt | Constant | -1.8 | 0.38 |

*Panel B: Variables in first differences*

| | Test Eq. Includes | Test Statistic | P-Value |
|---|---|---|---|
| Reserves | None | -3.0 | 0.00 |
| Trade (Imports plus Exports) | None | -3.4 | 0.00 |
| GDP per capita | None | -0.0 | 0.67 |
| M2 | Constant | -3.9 | 0.00 |
| Portfolio Liabilities | None | -3.8 | 0.00 |
| Short-Term Debt | None | -3.4 | 0.00 |

Notes: This table reports the ADF-test statistic under the null hypothesis that the series is nonstationary. Sample period: 1998Q4-2011Q4.

tor. The DOLS-versions of the equations are of the following form:

$$ln(\text{reserves/GDP})_t = \alpha\, \text{mis}_t + \beta' X_t + \sum_{s=-l_2}^{s=l_1} \gamma_s' \Delta X_{t+s} + \varepsilon_t, \qquad (3.10)$$

where $mis_t$ refers to RER misalignment and vector $X_t$ contains the other regressors. The DOLS regression also includes $l_1$ leads and $l_2$ lags of the first-differenced $X_t$ variables.

### 3.4.2 Results

I initially estimate the "traditional" reserve demand model that, in addition to RER misalignment, includes total trade and the scale variable, GDP per

Table 3.3: Reserve demand.

| Independent variable | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Δ GDP per capita | 2.97 (6.86) | | | | |
| Trade | 2.99 (0.59)*** | 0.13 (0.15) | | | |
| M2 | | 1.58 (0.19)*** | 1.61 (0.14)*** | 1.62 (0.14)*** | 1.64 (0.16) *** |
| Portfolio Equity Liabilities | | 0.38 (0.03)*** | 0.38 (0.02)*** | 0.38 (0.02)*** | 0.38 (0.02) *** |
| Short-Term Debt | | -0.02 (0.05) | | | |
| RER Misalignment | 6.87 (1.26)*** | -0.46 (0.30) | -0.31 (0.24) | | |
| RER Undervaluation | | | | -0.33 (0.24) | |
| RER Overvaluation | | | | 0.25 (0.22) | |
| Cumulative Undervaluation | | | | | 0.00 (0.002) |
| Observations | 53 | 53 | 53 | 53 | 53 |
| [leads, lags] | [2, 0] | [1, 2] | [2, 2] | [2, 2] | [2, 2] |

Notes: The dependent variable is the log of the reserves to GDP ratio. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Standard errors in parentheses. GDP per capita is expressed in logs. The other variables are measured in logs as a ratio of GDP (except RER misalignment).

capita. The result for this specification is reported in Table 3.3 Column 1. The expected positive long-run relationship between trade and reserves seems to hold. The coefficient on RER misalignment is positive and significant, which suggests that China accumulates international reserves at times of real overvaluation. As discussed, this estimation result was not expected. However, the results for the "traditional" reserve demand do not control for precautionary capital account variables and may therefore generate spurious results.

The reserve demand equation after adding M2, portfolio equity liabilities, and short-term debt is reported in Table 3.3 Column 2. Since GDP per capita does not form a long-run relationship with reserve holdings, it is dropped from the model. Once precautionary capital account variables are controlled for, the long-run relationship between reserves and RER misalignment turns insignificantly negative, suggesting that there is, at best, weak evidence of distortions in the RER affecting reserve accumulation in China.

Additionally, the coefficient on trade substantially shrinks in size and loses its statistical significance. The stocks of broad money and portfolio equity liabilities seem to be the sole variables that form a statistically significant long-run relationship with reserve holdings. Finally, consistent with the discussion in Section 3.3, short-term debt does not seem to matter for reserve accumulation in China. In fact, the negative, albeit insignificant point estimate of short-term debt suggests that, if anything, there is a weak pattern of declining reserves as the stock of short-term debt increases.

The estimates reported in Column 3 help in checking whether the lack of association between RER misalignment and reserves is a result of too much noise stemming from the other insignificant variables in the regression. Consequently, trade and short-term debt are dropped from the reserve demand equation. However, RER misalignment remains an insignificant determinant of reserve demand. Column 4 explores the possibility that reserve hoarding is asymmetric in real over- and undervaluation. To this end, I use the same approach as in Chapter 2 and split RER misalignment into two variables. The first takes the negative values of $mis_t$ when the RER is undervalued, and zero otherwise. The other equals $mis_t$ for positive values, and zero during exchange rate undervaluation. This procedure does not significantly change the results. While both RER over-and undervaluation enter the regression with the expected signs, they are not significant drivers of long-run reserve

accumulation.

The estimation results discussed so far may have failed to pick up the relationship between real undervaluation and reserve holdings due to misspecification. The issue is that the dependent variable is the stock of international reserves (as a ratio of GDP). While precautionary demand of reserves is linked to the holding of a particular stock, RER misalignment only affects reserve accumulation in a given period and hence refers to the flow rather than the stock. Ghosh et al. (2012) also recognize this point. To address this issue, I follow their approach and construct the variable CUMUVAL, which takes the value of the cumulative number of quarters that the RER is undervalued.[20] The logic behind using CUMUVAL is to better capture the gradual impact of RER misalignment on the stock of international reserves. Column 5 therefore includes CUMUVAL as a regressor, but there is no significant association between reserve holdings and the duration of real undervaluation episodes.

A fundamental weakness of CUMUVAL is that it leaves out important information relating to the degree of undervaluation. Unfortunately there are no better alternatives under the "stock setup". Therefore, in what follows, I re-specify the reserve demand model into a "flow equation" by using first differences of the dependent and explanatory variables, except RER over-

[20]Once a real undervaluation episode ends, *CUMUVAL* is reset to zero.

and undervaluation.[21] As a starting exercise, I employ OLS to estimate the trivariate relationship between reserves, real overvaluation, and real undervaluation. The first Column of Table 3.4 reports the result. The magnitude of the coefficient attached to RER undervaluation (-0.22) suggests that every percentage point of RER undervaluation leads to a 0.22 percent increase in the reserve to GDP ratio. RER overvaluation on the other hand seems to significantly slow down the pace of reserve accumulation. The relevant coefficient is -0.81, which suggests that a five percentage point increase in overvaluation reduces the reserve to GDP ratio by about four percent. In Column 2 I add first differenced M2 to the regression as this variable was previously found to be one of the most important determinants of reserve demand (cf. Table 3.3). Doing so, however, does not substantially change the magnitude of the coefficient attached to RER undervaluation (-0.23).

An issue with the OLS estimates is that they do not take into account reverse causality. Reserve accumulation also directly affects RER undervaluation, as suggested by the theory of ERER determination.[22] Moreover, reserve accumulation may lead to growth in the monetary base (M0) under imperfect sterilization, in which case the direction of causation between reserves and M2 would be reversed (Obstfeld et al., 2010). However, in China's instance this is not a concern since M0 (as a ratio of GDP) has been falling steadily

[21] Since the variables are expressed as ratios of GDP and measured in (natural) logarithms, first differences represent growth rates in the GDP ratios.

[22] See the discussions in Sections 3.2 and 3.3.3.

Table 3.4: Reserve demand (flow).

| Independent variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | OLS | OLS | 2SLS | 2SLS |
| ΔM2 | | 0.55 (0.20)*** | | 0.46 (0.22)** |
| RER Undervaluation | -0.21 (0.09)** | -0.23 (0.09)** | -0.24 (0.10)** | -0.22 (0.09)** |
| RER Overvaluation | -0.81 (0.26)*** | -1.02 (0.26)*** | -0.30 (0.51) | -0.70 (0.52) |
| Observations | 52 | 52 | 51 | 51 |
| $R^2$ | 0.36 | 0.46 | 0.36 | 0.42 |
| Sargan (p-value) | | | 0.55 | 0.55 |

Notes: The dependent variable is the change in reserve holdings. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Robust standard errors in parentheses.

during the 2000s, despite the rapid reserve build-up. Therefore, I instrument real over-, and undervaluation using their first two lagged values, whereas I treat M2 as exogenous.[23]

Column 3 in Table 3.4 reports the two stage least-squares (2SLS) results for the trivariate specification. Compared to the OLS results, the point estimates of both RER over- and undervaluation change considerably. In the case of real overvaluation, the magnitude of the coefficient shrinks to about one third of its previous size (from -0.81 to -0.30). The change in the point estimate of real undervaluation is less pronounced, but still a nontrivial 14 percent increase (in absolute value). My preferred specification reported in Column 4 additionally controls for first differenced M2, which leaves the point estimate of RER undervaluation virtually unchanged (-0.22). The size of the coefficient attached to RER overvaluation increases substantially, but loses its significance.[24] Finally, notice that the validity of the instruments

[23] Assuming that M2 is exogenous does not significantly affect the results.

[24] I have also experimented with including the other potential determinants of reserve de-

used in Columns 3 and 4 cannot be rejected on the basis of a Sargan test of overidentifying restrictions.

### 3.4.3 Reserve accumulation due to mercantilism

This section computes the cumulative contribution of mercantilism to China's reserve build-up on the basis of the consistent 2SLS point estimate of RER undervaluation, as reported in Column 4 of Table 3.4. The task is to calculate the amount of additional reserves accumulated in each quarter during the RER undervaluation episode in which reserves are judged excessive according to the RAI. I consider the same cut-off points of reserve excessiveness as for the back-of-the-envelope calculations: Q4 in 2002 and Q1 in 2005.

The results of these calculations are reported in Table 3.5. The Table comprises two panels: Panel A with 2005Q1 and Panel B with 2002Q4 as the starting date. The first two Columns list actual RAI reserve holdings (in US$ billions) and the RAI. Columns 3 and 4 report the hypothetical RAI (HYPRAI) and stock of international reserves (HYPRES) had there been no RER undervaluation. The fifth Column shows the amount of accumulated reserves (CONTRUVAL) that is due to real undervaluation in a given quarter,

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mand in the flow equation. While other potential specifications exist the point estimate of real undervaluation remains virtually unchanged compared to Column 4. The only exception is when I include the first difference of portfolio equity liabilities, which causes all other variables to lose their explanatory power. The results of those alternative specifications are available upon request.

with the cumulative sum reported at the bottom of the panel.

Table 3.5: Reserves without mercantilism.

*Panel A: Start 2005Q1*

| | Actual RAI | Actual (bn) | HYPRAI (% GDP) | HYPRES (bn) | CONTRUVAL (bn) | - 2 s.d. RAI | - 2.s.d. (bn) | CONTRUVAL -2 s.d. | + 2.s.d. RAI | +2 s.d. (bn) | CONTRUVAL +2.s.d |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005Q1 | 155.8 | 663.3 | 145.2 | 618.2 | 23.0 | 153.0 | 651.3 | 4.5 | 137.7 | 586.0 | 40.5 |
| 2005Q2 | 157.4 | 715.2 | 142.7 | 648.3 | 21.7 | 153.7 | 698.7 | 4.4 | 132.2 | 600.7 | 37.1 |
| 2005Q3 | 159.2 | 772.4 | 141.8 | 688.2 | 17.4 | 155.1 | 752.3 | 3.6 | 129.6 | 628.8 | 29.2 |
| 2005Q4 | 160.9 | 821.5 | 141.5 | 722.6 | 14.6 | 156.4 | 798.3 | 3.1 | 128.0 | 653.7 | 24.2 |
| 2006Q1 | 166.6 | 877.7 | 144.5 | 761.3 | 17.5 | 161.5 | 850.8 | 3.7 | 129.3 | 681.2 | 28.7 |
| 2006Q2 | 167.8 | 943.8 | 143.3 | 805.6 | 21.8 | 162.2 | 912.2 | 4.7 | 126.6 | 712.1 | 35.2 |
| 2006Q3 | 166.6 | 990.5 | 139.5 | 829.6 | 22.7 | 160.4 | 953.9 | 5.0 | 121.5 | 722.5 | 36.3 |
| 2006Q4 | 168.9 | 1068.0 | 140.2 | 887.0 | 20.1 | 162.4 | 1027.0 | 4.5 | 121.5 | 768.4 | 31.6 |
| 2007Q1 | 181.3 | 1203.9 | 151.2 | 1004.0 | 18.9 | 174.5 | 1158.6 | 4.2 | 131.7 | 874.7 | 29.6 |
| 2007Q2 | 186.7 | 1334.9 | 155.8 | 1114.3 | 20.6 | 179.7 | 1285.0 | 4.6 | 136.1 | 973.2 | 32.5 |
| 2007Q3 | 187.5 | 1436.0 | 156.4 | 1198.0 | 17.4 | 180.4 | 1382.2 | 3.9 | 136.7 | 1046.8 | 27.5 |
| 2007Q4 | 192.5 | 1530.0 | 159.8 | 1270.5 | 21.6 | 185.1 | 1471.5 | 4.8 | 139.2 | 1106.8 | 34.1 |
| 2008Q1 | 204.9 | 1684.1 | 171.7 | 1411.9 | 12.6 | 197.4 | 1622.7 | 2.8 | 151.0 | 1241.0 | 19.9 |
| 2008Q2 | 206.1 | 1810.9 | 174.2 | 1530.4 | 8.3 | 198.9 | 1747.7 | 1.8 | 154.2 | 1354.7 | 13.1 |
| 2011Q4 | 184.6 | 3203.0 | 167.6 | 2908.3 | 0.0 | 180.8 | 3136.7 | 0.0 | 157.0 | 2723.3 | 0.0 |
| Σ | | | | | 258.2 | | | 55.7 | | | 419.3 |

Notes: RAI refers to the reserve adequacy index, which is based on the IMF's (2011) measure. HYPRAI and HYPRES is the hypothetical RAI and stock of international reserves in the absence of RER undervaluation episode, respectively. CONTRUVAL indicates the amount of accumulated reserves that is due to real undervaluation in a given quarter. The last six columns show HYPRAI, HYPRES, and CONTRUVAL when 2 standard errors are added or subracted to the point estimate of RER undervaluation (column 4 of Table 3.4).

Table 3.5: Reserves without mercantilism (ctd.).

*Panel B: Start 2003Q1*

| | Actual RAI | Actual (bn) | HYPRAI (% GDP) | HYPRES (bn) | CONTRUVAL (bn) | - 2 s.d. RAI | - 2.s.d. (bn) | CONTRUVAL -2 s.d. | + 2.s.d. RAI | +2 s.d. (bn) | CONTRUVAL +2.s.d |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002Q4 | 103.3 | 291.1 | 100.7 | 283.7 | 3.7 | 102.8 | 289.6 | 0.7 | 98.6 | 277.8 | 6.6 |
| 2003Q1 | 109.3 | 321.0 | 104.8 | 308.0 | 5.6 | 108.4 | 318.4 | 1.1 | 101.4 | 297.8 | 9.9 |
| 2003Q2 | 111.4 | 351.5 | 104.9 | 331.2 | 7.2 | 110.1 | 347.4 | 1.4 | 100.0 | 315.6 | 12.6 |
| 2003Q3 | 116.5 | 389.0 | 108.1 | 360.8 | 8.0 | 114.8 | 383.3 | 1.6 | 101.7 | 339.4 | 13.8 |
| 2003Q4 | 116.5 | 408.2 | 105.5 | 369.6 | 10.4 | 114.3 | 400.4 | 2.1 | 97.4 | 341.0 | 17.6 |
| 2004Q1 | 123.7 | 444.4 | 109.5 | 393.6 | 12.2 | 120.8 | 434.1 | 2.5 | 99.3 | 356.9 | 20.3 |
| 2004Q2 | 125.0 | 475.2 | 108.9 | 413.9 | 10.4 | 121.7 | 462.6 | 2.2 | 97.5 | 370.6 | 17.1 |
| 2004Q3 | 131.3 | 519.1 | 113.2 | 447.3 | 10.6 | 127.6 | 504.2 | 2.3 | 100.6 | 397.4 | 17.1 |
| 2004Q4 | 147.4 | 614.5 | 126.4 | 527.0 | 15.7 | 143.0 | 596.2 | 3.4 | 112.2 | 467.6 | 25.2 |
| 2005Q1 | 155.8 | 663.3 | 130.5 | 555.4 | 20.4 | 150.5 | 640.6 | 4.5 | 113.6 | 483.7 | 32.8 |
| 2005Q2 | 157.4 | 715.2 | 129.3 | 587.8 | 19.5 | 151.4 | 688.1 | 4.3 | 111.1 | 504.9 | 30.7 |
| 2005Q3 | 159.2 | 772.4 | 129.7 | 629.2 | 15.8 | 152.9 | 741.7 | 3.6 | 110.8 | 537.6 | 24.5 |
| 2005Q4 | 160.9 | 821.5 | 130.2 | 664.9 | 13.4 | 154.3 | 787.8 | 3.0 | 110.9 | 566.1 | 20.7 |
| 2006Q1 | 166.6 | 877.7 | 133.8 | 705.0 | 16.1 | 159.5 | 840.3 | 3.7 | 113.4 | 597.4 | 24.8 |
| 2006Q2 | 167.8 | 943.8 | 133.5 | 750.9 | 20.2 | 160.3 | 901.7 | 4.6 | 112.5 | 632.6 | 30.9 |
| 2006Q3 | 166.6 | 990.5 | 130.6 | 776.5 | 21.2 | 158.7 | 943.6 | 4.9 | 108.8 | 647.1 | 32.2 |
| 2006Q4 | 168.9 | 1068.0 | 132.0 | 835.2 | 18.8 | 160.7 | 1016.6 | 4.4 | 110.1 | 696.3 | 28.3 |
| 2007Q1 | 181.3 | 1203.9 | 143.6 | 953.2 | 17.8 | 173.0 | 1148.3 | 4.2 | 121.3 | 805.4 | 26.8 |
| 2007Q2 | 186.7 | 1334.9 | 148.9 | 1064.6 | 19.6 | 178.3 | 1274.8 | 4.6 | 126.8 | 906.5 | 29.9 |
| 2007Q3 | 187.5 | 1436.0 | 150.0 | 1149.1 | 16.6 | 179.1 | 1372.0 | 3.8 | 128.2 | 981.9 | 25.6 |
| 2007Q4 | 192.5 | 1530.0 | 153.8 | 1222.4 | 20.7 | 183.8 | 1461.3 | 4.8 | 131.3 | 1044.0 | 32.0 |
| 2008Q1 | 204.9 | 1684.1 | 166.0 | 1364.4 | 12.2 | 196.1 | 1612.6 | 2.8 | 143.5 | 1179.4 | 18.8 |
| 2008Q2 | 206.1 | 1810.9 | 168.8 | 1483.2 | 8.0 | 197.8 | 1737.5 | 1.8 | 147.3 | 1293.7 | 12.5 |
| 2011Q4 | 184.6 | 3203.0 | 164.9 | 2861.4 | 0.0 | 180.2 | 3126.6 | 0.0 | 153.5 | 2663.1 | 0.0 |
| Σ | | | | | 324.0 | | | 72.6 | | | 510.5 |

Notes: RAI refers to the reserve adequacy index, which is based on the IMF's (2011) measure. HYPRAI and HYPRES is the hypothetical RAI and stock of international reserves in the absence of RER undervaluation episode, respectively. CONTRUVAL indicates the amount of accumulated reserves that is due to real undervaluation in a given quarter. The last six columns show HYPRAI, HYPRES, and CONTRUVAL when 2 standard errors are added or subracted to the point estimate of RER undervaluation (column 4 of Table 3.4).

The estimated cumulative contribution of mercantilism over the period 2005Q1 to 2008Q2 is about US$ 260 billion or 8 percent of the total stock of international reserves. In 2008Q2, a hypothetical reduction of US$ 260 billion in foreign exchange means that the stock of reserves would have amounted to US$ 1.53 trillion instead of the actual US$ 1.8 trillion. The RAI would have declined from 206 percent to 174 percent. So reserves would still be considered excessive according to the RAI, which suggests that mercantilist and precautionary motives alone cannot explain China's hoarding of foreign exchange reserves.

To provide a "confidence interval" for the impact of mercantilism, I add and subtract, respectively, 2 standard errors to the point estimate of RER undervaluation and repeat the above calculations. The last six Columns of Table 3.5 report the results. The "upper confidence bound" of mercantilism's contribution is US$ 420 billion. HYPRAI would stand at 154 percent, still slightly above the 150 percent benchmark. In other words, the null hypothesis that mercantilism explains China's excessive reserve hoarding would be rejected at the 5 percent level.

Panel B reports reserve hoarding due to mercantilism when reserves are deemed excessive from 2002Q4 onwards. Since in this case all quarters of real undervaluation count towards the mercantilist motive, the resulting numbers are somewhat larger. The cumulative sum of CONTRUVAL is US$

324 billion (10 percent of actual reserve holdings). At the end of the undervaluation episode in 2008Q2, the hypothetical RAI in the absence of mercantilist motives would still be at 169 percent, which is well above the 150 percent threshold. The observation thus still stands that mercantilism alone cannot explain China's excessive reserve hoarding. The absolute upper bound estimate of mercantilism that results from adding two standard errors to the point estimate of RER undervaluation is about US$ 500 billion. But even then the HYPRAI would still be near, albeit marginally below, 150 percent in 2008Q2.

Overall, these numbers are strikingly similar to the ones obtained from the back-of-the-envelope calculations in Section 3.3.4, further corroborating the inference that mercantilism has contributed substantially, but not totally, to the exorbitant reserve build-up in China. In addition, the estimates of the contribution to China's build-up in foreign exchange reserves in this study range between US$ 240 and US$ 500 billion, which translates into 3-7 percent of GDP (or about 10 percent of total reserve accumulation). Ghosh et al. (2014) provide a similar estimate at 4.5 percent of GDP. Their approach is to define any reserve accumulation associated with RER undervaluation as mercantilist. This comparability in estimation results thus underlines the earlier formulated view that the results are not sensitive to which particular method of measuring mercantilism's importance is chosen in the case of

China.

## 3.5 Conclusion

The purpose of this paper has been to test empirically whether the prevalent view holds that China engages in distortionary exchange rate policies which aim at maintaining an undervalued real exchange rate to support export-led growth. If this were so, these mercantilist policies would explain much of China's foreign exchange reserves stock, which is above of US$ 3 trillion as of 2011. This paper's goal has been to quantify how much precautionary and mercantilist motives have contributed to the reserve build-up in China. The study has highlighted how theory is consistent with employing two vastly differing approaches with respect to defining and estimating the role of mercantilism, either of which could generate misleading results. The study has, however, shown that the latter is not a concern in China's particular case since both approaches yield similar results.

The main results of this paper suggest that while the period rapid of the reserve build-up does coincide with a prolonged episode of RER undervaluation, distortionary foreign exchange market interventions during that time have only contributed between US$ 200-300 billion (less than 10 percent of total reserve accumulation). Indeed, even in the absence of mercantilist

motives, reserves would still be considered to be in excess of what is needed for precautionary purposes based on the RAI. This paper's results thus cast doubt on the widely-held view that mercantilism is an important factor in explaining China's unprecedented reserve hoarding, and more generally on the Bretton Woods II-view as formulated by Dooley et al. (2004).

The question then is: which factors beyond precautionary and mercantilist motives can account for China's extraordinary reserve demand? One possibility is that the accumulation of foreign exchange reserves includes the precautionary savings of the private sector as well. According to Caballero et al. (2008) and Mendoza et al. (2009) for example, agents in emerging countries such as China demand assets to insure themselves against idiosyncratic income shocks, however, financial market underdevelopment in emerging economies inhibits the supply of quality assets that allow hedging against those shocks. This supply-demand mismatch induces residents of emerging economies to acquire assets in countries with advanced financial markets, typically the US, to fill the void in insurance. In the particular case of China, the absence of adequate social insurance (Carroll and Jeanne, 2009; Chamon et al., 2013) may additionally explain an exceptionally high precautionary saving motive. Moreover, Wei and Zhang (2011) argue that the growing gender imbalances in China incentivize parents to raise their savings to increase their son's attractiveness in the marriage market. These studies offer plausi-

ble explanations as to why China operates under current account surpluses and accumulates foreign assets. However, as pointed out by Gourinchas and Jeanne (2013), specifically accounting for the hoarding of international reserves requires the additional assumption that the government accumulates the latter on behalf of the private sector.

Another plausible explanation for the surge in reserves that deserves more attention is China's joining of the World Trade Organization (WTO) in 2002. Athukorala (2009a) argues that this event significantly reduced China's perceived country risk, which triggered substantial inflows of foreign direct investment (FDI) in export-linked industries. China's integration into global production networks was thus a significant contributor to the record trade surpluses, which might have been, by and large, independent of the RER. China has become the premier assembly center within global production networks within vertically integrated dynamic industries, in particular electronics and electrical goods (Athukorala, 2009b). There is evidence that the RER is only one among the many other variables which determine Chain's attractiveness as a final assembly center (Cline and Williamson, 2007; Schnatz, 2011; Thorbecke, 2013; Xing, 2012). These other variables include: low labor cost relative to that in the US and other home countries of multinational enterprises (MNEs) involved in these industries[25]; ample availability of labor

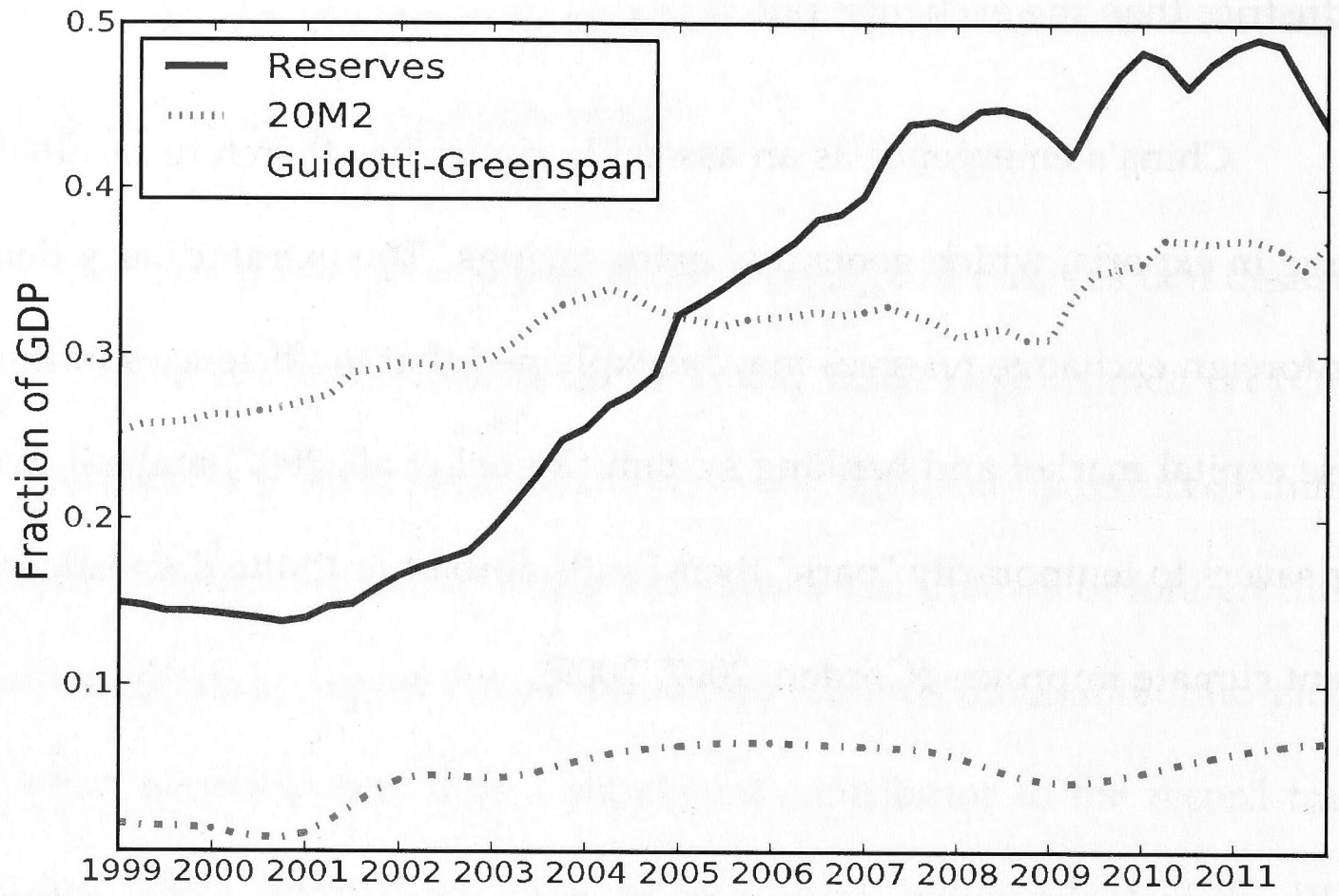
[25]The labor cost in China has increased significantly over the past decade or so, but still, the average hourly wage of a factory worker amounts to less than 5 percent of the US equivalent in 2009 (Banister, 2013).

(including supervisory manpower) required for mass assembly operations (Rawski, 2011); high-quality trade-related infrastructure; and political stability. These factors are perhaps far more important for the expansion of these industries than the exchange rate.

China's emergence as an assembly center has therefore resulted in a surge in exports, which generated extra savings. The extraordinary demand for foreign exchange reserves may be explained that inefficiencies in the Chinese capital market and banking system (Riedel et al., 2007) make it rational for savers to temporarily "park" their funds abroad until the domestic investment climate improves (Corden, 2007, 2009).

# Appendix

Figure 3A.1: Traditional measures of reserve adequacy, 1998Q4-2011Q4.



Chapter 4

# Valuation effects, risk sharing, and consumption smoothing


*Summary*

This chapter studies the macroeconomic impact of valuation effects (changes in net external assets of a country arising from movements in exchange rates or asset returns). In theory, valuation effects are an important channel of international risk sharing as they facilitate external adjustment. However, the effects can also be economically destabilizing in the presence of frictions in the international financial system. Despite the growing significance of valuation effects in an era of financial globalization, the nature and extent of their macroeconomic effect has not yet been systematically examined, especially in relation to emerging market economies (EMEs). The study examines the macroeconomic impact of valuation effects for 53 countries from 1980–2010. Valuation effects seem to operate as a risk sharing channel in high income countries. For EMEs the results depend on how valuation effects correlate with domestic consumption growth. There is weak evidence that valuation effects act as a risk sharing channel only if the correlation is negative, and are destabilizing otherwise. In the latter case, the welfare loss may well exceed one percent of permanent consumption.

## 4.1 Introduction

The net foreign asset position limits the present value of future current account deficits. The current account is often used as an approximate measure of periodic changes in net external assets. However, a number of recent studies show that "valuation effects" resulting from changes in asset prices or exchange rates act as a separate impetus driving the net foreign asset position (Tille, 2003; Obstfeld, 2004; Blanchard et al., 2005; Lane and Milesi-Ferretti, 2007; Gourinchas and Rey, 2007; Gourinchas, 2008). The magnitude of valuation effects is proportional to gross asset and liability positions. The proliferation in asset trade over the past two decades has therefore led to a significant increase in the size of valuation adjustments.

Economic theory suggests that the valuation channel plays an important role in international consumption risk sharing. The two-country model of Devereux and Sutherland (2010) illustrates this point. If the home and foreign country are symmetric and choose their international portfolios optimally so that risk sharing is complete, they equally share a unit negative endowment shock in the home country in the sense that consumption in both countries declines by half a unit. The latter represents home's (foreign's) current account deficit (surplus). Provided the shock fully dissipates after the period, home (foreign) at the same time experiences an "unpredictable" valuation gain (loss) that exactly offsets the current account balance, leaving

the net foreign asset position unchanged.[1] The crucial role of the valuation channel is thus to bring about external adjustment.

However, there are reasons to suspect that the valuation channel is economically destabilizing, especially for emerging market economies (EMEs). This is the case if valuation adjustments occur in a pro-cyclical fashion, thereby amplifying the propagation of shocks. The most prominent example for pro-cyclicality is the case when countries are unable to borrow in their own currencies. Gourinchas (2008) discusses this point using a portfolio balance model featuring "dollarized" net debt. The model predicts that a currency depreciation, triggered for example by a negative demand shock, increases net liabilities valued in local currency. The valuation component captures this capital loss. In this model, the valuation channel is destabilizing because, despite the shock, the equilibrium value of external net debt does not change and this requires trade balance surpluses to reduce international indebtedness to its long-run value. Pro-cyclical valuation effects due to "original sin" (the inability to borrow in domestic currency) are well known to be a problem for EMEs since Eichengreen and Hausmann (1999) and Eichengreen et al. (2003).

There are only a few studies that investigate valuation effects in the

[1]The current account balance and the valuation channel need not necessarily exactly offset each other. For instance, if shocks are persistent, the valuation channel exceeds the current account balance in absolute value so as to ensure an optimal sharing of shocks across the two countries. See Devereux and Sutherland (2010) for more details.

context of consumption risk sharing. For instance, Balli et al. (2012) show that valuation effects have indeed become an empirically important channel through which countries that are part of the European Monetary Union (EMU), EU, or the OECD share their risks. The only study that empirically examines the risk sharing properties of valuation effects in EMEs is that of Bracke and Schmitz (2011). However, they restrict their analysis to portfolio equity, which represents only a small share of a typical emerging country's international portfolio. Interestingly, they conclude that the valuation effects that emanate from portfolio equity do not satisfy the necessary risk sharing characteristics in EMEs.

Therefore, despite the growing significance of valuation effects in an era of financial globalization, the nature and extent of their macroeconomic effect has not yet been systematically examined, especially in relation to EMEs. The purpose of this paper is to investigate empirically whether valuation effects are destabilizing, or are one of the operative channels of risk sharing. My analysis mostly focuses on EMEs but includes high income countries as well. The period covered is 1980-2010 and the country sample consists of 18 high income countries and 35 EMEs.

I first examine whether the valuation channel is part of the international risk sharing mechanism. Acknowledging that international risk sharing is far from perfect allows me to test this indirectly: if valuation effects repre-

sent flow payments related to risk sharing, then an increase in the size of the valuation channel (measured as the standard deviation of valuation effects) driven by financial integration should be associated with improved risk sharing outcomes across countries (Gourinchas, 2008). My econometric results suggest that this association holds for the group of high income countries. But there is no significant evidence that the same relationship holds for the group of EMEs. The latter result is thus in line with Kose et al. (2009), Bai and Zhang (2012), and others who find that financial integration has not had a material impact on the EMEs' ability to offload their income risk to the rest of the world.

I then subdivide EMEs into two groups: one for countries where the correlation between valuation effects and domestic consumption growth is negative (NC), and another for which it is positive (PC). I argue that the sign of this correlation contains information about the nature of the valuation channel in EMEs. In particular, the model of Devereux and Sutherland (2010) implies that the covariance between consumption growth and valuation adjustments, when measured over longer time horizons, should be negative in economies that are more frequently subjected to shocks relative to the rest of the world. Assuming that macroeconomic volatility measures the frequency of shocks, the covariance between consumption growth and valuation effects should therefore be negative in EMEs. Pro-cyclical or destabilizing valua-

tion effects, on the other hand, imply a positive correlation in these countries. Overall, however, there is only weak evidence of a functioning valuation channel in EMEs. The correlation coefficients are negative in only 21 out of 35 EMEs and rarely statistically different from zero. On the other hand, there has been a slight improvement in the degree of risk sharing for the set of NC-economies during the era of financial globalization. For PC-economies, the findings are much clearer: the greater the size of valuation effects, the worse the extent of risk sharing becomes. For this group, the extent of risk sharing has substantially deteriorated over the last 15 years and is almost non-existent in 2010.

Motivated by the above findings, I proceed to test explicitly whether and to what extent valuation effects inflict welfare costs through volatility in consumption in PC-economies. I also examine whether some inefficiencies in the valuation channel remain in high income and NC-countries. For the PC-group, my results suggest that for every doubling of the size of the valuation channel, consumption volatility increases by about 10 percent. For NC-countries on the other hand, there is no evidence of an adverse impact of valuation effects on consumption smoothing. If anything, an increase in the size of the valuation channel is associated with slightly more stable consumption paths. I also find this to be the case for high income countries. Finally, I conduct a welfare analysis in the spirit of Lucas (1987), Obstfeld

(1994b), and Pallage and Robe (2003) by calculating for a representative consumer the welfare loss in a PC-economy that is due to additional fluctuations in consumption brought about by increased valuation-effect volatility. Using various model economies, the cost estimates point to a substantial welfare loss in the sense that the equivalent variation may exceed 1 percent of permanent consumption. For some countries, however, the welfare cost can be multiples higher.

The rest of the chapter is structured as follows. Section 4.2 defines and provides stylized facts of valuation effects. Section 4.3 examines the link between risk sharing and valuation effects. Section 4.4 analyzes the impact of the valuation channel and consumption smoothing. Section 4.5 conducts the welfare analysis. The final section concludes.

## 4.2 Definition and stylized facts of valuation effects

This section defines and provides some stylized facts about valuation effects. As discussed, the current account is traditionally viewed to measure the change in a country's net foreign asset position. In reality, however, there are two reasons why the current account is an imprecise estimate of the evolution of net external assets. The first is capital transfers (debt relief programs

or migrants' transfers) and discrepancies between the current account and the financial account, commonly called errors and omissions. Lane and Milesi-Ferretti (2007) refer to positive (negative) values of errors and omissions as unrecorded capital inflows (outflows), but they note that errors and omissions could also reflect mismeasured trade flows (or a mixture). Therefore, to the extent that data on stocks do not capture errors and omissions (Lane and Milesi-Ferretti, 2007), the period change in net foreign assets equals the sum of the current account balance (CA), the capital account balance (CAP), and errors and omissions (EOM):

$$\Delta NFA_t = CA_t + CAP_t + EOM_t. \tag{4.1}$$

The second reason is that valuation effects arising from asset price or exchange rate changes are an important driver of net foreign assets, as documented by a number of studies (Tille, 2003; Obstfeld, 2004; Blanchard et al., 2005; Lane and Milesi-Ferretti, 2007; Gourinchas and Rey, 2007). To illustrate, consider the following accumulation equation as discussed by Gourinchas (2008). Define $NFA_{t+1}$ as the economy's net foreign asset position at the end of period $t$. That is, the difference between gross assets ($A_{t+1}$) and gross liabilities ($L_{t+1}$). The period change in net foreign assets is given by:

$$A_{t+1} - L_{t+1} = NFA_{t+1} = R_t\, NFA_t + NX_t + CAP_t + EOM_t, \tag{4.2}$$

where the terms $R_t$ and $NX_t$ refer to the gross net portfolio return and the balance on goods, services, and net transfers, respectively. Adding and subtracting the net investment income balance $NI_t$, we have

$$NFA_{t+1} - NFA_t = (R_t - 1)NFA_t - NI_t + \underbrace{NX_t + NI_t}_{CA_t} + CAP_t + EOM_t$$

$$= \underbrace{[(R_t - 1)NFA_t - NI_t]}_{VAL_t} + CA_t + CAP_t + EOM_t$$

$$= VAL_t + CA_t + CAP_t + EOM_t. \tag{4.3}$$

The change in the NFA is equivalent to the sum of the current account balance, capital transfers, errors and omissions, and a valuation component. Here, the last is equal to the total net return on the net foreign asset portfolio minus income, dividends, and earnings distributed.

Eq. 4.4 can be used to compute valuation terms indirectly:

$$VAL_t = \Delta NFA_t - CA_t - CAP_t - EOM_t. \tag{4.4}$$

Data on net foreign asset positions come from the External Wealth of Nations Mark II (EWN II) database developed by Lane and Milesi-Ferretti (2007). Observations on the current account, capital account, and errors and omissions

are sourced from the IMF's Balance of Payments Statistics. Each variable is scaled by GDP. My analysis includes most countries for which it is possible to obtain at least 20 observations.[2] My final sample then comprises 53 economies, which I classify into 18 high income countries and 35 EMEs.[3] Since the EWNII database starts in 1970, valuation effects can be calculated at annual frequency over the period 1971-2010.

We can now have a closer look at trends and patterns of valuation effects. Although previous studies have done this extensively, their focus is constrained to industrialized countries. Table 4.1 reports a number of characteristics of valuation effects for each of the 53 countries in the sample, extending the analysis of Devereux and Sutherland (2010) to EMEs. Defining $VR = \text{var}(VAL)/\text{var}(NFA)$ as the share of the variation in net foreign assets explained by valuation effects, it turns out that this fraction is rarely below 80 percent for most countries and often close to 100 percent. This means that the current account only accounts for a small fraction of the total variation in international portfolios. Devereux and Sutherland (2010) find that valuation effects are not serially correlated in OECD countries. AR(1) regressions show that this pattern holds for most countries. The coefficients on lagged $VAL_t$ are statistically indistinguishable from zero.[4] Finally, valuation terms

[2]In this study I do not consider Sub-Saharan African countries (except Botswana), other low income countries such as Papua New Guinea and major oil producers (Iran). These countries are not integrated with world financial markets. I also exclude from the sample small countries with population size of below 1 million.

[3]See Table 4A.1 in the Appendix for a complete list of countries.

[4]The AR(1) regression specification is $VAL_t = \beta_0 + \beta_1 VAL_{t-1} + \epsilon_t$.

tend to be centered on zero in most countries, although there are a number of exceptions, especially among EMEs.

Overall, the stylized facts of valuation effects for high income countries seem thus to carry over to EMEs. Devereux and Sutherland (2010) refer to these stylized facts as "first order" in nature, whereas Gourinchas (2008) calls these "unpredictable" (transitory) valuation effects. The unpredictable component of valuation effects is of first order and reflects the flow payment associated with the sharing of output risk across countries. However, a number of studies such as Gourinchas et al. (2010) and Forbes (2010) show that the US benefits from substantial excess returns of gross assets over gross liabilities, which implies the existence of "predictable" valuation effects as well. The predictable component arises from the excess return of a country's international portfolio due to differences in country risk premiums, which, in theory, allows a "safe haven-country" to operate under a persistent current account deficit. Indeed, Gourinchas and Rey (2007) find that a predictable excess return on the US's net foreign asset portfolio contributes 27 percent to the cyclical external adjustment. While significant for the US, the predictable component of valuation effects is of second order and typically "very small" compared to the unpredictable element in dynamic stochastic equilibrium models (Devereux and Sutherland, 2010). In the following, therefore, I will not distinguish between predictable and unpredictable valuation effects.[5]

[5]In any case, note that it is not necessary to differentiate between unpredictable and pre-

Table 4.1: Properties of valuation effects.

| | $\rho(VAL, CA)$ | $\rho(VAL, \Delta y)$ | $\rho(VAL, \Delta c)$ | Mean($VAL$) | sd($VAL$) | VR | AR(1) |
|---|---|---|---|---|---|---|---|
| Argentina | 0.40** | -0.16 | -0.26 | 0.02 | 0.09 | 0.81 | -0.33* |
| Australia | 0.10 | -0.15 | -0.11 | 0.00 | 0.06 | 0.88 | -0.04 |
| Austria | -0.13 | -0.09 | 0.29* | 0.00 | 0.03 | 0.84 | 0.12 |
| Bangladesh | -0.27 | -0.27 | -0.14 | -0.01 | 0.02 | 0.66 | -0.18 |
| Bolivia | 0.07 | 0.38** | 0.06 | 0.02 | 0.08 | 0.45 | 0.36* |
| Botswana | -0.12 | -0.16 | -0.01 | -0.03 | 0.11 | 1.13 | -0.18 |
| Brazil | -0.28 | -0.20 | -0.23 | 0.00 | 0.06 | 1.07 | -0.14 |
| Canada | -0.09 | 0.23 | 0.00 | 0.00 | 0.04 | 0.75 | 0.13 |
| Chile | -0.17 | -0.25 | -0.26 | 0.01 | 0.06 | 0.90 | -0.14 |
| China | -0.03 | -0.20 | -0.15 | 0.00 | 0.02 | 0.33 | -0.18 |
| Colombia | 0.12 | -0.30* | -0.29* | 0.00 | 0.02 | 0.42 | 0.20 |
| Denmark | 0.36** | -0.24 | -0.31 | 0.00 | 0.05 | 0.71 | 0.17 |
| Egypt | 0.54 | -0.35** | -0.10 | -0.02 | 0.06 | 0.48 | 0.11 |
| Finland | 0.06 | -0.20 | -0.10 | -0.01 | 0.21 | 1.05 | 0.29 |
| France | 0.07 | 0.12 | 0.13 | -0.01 | 0.05 | 0.87 | -0.19 |
| Germany | -0.42*** | -0.04 | 0.15 | -0.01 | 0.03 | 0.76 | 0.20 |
| Guatemala | 0.00 | -0.28 | -0.26 | 0.03 | 0.03 | 0.69 | 0.05 |
| Honduras | 0.09 | 0.15 | 0.28* | 0.00 | 0.04 | 0.47 | -0.10 |
| Hungary | 0.29 | -0.07 | -0.23 | -0.01 | 0.08 | 0.66 | 0.24 |
| India | -0.16 | -0.47 | -0.22 | 0.00 | 0.04 | 1.12 | -0.38 |
| Indonesia | -0.14 | 0.25 | 0.07 | -0.03 | 0.07 | 0.65 | -0.03 |
| Israel | 0.00 | -0.01 | 0.09 | 0.00 | 0.04 | 0.42 | -0.17 |
| Italy | -0.21 | -0.02 | -0.11 | 0.00 | 0.03 | 1.09 | 0.20 |
| Jamaica | -0.01 | -0.08 | -0.28 | 0.02 | 0.10 | 0.88 | -0.16 |
| Japan | 0.07 | -0.18 | -0.20 | 0.00 | 0.03 | 0.73 | -0.23 |
| Jordan | 0.05 | -0.23 | -0.16 | -0.02 | 0.16 | 0.89 | -0.08 |
| Korea | -0.35** | 0.12 | 0.19 | -0.02 | 0.06 | 1.04 | -0.23 |
| Malaysia | -0.40*** | 0.04 | 0.01 | -0.03 | 0.07 | 0.69 | 0.25 |
| Mexico | -0.43*** | -0.11 | -0.08 | 0.00 | 0.04 | 1.34 | -0.12 |
| Morocco | -0.43*** | -0.03 | -0.14 | 0.00 | 0.06 | 0.95 | 0.52*** |
| Netherlands | -0.05 | -0.12 | -0.08 | -0.02 | 0.08 | 0.92 | -0.31* |
| New Zealand | -0.16 | -0.08 | -0.13 | -0.01 | 0.11 | 1.00 | 0.19 |
| Norway | -0.12 | -0.16 | -0.19 | 0.00 | 0.06 | 0.45 | -0.14 |
| Pakistan | -0.35** | -0.13 | 0.26 | 0.00 | 0.03 | 0.72 | 0.17 |
| Paraguay | 0.00 | 0.26 | 0.28 | -0.02 | 0.25 | 1.06 | -0.12*** |
| Peru | -0.18 | -0.07 | -0.07 | 0.01 | 0.04 | 0.67 | 0.04 |
| Philippines | -0.34** | 0.19 | 0.07 | 0.00 | 0.04 | 0.87 | 0.13 |
| Poland | -0.23 | -0.06 | 0.04 | -0.01 | 0.05 | 0.87 | -0.04 |
| Portugal | 0.03 | 0.07 | 0.14 | -0.01 | 0.07 | 0.75 | 0.04 |
| Singapore | 0.02 | -0.34** | -0.49*** | 0.04 | 0.21 | 0.74 | -0.04 |
| South Africa | -0.22 | 0.06 | 0.00 | 0.00 | 0.06 | 1.03 | -0.27** |
| Spain | 0.16 | -0.11 | -0.13 | -0.01 | 0.06 | 0.81 | -0.04 |
| Sri Lanka | -0.39 | -0.09 | -0.16 | 0.00 | 0.04 | 0.90 | 0.24 |
| Sweden | -0.22 | -0.11 | 0.02 | -0.01 | 0.04 | 0.93 | 0.17 |
| Switzerland | -0.02 | -0.11 | 0.02 | -0.01 | 0.13 | 1.17 | -0.03 |
| Syrian Arab Republic | -0.21 | 0.11 | 0.23 | -0.01 | 0.13 | 1.20 | 0.11 |
| Thailand | -0.27 | 0.01 | 0.16 | -0.01 | 0.06 | 0.77 | -0.07 |
| Tunisia | 0.18 | 0.18 | -0.04 | -0.03 | 0.06 | 0.81 | -0.07 |
| Turkey | -0.24 | -0.08 | -0.13 | -0.01 | 0.06 | 1.08 | -0.42* |
| United Kingdom | 0.05 | 0.05 | 0.09 | 0.00 | 0.06 | 0.85 | -0.25 |
| United States | -0.35** | -0.10 | -0.10 | 0.01 | 0.03 | 0.87 | -0.06 |
| Uruguay | -0.02 | -0.53*** | -0.46*** | 0.01 | 0.04 | 1.57 | -0.04 |
| Venezuela | 0.06 | 0.12 | 0.15 | -0.01 | 0.05 | 0.49 | 0.03 |

Notes: $\rho(VAL, CA)$ refers to the correlation between valuation effects and the current account. $\rho(VAL, \Delta y)$ is the correlation between valuation effects and real GDP growth. $\rho(VAL, \Delta c)$ denotes the correlation between domestic consumption growth and valuation adjustments. Mean($VAL$) is the average valuation effect over the sample period. The standard deviation of valuation effects is denoted by sd($VAL$). VR is the ratio of the variance of the valuation term over the variance of the change in the net foreign asset position. Column "AR(1)" reports the AR(1) coefficient of the regression $VAL_t = \beta_0 + \beta_1 VAL_{t-1} + \epsilon_t$. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent.

Figure 4.1 reports the yearly valuation adjustment and the current account balance relative to GDP for China, Malaysia, and the US. The common pattern for these three countries is that valuation effects have been of negligible size until the mid 1980s. Since then their magnitude has been steadily increasing. As the example of Malaysia illustrates, wealth transfers via the valuation channel can be large. For instance, following the Asian Financial Crisis, Malaysia experienced a valuation loss that amounted to 20 percent of GDP. This valuation loss was the result of a large nominal exchange rate devaluation (in excess of 30 percent) coupled with substantial foreign currency denominated net debt holdings. As predicted by the portfolio balance model, Malaysia subsequently needed to run a current surplus in order to repay the additional debt incurred through this valuation loss. In Malaysia's case we can observe this pattern in the data. The described example showcases how valuation effects can be destabilizing.

The China-US story comes closer to the scenario of valuation effects being a channel of international risk sharing, as described in Devereux and Sutherland (2010). China's net foreign asset portfolio is long in US dollars and short in domestic equity, whereas the US's international portfolio is long in foreign (Chinese) equity and short in US dollars (Gourinchas, 2008; Lane and Milesi-Ferretti, 2007; Lane and Shambaugh, 2010). Therefore, the combi-

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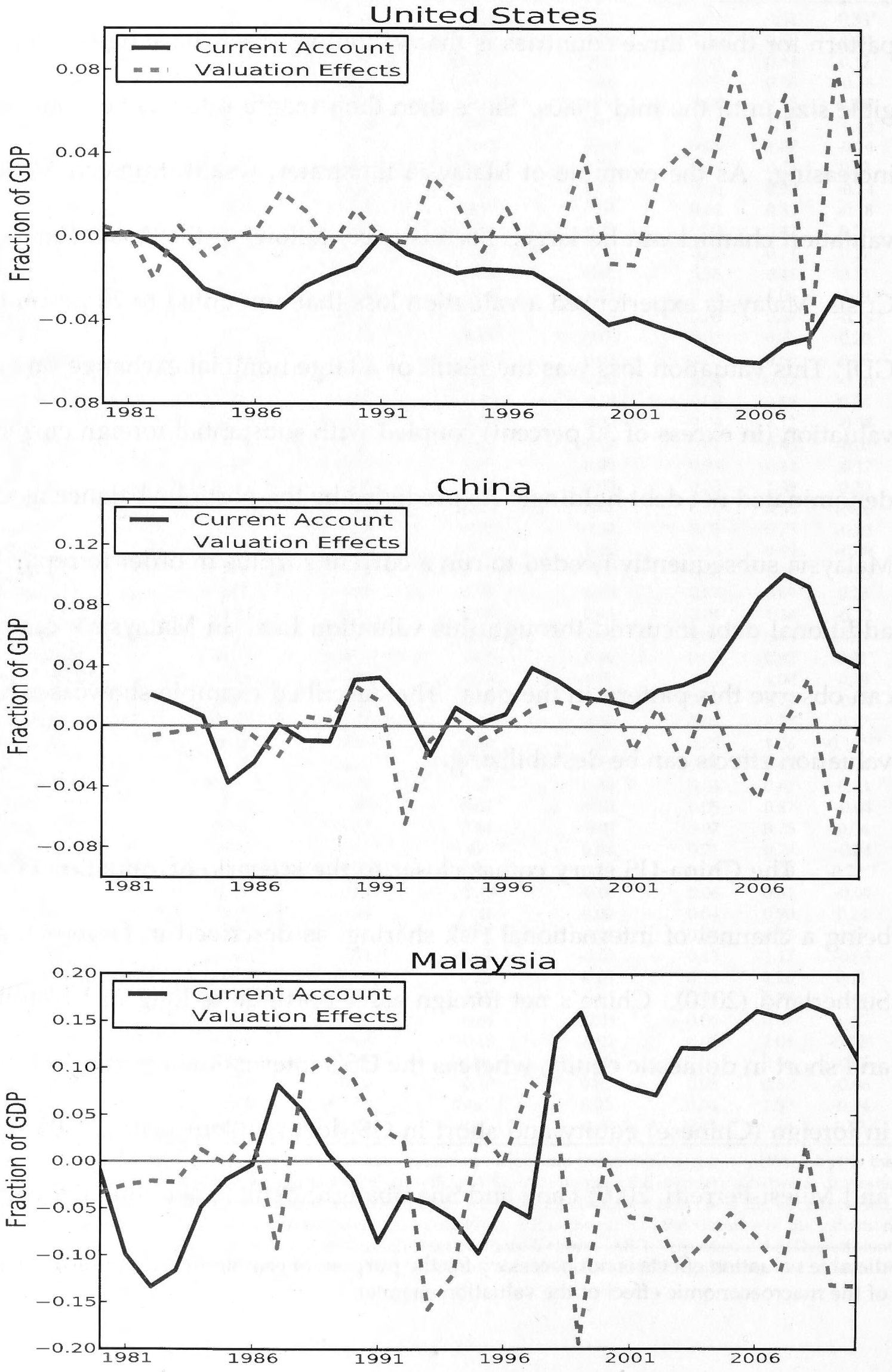
dictable valuation effects is not necessary for the purpose of examining the nature and extent of the macroeconomic effect of the valuation channel.

Figure 4.1: Current account and valuation component for selected countries, 1980-2010.




*Source:* Compiled from Lane and Milesi-Ferretti (2007) and IMF BOP statistics.

nation of a depreciating dollar from 2002 onwards and an excess return on foreign equity has led to substantial valuation gains for the US on the one hand, and valuation losses for China on the other. As is apparent from Figure 4.1, those valuation adjustments have, at least in part, offset the current account balances. During this period, China experienced an unprecedented economic expansion, which was shared with foreign investors, including the US.[6] From the discussion so far we can thus deduce that the theorized sign of the correlation between the current account and the valuation component is negative, regardless of whether valuation effects are stabilizing or destabilizing. Empirically, the negative correlation between valuation effects and the current account seems to hold not only in high income countries, but also in the vast majority of EMEs (see Table 4.1).

In addition, it is particularly worth emphasizing how the amplitude of valuation effects and the index of financial integration, defined as the sum of gross assets and liabilities over GDP, move in the same direction. To illustrate this point, I measure valuation-term volatility as the rolling standard deviation of valuation effects using a window of 10 years.[7] Figure 4.2 reports yearly cross-sectional averages of valuation-term volatility and the index of financial integration for the full sample and for samples of high income coun-

[6] As mentioned, the US is "special" so a significant proportion of these valuation gains would have been attributable to the predictable component.

[7] This means that the estimated standard deviation in period $t$ is the standard deviation computed over the years $t-9$ to $t$.

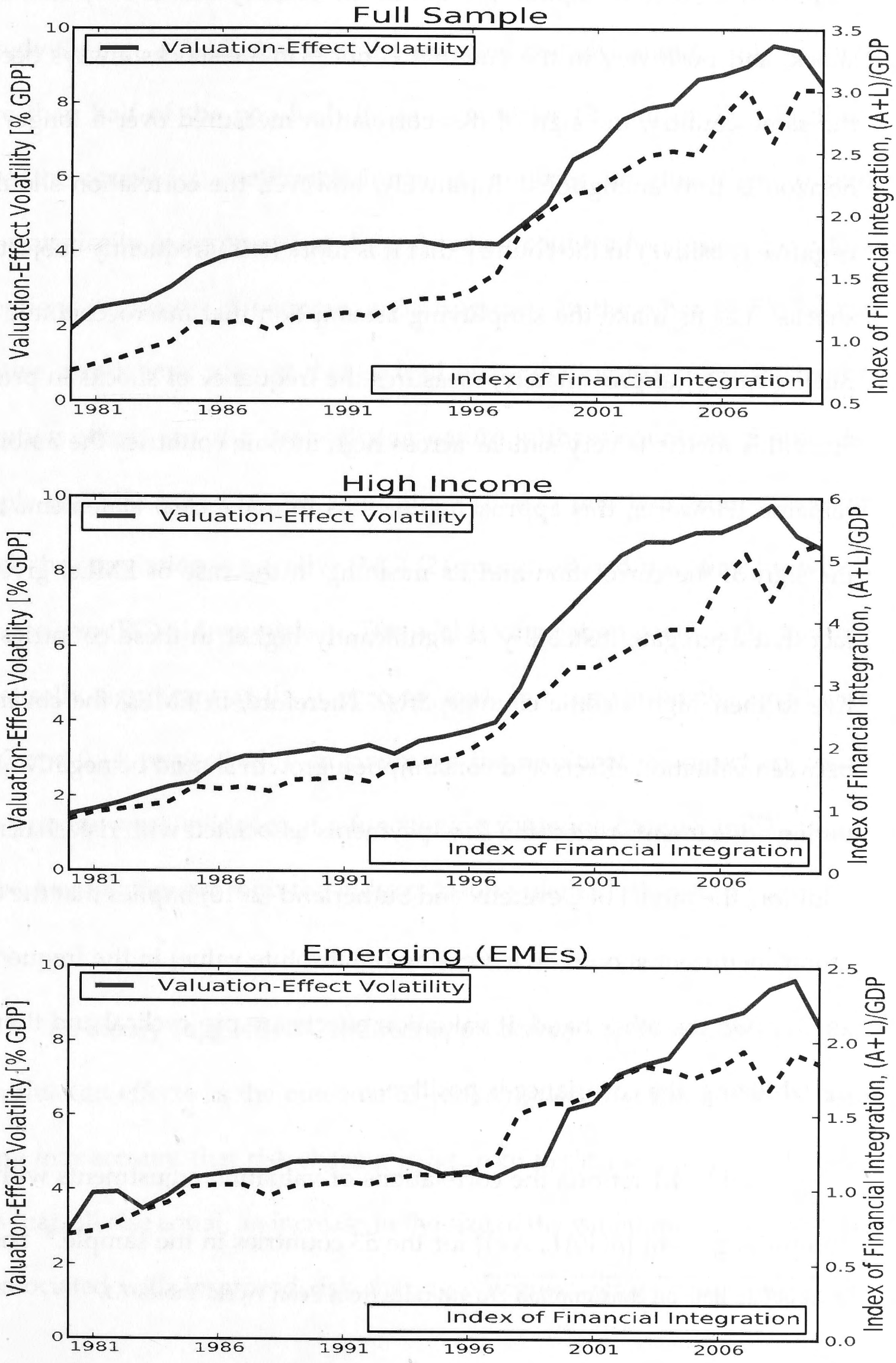
tries and EMEs. These plots clearly show the co-movement between gross asset positions and volatility of valuation adjustments, irrespective of the sample under consideration. The reason is that when a country holds large stocks of assets and liabilities relative to output, even moderate exchange rate movements or asset price changes have a substantial effect on the net external position. As a result of financial globalization, in high income and EMEs alike, the size of the valuation channel in 2010 is at least three times lager relative to 1980.

## 4.3 Valuation effects and risk sharing

This section investigates whether valuation effects satisfy the properties necessary to conclude that the valuation channel facilitates external adjustment in a risk sharing context. The stylized facts discussed in the last section are useful in giving us some idea about the general characteristics and behavior of valuation adjustments, but not the risk sharing properties. There are two ways of examining the functioning of the valuation channel: a direct and an indirect test.

To motivate the direct approach, consider again the example described in the introduction in which the home country experiences an unexpected valuation gain so as to facilitate external adjustment following a negative en-

Figure 4.2: Valuation-effect volatility and index of financial integration, 1980-2010.




*Note:* Volatility measured as the rolling standard deviation over 10-year periods.
*Source:* Compiled from Lane and Milesi-Ferretti (2007) and IMF BOP statistics.

dowment shock. This suggests that the valuation adjustment is negatively correlated with consumption growth in the country that is subjected to the shock, and positively in the one that is not. Unless shocks always occur in the same country, the sign of this correlation measured over a longer time horizon is thus ambiguous. Intuitively, however, the correlation should be negative (positive) in the country that it is more (less) frequently subjected to shocks. Let us make the simplifying assumption that macroeconomic (output) volatility (approximately) measures the frequency of shocks in practice. Since this metric is very similar across high income countries the ambiguity remains. However, this approach allows us to make clear statements about the sign of the correlation and its meaning in the case of EMEs, given the fact that aggregate instability is significantly higher in these countries relative to their high income counterparts. Therefore, in EMEs, the covariance between valuation effects and consumption growth should be negative if valuation adjustments reflect the flow payments associated with risk sharing. In addition, the model of Devereux and Sutherland (2010) implies that the correlation coefficient should be increasing (in absolute value) in the frequency of shocks. On the other hand, if valuation effects are pro-cyclical and therefore destabilizing, the covariance is positive.

Table 4.1 reports the correlations of valuation adjustments with consumption growth $[\rho(VAL, \Delta c)]$ for the 53 countries in the sample.[8] The cor-

[8] I obtain data on consumption growth rates from Penn World Tables 7.1.

relation is negative in some high income countries and positive in others. As argued, this was expected and we cannot infer much from this. More interestingly though, $\rho(VAL, \Delta c)$ is of the expected negative sign in only slightly more than half of the non-high income countries (21 out of 35). Furthermore, the correlation coefficients for most countries are often close to zero and statistically insignificant at the individual country level, save for a few exceptions (Colombia, Singapore, and Uruguay). In the other 14 EMEs, the positive correlations suggest that instead of facilitating external adjustment, valuation effects are of a destabilizing nature in these countries. I split the sample of EMEs based on the sign of $\rho(VAL, \Delta c)$ into two groups, one for which the correlation is negative (NC) (21 countries) and the other for which it is positive (PC) (14 countries). This yields correlation coefficients that are statistically significant at the 1 percent level, but remain on the small side (-0.17 and 0.14, respectively). In summary, the results of the direct approach only provide weak evidence of a functioning valuation channel in EMEs and are best supplemented with the indirect testing method discussed below.

As theory suggests, the indirect approach we can derive by interpreting valuation effects as the outcome of consumption risk sharing while also taking into account that risk sharing is far from perfect in practice. This implies that, all else equal, an increase in the size of the valuation channel should be associated with improved risk sharing outcomes across countries (Gour-

inchas, 2008). The magnitude of the valuation channel refers to the standard deviation of valuation effects, which Devereux and Sutherland (2010) show to be a function of the following variables:

$$\sigma(VAL) = F\left(\underset{(+)}{\frac{A+L}{GDP}}, \underset{(+)}{\sigma_Y}, \underset{(+)}{\phi_Y}\right), \tag{4.5}$$

where (A+L)/GDP denotes the index of financial integration, while $\sigma_Y$ and $\phi_Y$ represent the size and persistence of output shocks, respectively.

Assuming that the persistence of shocks has been unchanged over time and taking into account that the size of shocks has been decreasing due to the Great Moderation, it follows that the observed increase in the size of the valuation channel (cf. Figure 4.2) must have been driven by the proliferation in asset trade over the last few decades. This means that if there is an association between an increase in $\sigma(VAL)$ and better risk sharing, then there is also one with the latter and financial globalization. Based on the results of previous studies such as Kose et al. (2009) and the results of the above direct testing method for the functioning of the valuation channel, we would expect this to be the case for high income countries and the set of NC-economies, but not PC-countries.

### 4.3.1 Empirical model

The framework I use for conducting the indirect approach is similar to previous empirical studies of international risk sharing (Lewis, 1996; Kose et al., 2009). In particular, markets are complete and there are $J$ countries, where country $j$ is populated by $\theta_j$ identical and infinitely lived agents with a constant relative risk aversion (CRRA) utility function over consumption ($c_{jt}$). Country $j$'s expected utility function is:

$$U_0^j = \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \frac{c_{jt}^{1-\gamma}}{1-\gamma} \right\}. \tag{4.6}$$

I assume that the coefficient of risk aversion ($\gamma$) and discount factors ($\beta$) are equal across countries. To find the optimal allocation of cross-country consumption, let us solve the social planner problem of maximizing utility over the $J$ countries subject to the world resource constraint:

$$\sum_{j=1}^{J} \theta_j c_{jt} \leq \sum_{j=1}^{J} \theta_j y_{jt} = f(\zeta_t), \tag{4.7}$$

where output, $y_{jt}$, is stochastic and governed by a vector of country-specific endowment shocks, $\zeta_t$ (Baxter, 2012). The first-order condition with respect to consumption for the $j$-th country at time $t$ is:

$$\beta^t \kappa_j c_{jt}^{-\gamma} = \theta_j \lambda_t, \tag{4.8}$$

where $\kappa_j$ is the weight the planner designates on country $j$. Taking the ratio of the first order conditions at time $t$ to $t-1$ for countries $j$ and $i$ yields the following expression:

$$\frac{\beta c_{jt}^{-\gamma}}{c_{j,t-1}^{-\gamma}} = \frac{\beta c_{it}^{-\gamma}}{c_{i,t-1}^{-\gamma}} = \frac{\lambda_t}{\lambda_{t-1}}. \tag{4.9}$$

This equation says that discounted marginal utility growth rates are equalized across countries. This implies that consumption growth in a specific country should not differ from the world consumption growth rate. In addition, individual-country consumption growth should be unrelated to idiosyncratic risk (Obstfeld, 1994a; Lewis, 1996). The regression framework for empirically testing this hypothesis takes the following form:

$$\Delta ln\, c_{it} - \Delta ln\, C_t^W = \alpha + \beta(\Delta ln\, y_{it} - \Delta ln\, Y_t^W) + \epsilon_{it}, \tag{4.10}$$

where $\alpha$ is a constant and $C^W$ and $Y^W$ refer to world consumption and output per capita, respectively. The second term on the right-hand side represents the measure for country-specific risk: domestic GDP per capita growth demeaned by aggregate world output per capita growth under the assumption that the latter captures uninsurable common shocks (Lewis, 1996). Country idiosyncratic risk is assumed to be exogenous. The stationary mean zero error term, $\epsilon_{it}$, captures measurement errors in consumption.

The null hypothesis of complete risk sharing is $\beta = 0$. But this

hypothesis is typically rejected. In this case, estimates of $\beta > 0$ have the natural interpretation of measuring the proportion of uninsured country idiosyncratic risk. As the extent of international risk sharing improves, this proportion should become smaller. Consequently, the lower the estimate of $\beta$, the higher the degree of international risk sharing. A simple measure for the degree of risk sharing is thus (1-$\beta$), where a value of 1 indicates perfect risk sharing, and 0 no risk sharing (Sørensen et al., 2007; Kose et al., 2009).

I use the above concept to indirectly test whether valuation effects are the outcome of risk sharing. If so, the observed increase in the size of the valuation channel should be associated with better risk sharing. To investigate this formally, I use a similar approach to Sørensen et al. (2007) and estimate the following panel regression:

$$\Delta ln\, c_{it} - \Delta ln\, C_t^W = \alpha + \beta_0(\Delta ln\, y_{it} - \Delta ln\, Y_t^W)$$
$$+ \beta_1 (\Delta ln\, y_{it} - \Delta ln\, Y_t^W) \times VOLVAL_{it} + \epsilon_{it}, \tag{4.11}$$

where *VOLVAL* is the valuation-effect volatility, which serves as the measure for the size of the valuation channel. I define volatility as the rolling standard deviation over 10-year windows. In this setting, the estimate of (1-$\beta_0$) indicates the average degree of risk sharing of the group of countries included

over the time period under study, whereas (1-$\beta_0$-$\beta_1 \times VOLVAL_{jt}$) measures country $j$'s extent of risk sharing at time $t$ (Sørensen et al., 2007; Kose et al., 2009). Consequently, larger fluctuations in valuation effects would be associated with better risk sharing outcomes when $\beta_1$ is negative. I do not include country fixed effects because these might partially pick up differences between a specific country's consumption growth rate and the world growth rate (Flood et al., 2012). I also do not control for year-specific effects since common fluctuations are already controlled for. Either way, these decisions do not affect my results.

### 4.3.2 Data

Section 4.2 has described the procedure and data sources used to calculate valuation effects. Since I define volatility as the rolling standard deviation using 10-year windows, the estimated standard deviation in period $t$ is the standard deviation computed over the years $t-9$ to $t$. The sample period covers the years 1980-2010. I obtain the time series on real consumption and real GDP from Penn World Tables (PWT) 7.1. The PWT-data is balanced for the 53 countries under study so that computing "world" consumption and output growth rates is straightforward.[9]

[9]Here, the "world" comprises the sample of 53 countries.

### 4.3.3 Results

As a starting exercise, I estimate Eq. 4.10 for the full sample of countries and then separately both for the set of high income countries and the EMEs. This allows us to gauge the average degree of risk sharing over the sample period for the group of countries in question. Table 4.2, Panel A, Columns 1-3 reports the results. As expected, the null hypothesis of complete risk sharing ($\beta = 0$) is rejected for every country group. In addition, the estimated extent of risk sharing, (1-$\beta$), is limited across the board – 0.37 for the set of high income countries (Column 2) and 0.20 for the group of EMEs. To specifically test whether there is a link between the magnitude of the valuation channel and risk sharing, I estimate Eq. 4.11 for the same country-groups. Table 4.2 Panel B, Columns 1-3 presents the results. The point estimate of the interaction is negative and statistically significant only for the set of high income countries (Column 2). In particular, the magnitude of the coefficient attached to the interaction term (-0.02) suggests that every percentage point increase in the standard deviation of valuation effects (measured in terms of GDP) would be associated with an improvement in the extent of risk sharing of 0.02. For the group of EMEs the coefficient attached to the interaction term is close to zero and fails to achieve statistical significance, suggesting that there is no link between the size of the valuation channel and risk sharing (Column 3). As mentioned at the beginning of this section, these results were expected.

Table 4.2: Main results — Valuation effects and risk sharing.

| Independent variable | (1) Full | (2) High Income | (3) Emerging | (4) Emerging, $\rho(VAL, \Delta c_{it}) < 0$ | (5) Emerging, $\rho(VAL, \Delta c_{it}) > 0$ |
|---|---|---|---|---|---|
| *Panel A: Output* | | | | | |
| $\Delta ln\, y_{it} - \Delta ln\, Y_t^W$ | 0.79 (0.04)*** | 0.63 (0.04)*** | 0.80 (0.05)*** | 0.80 (0.07)*** | 0.80 (0.05)*** |
| Observations | 1445 | 521 | 924 | 546 | 378 |
| N | 53 | 18 | 35 | 21 | 14 |
| $R^2$ | 0.56 | 0.57 | 0.56 | 0.57 | 0.55 |
| *Panel B: Output and interaction* | | | | | |
| $\Delta ln\, y_{it} - \Delta ln\, Y_t^W$ | 0.83 (0.06)*** | 0.76 (0.04)*** | 0.83 (0.07)*** | 0.93 (0.06)*** | 0.74 (0.06)*** |
| $\Delta ln\, y_{it} - \Delta ln\, Y_t^W$ ×Valuation-Effect Volatility | -0.01 (0.01) | -0.02(0.004)*** | -0.01 (0.01) | -0.02 (0.008)** | 0.01 (0.002)*** |
| Observations | 1445 | 521 | 924 | 546 | 378 |
| N | 53 | 18 | 35 | 21 | 14 |
| $R^2$ | 0.56 | 0.60 | 0.56 | 0.58 | 0.55 |
| *Panel C: Robustness to outliers* | | | | | |
| $\Delta ln\, y_{it} - \Delta ln\, Y_t^W$ | 0.83 (0.06)*** | 0.76 (0.04)*** | 0.82 (0.06)*** | 0.92 (0.08)*** | 0.74 (0.06)*** |
| $\Delta ln\, y_{it} - \Delta ln\, Y_t^W$ ×Valuation-Effect Volatility | -0.01 (0.01) | -0.02(0.004)*** | 0.00 (0.01) | -0.016 (0.016) | 0.01 (0.002)*** |
| Observations | 1445 | 521 | 894 | 516 | 378 |
| N | 53 | 18 | 34 | 20 | 14 |
| $R^2$ | 0.56 | 0.60 | 0.57 | 0.58 | 0.55 |

Notes: The dependent vairable is $\Delta ln\, c_{it} - \Delta ln\, C_t^W$. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Clustered standard errors are in parentheses. Each regression includes a constant. Valuation-effect volatility is defined as the rolling standard deviation over 10-year windows. Columns 5 and 7 include emerging and developing economies only. Columns 7 and 8 restrict the sample to high income countries. Sample period: 1980-2010.

In the following I test whether the lack of association between the degree of risk sharing and valuation-effect fluctuations in EMEs can be explained by the observation that valuation effects in some of these countries do not possess the necessary properties in the sense of risk sharing. Specifically, recall that I argue at the beginning of this section that for valuation effects to reflect flow payments related to risk sharing, they should be negatively correlated with domestic consumption growth in EMEs. I therefore split the sample of EMEs based on the sign of $\rho(VAL, \Delta c)$. I then separately re-estimate Eq. 4.11 for the countries for which the correlation is positive (PC) (21 countries) and negative (NC) (14 countries). Panel B Columns 4 and 5 report the results. For the set of NC-economies, the estimation result changes significantly. The point estimate of the interaction term is now negative and statistically significant at the 5 percent level (Column 5). This suggests that for the NC-group an increase in valuation-effect fluctuations is associated with better risk sharing. However, the degree of risk sharing for this group remains limited. The average during the sample period is 0.07 and, based on the magnitude of the coefficient on the interaction term, improves by 0.02 for every percentage point increase in the rolling standard deviation of valuation effects. The estimation result in Column 4 thus seems to corroborate the earlier formulated hypothesis that valuation effects need to be negatively correlated with consumption growth in EMEs in order to facilitate external adjustment. For the sample of PC-economies on the other hand, the coeffi-

cient attached to the interaction term is significantly positive, meaning that an increase in the size of the valuation channel is associated with worse risk sharing outcomes. The latter is akin to saying that financial globalization worsens risk sharing, since the magnitude of the valuation channel is proportional to gross asset and liability positions (the common *de facto* measure for financial globalization).

A concern related to the above estimates is that outliers might drive the results for the NC-group. This could be the case for Singapore which is not representative of the average NC- country characteristics since it is a financial hub and one of the only countries displaying a strong and statistically significant correlation between valuation adjustments and consumption growth. I therefore re-estimate Eq. 4.11 for the set of NC countries, but with Singapore excluded. Panel C, Column 4 reports the result. The coefficient on the interaction term is still negative, but drops by about one quarter in absolute value and fails to achieve statistical significance at conventional levels. This result is thus more in line with those of the direct approach in the sense that there is, at best, weak evidence that valuation effects satisfying the risk sharing properties. Therefore, Singapore as an outlier was indeed driving the previous result for the NC-group.

### 4.3.4 Evolution of the degree of risk sharing

In light of last the section's findings, it is interesting to explicitly estimate the evolution of the degree of risk sharing for the sets of high income, NC, and PC-countries. The model in Eq. 4.11 allows the extent of risk sharing to vary only through the size of the valuation channel. I follow Kose et al. (2009) and estimate Eq. 4.10 over 10-year rolling panels over the period 1971-2010.[10]

Figure 4.3 plots the evolution of (1-$\beta$) of the panel-estimates over the period 1980-2010. The graphs show that risk sharing has declined for all three country groups up until 1990. Since then the extent of risk sharing has greatly improved in high income countries (from 0.2 to about 0.6), which is not surprising given the results of the previous section. The NC-group has also experienced an increase in the degree of risk sharing after the turning point of 1990. However, this improvement is small in comparison to the high-income group. Also, the extent of risk sharing in 2010 is no better than it was in the 1980s. Nonetheless, this finding provides some evidence that risk sharing has improved during the era of financial globalization for some EMEs; the finding is consistent with the earlier results that there is some weak evidence of a functioning valuation channel in NC-economies. For the set of PC-economies the situation is the opposite. The extent of risk sharing has

[10] Another approach would be to estimate Eq. 4.10 year-by-year and then smooth out the $\beta$s by computing rolling means over 10-year windows. The results of this approach are similar to those obtained by using rolling panels. The latter method is, however, the preferable one since the cross-sections of the various country groups are very small in this study.

further deteriorated after 1990 and is only slightly above 0.1 in 2010.

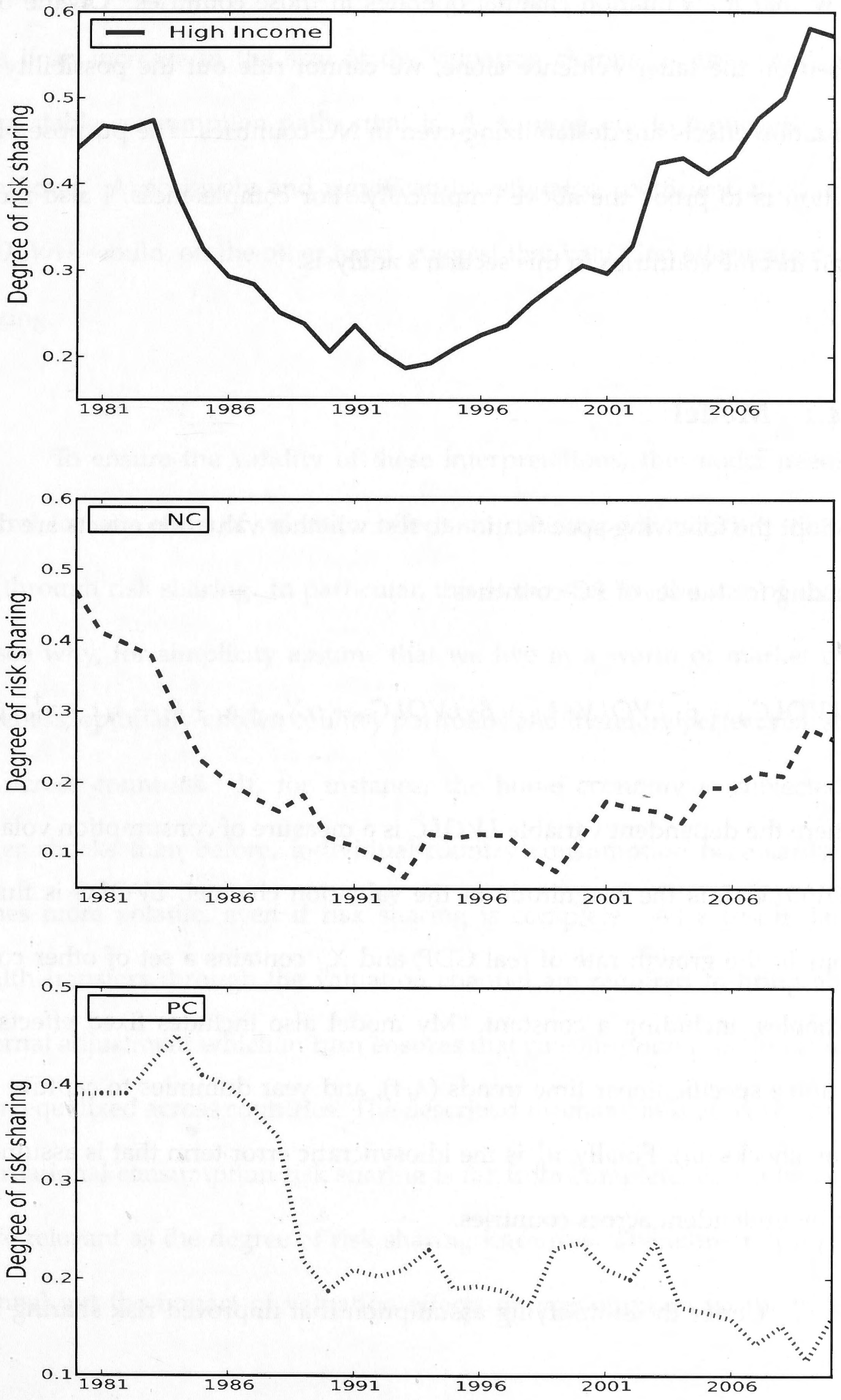
However, one issue with the approach used in this section is that changes in the variance of $(\Delta ln\, y_{it} - \Delta ln\, Y_t^W)$ over time might dilute the estimates of $\beta$ (Kose et al., 2009; Flood et al., 2012).[11] Indeed, in all three country groups, fluctuations in the country-specific output component have been on a steady decline since the 1980s (graph not shown). This development biases the estimates of $\beta$ upward, which puts the results for the PC-group into perspective, but strengthens further the finding that risk sharing improved in high income and NC-economies.

## 4.4 Valuation effects and consumption smoothing

The results of the previous section suggest that an increase in the magnitude of the valuation channel is associated with worse risk sharing in those EMEs where the covariance between consumption growth and valuation effects is positive. Throughout this section I operate under the simplifying assumption that improved risk sharing leads to consumption smoothing. This implies that the valuation channel may inflict welfare costs through volatility in consumption for risk-averse agents in PC-countries. Whether valuation effects are destabilizing in NC-economies is *a priori* ambiguous. On the one hand,

[11] This follows from: $\beta = \frac{\text{cov}(\Delta ln\, c_{it} - \Delta ln\, c_t^W,\, \Delta ln\, y_{it} - \Delta ln\, y_t^W)}{\text{var}(\Delta ln\, y_{it} - \Delta ln\, y_t^W)}$.

Figure 4.3: Evolution of the degree of risk sharing, 1980-2010.



the previous section's analysis generated some weak evidence in favor of the view that the valuation channel operates in those countries. On the other, based on the latter evidence alone, we cannot rule out the possibility that valuation effects are destabilizing even in NC-countries. The purpose of this section is to probe the above empirically. For completeness, I also include high income countries in this section's analysis.

### 4.4.1 Model

I adopt the following specification to test whether valuation effects are destabilizing for the set of PC-countries:

$$LVOLC_{it} = \beta_1 LVOLVAL_{it} + \beta_2 LVOLG_{it} + \gamma X_{it} + \alpha_i + \theta_t + \lambda_i t + u^{\dagger}_{it}, \quad (4.12)$$

where the dependent variable *LVOLC* is a measure of consumption volatility, *LOVOLVAL* is the magnitude of the valuation channel, *LVOLG* is fluctuations in the growth rate of real GDP, and $X_{it}$ contains a set of other control variables, including a constant. My model also includes fixed effects ($\alpha_i$), country-specific linear time trends ($\lambda_i t$), and year dummies to capture common shocks ($\theta_t$). Finally, $u^{\dagger}_{it}$ is the idiosyncratic error term that is assumed to be indepdendent across countries.

Under the simplifying assumption that improved risk sharing leads

to consumption smoothing, the above model can also be used to indirectly test for the functioning of the valuation channel. The latter would be the case if an increase in the size of the valuation channel is associated with more stable consumption paths, that is, $\beta_1$ turning out to be negative and significant. A positively and significantly estimated coefficient attached to *LVOLVAL* would, on the other hand, suggest that valuation effects are destabilizing.

To ensure the validity of these interpretations, the model needs to control for any effect of valuation effects on consumption volatility that occur through risk sharing. In particular, this is the case for the size of shocks. To see why, for simplicity assume that we live in a world of market completeness, optimally-chosen country portfolios and therefore perfect risk sharing across countries. If, for instance, the home economy is subjected to larger shocks than before, individual-country consumption necessarily becomes more volatile, even if risk sharing is complete. As a result, larger wealth transfers through the valuation channel are required to bring about external adjustment which in turn ensures that consumption growth rates remain equalized across countries. The described mechanism is at work, even if international consumption risk sharing is far from complete, and it becomes more relevant as the degree of risk sharing improves. Therefore, to properly channel out the impact of valuation effects on consumption volatility, I in-

clude the volatility of real GDP growth in the model to control for the size of shocks.

Nonetheless, there is one important caveat inherent in the above specification. The assumption that improved risk sharing implies consumption smoothing may not always hold in practice. For example, a country with a low volatility in its endowment stream may start sharing risk with another country that is subject to higher endowment volatility. In this case, the relationship between valuation-effect and consumption volatility would be positive, but it would be wrong to conclude that the valuation channel is destabilizing. In practice, however, this scenario is unlikely to be relevant for EMEs. First, there is little evidence of improved risk sharing outcomes for the emerging country group. Second, even if there was, the average emerging country would share its income risk with high income countries, which, as empirical regularity tells us, are less subject to macroeconomic instability. For high income countries, the stated concern may well be valid. Therefore, $\beta_1$ is perhaps best interpreted as the upper bound estimate of the impact of valuation effect volatility on consumption uncertainty.

As for the other control variables, the volatility of inflation is used to capture the uncertainty that consumers face with respect to their future real income. Moreover, the model adds nominal exchange rate volatility as a control variable. Higher nominal exchange rate volatility inherently mag-

nifies the valuation channel. However, fluctuations in the nominal exchange rate may independently affect consumption patterns, for example through facilitating the adjustment process following external shock (Edwards and Levy Yeyati, 2005). Finally, I control for trade openness, which is motivated by the finding of di Giovanni and Levchenko (2009) that the removal of trade restrictions has a positive and economically significant impact on aggregate volatility. I proxy trade openness, (as is standard in the empirical literature), through the ratio of total exports plus imports to GDP, under the assumption that removing trade restrictions leads to higher trade volumes, all else equal. Table 4A.2 in the Appendix summarizes the details on data sources and definitions.

### 4.4.2 Method

As a first step, I examine the time series properties of the variables. If the individual time series are cross-sectionally dependent, first generation panel unit root tests such as Maddala and Wu (1999) or Im et al. (2003) can lead to invalid inferences. Performing the cross-section dependence (CD) test of Pesaran (2004) reveals that the null hypothesis of cross-section independence is rejected at the 1 percent level (results not reported). Pesaran (2007) shows that an augmentation of standard individual-specific ADF regressions with cross-section averages of lagged levels and first differences of the data series

under consideration can deal with this problem. This procedure results in cross-sectionally augmented ADF statistics (CADF) for each panel individual. Averaging of the group-specific CADF-statistics allows a modified version of the t-bar statistic in Im et al. (2003) to be constructed. Pesaran (2007) tabulates asymptotic critical values under the unit root null. Importantly, the CADF test has satisfactory small sample properties, even for $T$ as small as 10 (Pesaran, 2007). Table 4.3 reports the test results for different lag lengths.[12] The null of nonstationarity cannot be rejected for each of the variables. The next steps involve estimating the long-run relationship between the variables and testing for cointegration. The method adopted in this section is the panel dynamic OLS (DOLS) estimator developed by Mark and Sul (2003). The DOLS method adds leads and lags of first differenced independent variables to the OLS regression. Asymptotically, the DOLS estimates are robust to measurement error and simultaneity and omitted variable bias (Phillips and Durlauf, 1986). In addition, DOLS outperforms other panel cointegration estimators such as fully modified OLS (FMOLS) (Kao and Chiang, 2000; Wagner and Hlouskova, 2009).

The DOLS specification of the model with $m$ leads and lags of first

[12] All CADF regressions include heterogeneous time trends.

Table 4.3: Unit root tests: Pesaran (2007).

*Panel A: Variables in levels*

| lags | LVOLC | LVOLVAL | LVOLG | LVOLINFL | LVOLXR | OPEN |
|---|---|---|---|---|---|---|
| 0 | 1.6 | 1.9 | 4.0 | 6.1 | 3.7 | 2.2 |
| 1 | -0.3 | 0.3 | 1.6 | 3.5 | -0.9 | 2.4 |
| 2 | -0.2 | 2.3 | 4.1 | 5.1 | 0.4 | 3.4 |
| 3 | -1.1 | 4.4 | 3.5 | 4.6 | -2.4*** | 4.6 |

*Panel B: Variables in first differences*

| lags | LVOLC | LVOLVAL | LVOLG | LVOLINFL | LVOLXR | OPEN |
|---|---|---|---|---|---|---|
| 0 | -26.7*** | -17.8*** | -17.0*** | -12.2*** | -7.3*** | -19.5*** |
| 1 | -16.1*** | -10.5*** | -8.7*** | -6.3*** | -4.4*** | -10.5*** |
| 2 | -7.5*** | -4.5*** | -3.2*** | -1.9** | -0.7 | -3.8*** |

Notes: This table reports the Zt-bar statistic under the null hypothesis that all series are nonstationary. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. All ADF regressions for variables in levels include a constant and a trend. ADF regressions for variales in first differences include a constant.

differenced regressors takes the following form:

$$LVOLC_{it} = \alpha_i + \theta_t + \lambda_i t + \beta' x_{it} + u^{\dagger}_{it},$$

$$u^{\dagger}_{it} = \sum_{-m}^{m} \delta_i' \Delta x_{i,t+m} + u_{it}, \tag{4.13}$$

where $x_{it}$ includes the control variables and $[1, -\beta']$ is the cointegrating vector between *LVOLC* and the independent variables.[13] In Mark and Sul's (2003) version of panel DOLS, the cointegrating vector is homogenous across individuals, while country fixed effects ($\alpha_i$), group-specific linear time trends ($\lambda_i t$), and individual-specific short-run dynamics ($\delta_i' \Delta x_{i,t+m}$) account for group-

[13] All my empirical results use $m$=1 as suggested by Mark and Sul (2003).

specific heterogeneity.[14] Common time fixed effects ($\theta_t$) allow for some degree of cross-section dependence, but $u_{it}^{\dagger}$ is assumed to be independent across countries. To ensure that this assumption holds, I resort to Pesaran's (2004) CD test. The idiosyncratic error term is denoted by $u_{it}$.

Finally, cointegration requires that the residuals are stationary. To examine this property, I employ the Ztbar (IPS) test of Im et al. (2003).

### 4.4.3 Results

I first estimate the model as specified in Eq. 4.12 for the sample of EMEs. Table 4.4, Column 1 presents the estimation result.[15,16] The coefficient attached to valuation-effect volatility is positive and statistically significant at the 1 percent level. The magnitude of the coefficient (0.06) suggests that a doubling of the size of the valuation channel increases volatility in consumption paths by about 6 percent. This result thus seems to confirm the concern that valuation effects inflict welfare costs in EMEs.

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[14] Heterogeneous deterministic trends may also capture the effect of determinants of macroeconomic volatility for which reliable data are not available, especially at annual frequencies (e.g. institutional quality).

[15] All specifications include time fixed effects initially but they turned out to be statistically insignificant. The final model thus contains fixed effects and country-specific time trends. Including the latter reduces the information criteria significantly.

[16] For all specifications, diagnostic testing on the residuals using Pesaran's (2004) CD test suggests that the hypothesis of cross-section independence in the residuals cannot be rejected at the 10 percent level (results not reported). Furthermore, the null of no cointegration can be rejected at the 1 percent level based on the IPS test. In the following, no further reference to this will be made unless the null of no cointegration cannot be rejected.

Table 4.4: Valuation effects and consumption smoothing.

| Independent variable | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Emerging | Emerging | Emerging, $\rho(VAL, \Delta c_{it}) < 0$ | Emerging, $\rho(VAL, \Delta c_{it}) > 0$ | High Income |
| Valuation Effect-Volatility | 0.06 (0.02)** | 0.09 (0.04)*** | 0.01 (0.04) | 0.12 (0.05)*** | 0.06 (0.06) |
| Real GDP Growth-Volatility | 0.93 (0.03)*** | 0.94 (0.03)*** | 0.93 (0.05)*** | 0.86 (0.05)*** | 0.78 (0.07)*** |
| Inflation Volatility | 0.12 (0.01)*** | 0.12 (0.02)*** | 0.14 (0.02)*** | | 0.11 (0.05)*** |
| Nominal Exchange Rate-Volatility | -0.06 (0.01)*** | -0.06 (0.01)*** | -0.07 (0.02)*** | -0.03 (0.02)** | -0.10 (0.04)*** |
| Trade Openness | 0.35 (0.07)*** | 0.36 (0.07)*** | | 0.63 (0.11)*** | |
| $\rho(VAL, \Delta c_{it}) < 0$ ×Valuation-Effect Volatility | | -0.09 (0.05)* | | | |
| Observations | 735 | 735 | 438 | 322 | 429 |
| N | 34 | 34 | 20 | 14 | 18 |
| IPS (p-value) | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 |

Notes: The dependent variable is consumption growth volatility. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Standard errors are in parentheses. IPS refers to the Im et al. (2003) unit root test performed on the residuals under the unit root null. Singapore is excluded from the sample of EMEs.

It is sensible to believe, however, that the EMEs are not a homogenous group in terms of how consumption uncertainty is affected by valuation effects. In particular, we would expect valuation effects to be considerably more destabilizing in PC-countries than in NC-economies because they are pro-cyclical in the former and countercyclical in the latter. To incorporate these possible differences in the model, in the following I include as an additional regressor a dummy variable for NC-countries, which is interacted with valuation effect fluctuations. Column 2 reports the result for this new specification. This result suggests that the impact of valuation effects on consumption uncertainty is indeed heterogenous across EMEs. The magnitude of the estimated coefficient attached to the size of the valuation channel is 0.09 and significant at the 1 percent level; this suggests that a twofold increase in valuation effect fluctuations magnifies consumption volatility by about 9 percent in PC-countries. Conversely, valuation effects do not seem to have a material effect on consumption volatility in NC-countries: the point estimate of the interaction term is -0.09 and significant at the 10 percent level. For comparison, I estimate the baseline model (Eq. 4.12) separately for the NC and PC groups. The estimation result changes very little compared to the previous one in the sense that valuation effects seem to be destabilizing only in PC but not NC economies (Columns 3 and 4).[17]

[17]I only report the most parsimonious specification, meaning that if a regressor other than valuation effect-volatility turns out to be statistically insignificant, it is dropped.

Finally, it is worthwhile investigating how an increase in the size of the valuation channel affects consumption volatility in high income countries. I thus re-estimate the baseline model, restricting the sample to high income countries. Column 5 shows the result. The point estimate of valuation effect fluctuations is positive but statistically indistinguishable from zero. Does this result contradict the finding of the last section that an increase in the magnitude of the valuation channel is associated with better risk sharing? The answer is no. While we would have expected valuation effect volatility to be negatively associated with consumption fluctuations, as mentioned at the beginning of this section, this needs not necessarily be the case, e.g. when the average high income country enters risk sharing arrangements with countries that are subjected to larger shocks than itself. For this reason, the framework used in Section 4.3.1 to test for the functioning of the valuation channel is preferable to the one of this section, as the latter cannot incorporate the scenario just described.

In the following I probe the sensitivity of the above results to defining volatility as the rolling standard deviation over 10-year windows. To this end I use 5- and 7-year windows for calculating rolling standard deviations. I first re-do the analysis for the sample of EMEs using 7-year windows and the specification that includes the interaction term for NC-economies (cf. Table 4.4, Column 2). The rolling standard deviations are calculated over 7-year win-

dows. Table 4.5, Column 1 reports the result. The point estimate of valuation effect volatility is significant at the 1 percent level and suggests that a twofold increase in the size of valuation effects amplifies consumption growth volatility by about 13 percent, which is very similar to the previously estimated 9 percent. Another slight difference is that for NC-economies an increase in the magnitude of the valuation channel seems to be associated with more stable consumption paths. But based on the magnitude of the coefficient attached to the interaction term (-0.18, significant at the 1 percent level), this effect is rather small: consumption volatility decreases by 5 percent as fluctuations in valuation effects double. This result can again be seen as weak evidence of a functioning valuation channel in NC-countries. However, the latter finding does not carry over to using 5-year windows for calculating the rolling standard deviations (Table 4.5, Column 3). The coefficient on the interaction term is smaller in magnitude than the one attached to valuation effect volatility. This corroborates the previous findings in this paper that the evidence regarding the operation of the valuation channel in NC-economies is at best weak. As for the PC-group, Column 3 adds further support to the notion that valuation effects are destabilizing in these countries. The estimated valuation effect-volatility elasticity is again 0.13 and significant at the 1 percent level.

Another interesting difference compared to the main results is that a larger valuation channel is related to more stable consumption paths in high

Table 4.5: Robustness: Alternative window lengths.

| Independent variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Emerging | High Income | Emerging | High Income |
| Valuation Effect-Volatility | 0.13 (0.03)*** | -0.13 (0.05)*** | 0.13 (0.06)** | -0.10 (0.05)** |
| Real GDP Growth-Volatility | 0.64 (0.05)*** | 0.72 (0.03)*** | 0.56 (0.06)*** | 0.54 (0.06)*** |
| Inflation Volatility | 0.06 (0.02)*** | | 0.09 (0.03)*** | |
| Nominal Exchange Rate-Volatility | | -0.06 (0.01)*** | | 0.10 (0.05)** |
| Trade Openness | 0.39 (0.17)** | -0.99 (0.33)*** | 0.73 (0.22)*** | -1.38 (0.33)*** |
| $\rho(VAL, \Delta c_{it}) < 0 \times$Valuation-Effect Volatility | -0.18 (0.06)*** | | -0.10 (0.08) | |
| Observations | 840 | 464 | 914 | 507 |
| N | 34 | 18 | 34 | 18 |
| IPS (p-value) | 0.07 | 0.04 | 0.03 | 0.00 |

Notes: The dependent variable is consumption growth volatility. ***, **, * denote the level of statistical significance at 1, 5, and 10 percent. Standard errors are in parentheses. IPS refers to the Im et al. (2003) unit root test performed on the residuals under the unit root null. In Columns 1 and 2 (3 and 4), volatility is defined as the rolling standard deviation over 7- (5-) year windows. Singapore is excluded from the sample of EMEs.

income countries (Columns 2 and 4). Regardless of window length, the coefficient on valuation effect-volatility is estimated negatively and significant at least at the 5 percent level. These results thus further strengthen the earlier finding that the valuation channel operates effectively in high income countries.

## 4.5 Welfare analysis

The previous section estimated the valuation-effect volatility elasticity of consumption variability at around 0.1 in PC-countries. While this number indicates that even a mere doubling of valuation-effect variability substantially increases consumption uncertainty in a *ceteris paribus* sense, it leaves open the question of how much the associated welfare loss amounts to for risk-averse consumers in PC-countries. The study of Pallage and Robe (2003) suggests

that this cost is far from trivial. They assess how much a representative agent would gain if all fluctuations in consumption were to be eliminated in developing countries. Due to the large menu of available modeling choices they are unable to pin down this welfare gain to a definite number. However, the common feature emerging across all of their specifications is that the welfare gain is always at least 10 times larger in developing countries compared to the US They also find that in many developing countries a representative consumer would, if given the choice, strictly prefer seeing all consumption uncertainty eliminated relative to being awarded an additional percentage point increase in consumption forever.

To provide a more definite quantity of the welfare cost stemming from valuation effects, I conduct a welfare analysis on the basis of last section's elasticity estimates. I use as the benchmark the NC-group, for which, based on the main results of the previous section, valuation effect-volatility has no impact on consumption uncertainty. Moreover, to ensure that my cost estimates are not driven by particular assumptions, in what follows, I consider two different model economies. They build heavily on Lucas (1987), Obstfeld (1994b), and Pallage and Robe (2003).

### 4.5.1 The model economies

Individuals are assumed to be identical and population sizes are normalized to one infinitely lived agent. The consumer in the first economy has constant relative risk aversion (CRRA) preferences over consumption streams (the level of real per capita consumption) $\{C_t\}_{t=0}^{\infty}$ :

$$U_0 = \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \frac{C_t^{1-\gamma}}{1-\gamma} - \frac{1}{1-\gamma} \right\}, \tag{4.14}$$

where $\beta \in (0,1)$ is the subjective discount factor and the parameter $\gamma$ ($\gamma \geq 0$) refers to the constant coefficient of risk aversion.

In both economies, consumption is assumed to follow a random walk as in Obstfeld (1994b):

$$C_t = (1+g)\, C_{t-1}\, e^{(\nu_t - \frac{1}{2}\sigma_\nu^2)}. \tag{4.15}$$

Here, $g$ refers to the trend growth rate of consumption, $\{\nu_t\}$ is a stationary process given by $\nu_t \sim N(0, \sigma_\nu^2)$, and $\mathbb{E}[e^{(\nu_t - \frac{1}{2}\sigma_\nu^2)}] = 1$. Letting lower case letters denote natural logarithms and using the approximation $ln(1+x) = x$, the process in Eq. 4.15 can be rewritten as:

$$c_t = g + c_{t-1} - \frac{1}{2}\sigma_\nu^2 + \nu_t, \qquad \text{where} \qquad \nu_t \sim N(0, \sigma_\nu^2). \tag{4.16}$$

Assuming this process means that shocks are cumulative over time and the conditional variance is time varying. This implies greater uncertainty with respect to consumption for consumers compared to a process in which consumption randomly fluctuates around a deterministic trend (Obstfeld, 1994b).

In the second economy, consumption also follows a random walk. However, to incorporate in the consumers' preferences their willingness to substitute over time, following Obstfeld (1994b) and Pallage and Robe (2003), I also consider the Epstein and Zin (1989) recursion as formulated by Weil (1990):

$$U_t = \frac{\left((1-\beta)C_t^{(1-\theta)} + \beta\left[1+(1-\beta)(1-\gamma)\mathbb{E}_t(U_{t+1})\right]^{(1-\theta)/(1-\gamma)}\right)^{(1-\gamma)/(1-\theta)} - 1}{(1-\beta)(1-\gamma)}, \tag{4.17}$$

where the inverse of $\theta$ refers to the elasticity of intertemporal substitution, meaning the higher the value of $\theta$, the less agents are willing to substitute consumption over time and vice versa. Under the restriction that $\gamma = \theta$, the preferences in Eq. 4.17 reduce to:

$$U_t = \left\{\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{1}{1-\gamma}\right\} + \mathbb{E}_t(U_{t+1}). \tag{4.18}$$

This is the recursive expression of CRRA preferences used in the first economy. Therefore, the preferences in Eq. 4.17 relax the restrictive assumption that the parameter of the intertemporal elasticity of substitution be the same

as the inverse of the risk aversion coefficient.

### 4.5.2 Calculating welfare costs

One way to evaluate the welfare cost of additional consumption fluctuations is to rely on the equivalent variation, defined as the uniform percentage increase of consumption across all states and dates that renders the consumer as well off after a shift from $(g, \sigma^2)$ to $(g', \sigma'^2)$. More formally, the equivalent variation denoted by $\lambda$ is expressed as $U[(1+\lambda)C_0, g, \sigma^2] = U[C_0, g', \sigma'^2]$. The consumption process as assumed in Eqs. 4.15 and 4.16 makes it possible to derive closed-form solutions for $\lambda$. This can be done through the direct calculation of lifetime expected utility followed by using the definition of the equivalence variation.[18] In the first economy, the equivalent variation, $\lambda_1[(g, \sigma_v^2), (g', \sigma_v'^2), \gamma]$, is given by:

$$\lambda_1[(g, \sigma_v^2), (g', \sigma_v'^2), \gamma] = \begin{cases} \left[\frac{1-\beta e^{(1-\gamma)(g-\frac{1}{2}\gamma\sigma_v^2)}}{1-\beta e^{(1-\gamma)(g'-\frac{1}{2}\gamma\sigma_v'^2)}}\right]^{(1-\gamma)^{-1}} - 1 & \text{for } \gamma \neq 1 \\ \left[e^{(g'-g)-\frac{1}{2}(\sigma_v'^2-\sigma_v^2)}\right]^{\beta/1-\beta} - 1 & \text{for } \gamma = 1. \end{cases} \tag{4.19}$$

[18] Obstfeld (1994b) derives these measures.

In the second economy, the fraction $\lambda_2(\cdot)$ of initial consumption that needs to be increased to make the consumer as well off as before is:

$$\lambda_2[(g,\sigma_v^2),(g',\sigma_v'^2),\theta,\gamma] = \left[\frac{1-\beta e^{(1-\theta)(g-\frac{1}{2}\gamma\sigma_v^2)}}{1-\beta e^{(1-\theta)(g'-\frac{1}{2}\gamma\sigma_v'^2)}}\right]^{(1-\theta)^{-1}} - 1 \quad \text{for } \theta \neq 1. \tag{4.20}$$

These equivalent variation measures highlight the link between uncertainty in consumption and risk aversion. When consumption follows a random walk, the cumulative nature of shocks results in the trend growth rate of becoming downward adjusted $(g - \gamma\sigma_v^2/2)$ (Obstfeld, 1994b). This adjustment is linear in both the risk aversion parameter and the variability of random shocks.[19] A comparison of Eqs. 4.19 and 4.20 demonstrates the role of intertemporal substitutability. As before, $\gamma$ determines the extent to which consumption variability adjusts the trend growth rate downwards. The role of $\theta$ is to assess the impact of changes in the risk-adjusted growth rate on welfare. In particular, a low elasticity of substitution (high $\theta$) means that an increase in trend growth accompanied by an increase in the interest rate leads to a relatively low rise in the consumption growth rate (Obstfeld, 1994b). The welfare gain is then relatively small, due to the fact that a higher $\theta$ implies relatively quickly declining intertemporal marginal utilities. In Eq. 4.19, by assumption $\gamma = \theta$, thus the risk aversion parameter also governs the welfare impact of this effect.

[19]Note that the welfare impact of the variability is nonlinear. See Obstfeld (1994b) for details.

Another way to assess the welfare change due to increased fluctuations is to ask by how much the trend growth rate has to rise perpetually to leave the consumer indifferent between a shift from $(g, \sigma^2)$ to $(g', \sigma'^2)$. The necessary change in the trend growth rate, $\Delta g = g' - g$, can be computed using the expression $U[C_0, g, \sigma^2] = U[C_0, g', \sigma'^2]$ and is given by:

$$\Delta g = \frac{1}{2}\gamma(\sigma'^2 - \sigma^2). \tag{4.21}$$

The required increase in trend growth depends, in a linear fashion, on the change in uncertainty and the degree of risk aversion. This cost measure is independent of the intertemporal elasticity of substitution because it equates the risk-adjusted trend growth rates $(g - \gamma\sigma_v^2/2)$ and $(g' - \gamma\sigma_v'^2/2)$ by construction, thus leaving no room for $\theta$ to enter the picture. However, there is a similar cost measure that also incorporates the intertemporal elasticity of substitution: this is done by comparing the equivalent variation to the cost a representative consumer faces with Epstein-Zin preferences after being stripped of a certain percentage of trend growth in consumption.

### 4.5.3 Calibration

The next step in evaluating the welfare cost associated with higher consumption uncertainty involves parameterizing the model economies to obtain nu-

merical solutions for the equivalent variations $\lambda_1$ and $\lambda_2$. I report results for each of the 14 countries that belong to the sample of PC-economies.

For the consumption process, the sample variance of the growth rate of consumption serves as the point estimate of $\sigma_v^2$.[20] Point estimates for the trend growth rate $g$ come from the addition of the sample mean of consumption growth and $\frac{1}{2}\sigma_v^2$.[21]

For the parameterization of the change in consumption uncertainty due to valuation-effect volatility ($\sigma'^2$), I use the underlying elasticity estimates of the previous section, under the assumption that valuation-effect variability has doubled in each country.[22] In light of the estimation results, I set $\sigma_v'$ 10 percent higher compared to $\sigma_v$ (see Table 4.4, Column 2; Table 4.5, Columns 1 and 3).

As for the other parameters, I follow Pallage and Robe (2003) and assume that the subjective discount factor $\beta$ equals 0.96. Other plausible $\beta$-values do not change the results much. Based on previous studies, the range of the coefficient of constant relative risk aversion is recognized to be anywhere in the interval $\gamma \in [1, 10]$. I therefore consider the following set of $\gamma$-values: $\gamma \in \{1, 2, 4, 7, 10\}$. Ogaki et al. (1996) estimate elasticities of

[20] It is readily verified that when consumption follows the process $c_t = g + c_{t-1} - \frac{1}{2}\sigma_v^2 + v_t$, then $\mathbb{E}[(c_t - c_{t-1}) - \mu]^2 = \sigma_v^2$, where $\mu$ is the expected value of consumption growth.

[21] Similarly, this follows from the fact that $\mathbb{E}[(c_t - c_{t-1})] = g - \frac{1}{2}\sigma_v^2$.

[22] This setting should be viewed as the lower bound since for many countries such as Indonesia, Malaysia, and Thailand variability in valuation effects has, in fact, quadrupled since the early 1980s. Also, see Figure 4.2

intertemporal substitution for a large group of developing countries. Their results suggest that the upper and lower bound of $\theta$ is 0.8 and close to zero, respectively. To cover that interval, I use the values $\theta \in \{1.25, 2, 4, 7, 10\}$.

**First economy** Table 4.6 shows the welfare loss, $\lambda_1$, associated with a doubling of valuation-effect volatility for the sample of PC-countries. The table reports these estimates for various values of the risk aversion parameter $\gamma$. As an additional cost estimate for comparison, I report the amount of additional trend growth that would be required to exactly offset $\lambda_1$ (cf. Eq. 4.21). Since the welfare loss of increased fluctuations depends on the risk-adjusted growth rate in this economy (cf. Eq. 4.19), the cumulative nature of random shocks results in significantly higher cost estimates compared to when consumption only fluctuates around the trend line, such as in Lucas (1987). The general pattern is that, other things being equal, the welfare cost of additional consumption uncertainty is higher in countries with an already high volatility of consumption growth, and lower for countries with a relatively high trend growth rate.

This means that the cost estimate rarely exceeds 1 percent of permanent consumption for countries with an trend growth rate above 3 percent. For instance, Korea's consumption growth volatility and trend growth rate is 3.9 and 5.1 percent, respectively. The cost estimates are always close to 0.3 percent of permanent consumption, independent of the value of the risk

Table 4.6: Cost of valuation-effect volatility (CRRA preferences) — PC-countries.

| | | | Cost of Valuation-Effect Volatility (in Percent) | | | | | Additional Trend Growth Required to Compensate For Volatility Increase | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\gamma$ | | | | | $\gamma$ | | | | |
| Country | $\sigma_v$ | $g$ | 1 | 2 | 4 | 7 | 10 | 1 | 2 | 4 | 7 | 10 |
| Bolivia | 2.86 | 0.57 | 0.21 | 0.37 | 0.64 | 1.04 | 1.62 | 0.01 | 0.02 | 0.03 | 0.06 | 0.09 |
| Honduras | 3.97 | 1.28 | 0.40 | 0.62 | 0.93 | 1.37 | 2.05 | 0.02 | 0.03 | 0.07 | 0.12 | 0.17 |
| Indonesia | 4.20 | 4.56 | 0.44 | 0.42 | 0.41 | 0.41 | 0.42 | 0.02 | 0.04 | 0.07 | 0.13 | 0.19 |
| Israel | 3.70 | 2.15 | 0.34 | 0.46 | 0.57 | 0.68 | 0.79 | 0.01 | 0.03 | 0.06 | 0.10 | 0.14 |
| Korea | 3.88 | 5.09 | 0.38 | 0.34 | 0.31 | 0.30 | 0.30 | 0.02 | 0.03 | 0.06 | 0.11 | 0.16 |
| Malaysia | 5.70 | 4.26 | 0.82 | 0.82 | 0.86 | 0.96 | 1.13 | 0.03 | 0.07 | 0.14 | 0.24 | 0.34 |
| Pakistan | 3.84 | 2.14 | 0.37 | 0.49 | 0.62 | 0.74 | 0.88 | 0.02 | 0.03 | 0.06 | 0.11 | 0.15 |
| Philippines | 1.66 | 1.49 | 0.07 | 0.10 | 0.13 | 0.15 | 0.16 | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 |
| Poland | 5.03 | 2.52 | 0.63 | 0.81 | 1.01 | 1.30 | 1.73 | 0.03 | 0.05 | 0.11 | 0.19 | 0.27 |
| Paraguay | 4.96 | 1.94 | 0.62 | 0.87 | 1.19 | 1.71 | 2.64 | 0.03 | 0.05 | 0.10 | 0.18 | 0.26 |
| Syria | 10.24 | 2.07 | 2.61 | 4.21 | 12.33 | | | 0.11 | 0.22 | 0.44 | 0.77 | 1.10 |
| Thailand | 3.77 | 3.70 | 0.36 | 0.38 | 0.39 | 0.40 | 0.42 | 0.01 | 0.03 | 0.06 | 0.10 | 0.15 |
| Venezuela | 7.19 | 1.83 | 1.30 | 1.96 | 3.37 | 12.02 | | 0.05 | 0.11 | 0.22 | 0.38 | 0.54 |
| South Africa | 2.52 | 1.33 | 0.16 | 0.24 | 0.34 | 0.42 | 0.49 | 0.01 | 0.01 | 0.03 | 0.05 | 0.07 |

Notes: $\sigma_v$ refers to the standard deviation of the consumption growth rate. $g$ is the trend growth rate in consumption. $\gamma$ denotes the paramter of constant relative risk aversion.

aversion parameter, $\gamma$. The welfare-loss estimates for Indonesia and Thailand are very similar to the ones for Korea, because these countries share almost the same characteristics in terms of the trend growth rate and volatility in consumption. For Malaysia, the cost estimates are slightly higher, which is the result of consumption paths being considerably more uncertain than, for example, in Korea. For a representative agent with a risk aversion parameter of $\gamma = 10$, an additional 1.1 percent in permanent consumption would be needed to offset the 10 percent increase in $\sigma_v$ that emanates from valuation effects. Nonetheless, notice that in some of the aforementioned countries, the size of the valuation channel has quadrupled over the last few decades. This means that the welfare cost may exceed 1 percent of permanent consumption, even in a country such as Korea.

There are some countries for which the cost estimates are extraordinarily high. For instance, for Syria or Venezuela where consumption uncertainty is high and growth relatively low, a representative consumer who is relatively risk-averse ($\gamma \geq 7$) would require an additional 0.5 percentage points of consumption growth forever in order to be compensated for the increase in consumption fluctuations caused by valuation-effect volatility.

**Second economy** I report the welfare cost estimate $\lambda_2$ and the cost associated with a 0.5 percent forgone trend growth rate for all members of the PC-group in Table 4.7. Since in this economy the representative consumer's preferences separate risk aversion from the elasticity of intertemporal substitution, Table 4.7 provides the cost estimates for different values of $\gamma$ and $\theta$ in matrix form for each country. This means that diagonal entries represent the welfare loss in the CRRA case (for $\gamma, \theta \geq 2$).

Table 4.7: Cost of valuation-effect volatility (Epstein-Zin preferences) – PC-Countries.

| | | | | Cost of Valuation-Effect Volatility (in Percent) | | | | | Cost of Foregone 0.5% Trend Growth (in Percent) | | | | | Cost of Valuation-Effect Volatility exceeding Cost of Foregone Trend growth? | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\theta$ | | | | | $\theta$ | | | | | $\theta$ | | | | |
| Country | $\sigma_v$ | $g$ | $\gamma$ | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 |
| Bolivia | 2.80 | 0.71 | 1.00 | 0.19 | 0.17 | 0.13 | 0.10 | 0.08 | 11.04 | 10.30 | 8.76 | 7.18 | 6.09 | No | No | No | No | No |
| | | | 2.00 | 0.38 | 0.34 | 0.27 | 0.20 | 0.16 | 11.06 | 10.38 | 8.96 | 7.45 | 6.40 | No | No | No | No | No |
| | | | 4.00 | 0.76 | 0.70 | 0.56 | 0.43 | 0.35 | 11.11 | 10.56 | 9.37 | 8.07 | 7.11 | No | No | No | No | No |
| | | | 7.00 | 1.34 | 1.25 | 1.06 | 0.85 | 0.72 | 11.19 | 10.85 | 10.08 | 9.21 | 8.55 | No | No | No | No | No |
| | | | 10.00 | 1.93 | 1.84 | 1.63 | 1.39 | 1.21 | 11.26 | 11.14 | 10.90 | 10.72 | 10.74 | No | No | No | No | No |
| Honduras | 3.93 | 1.10 | 1.00 | 0.36 | 0.31 | 0.22 | 0.15 | 0.11 | 10.81 | 9.56 | 7.31 | 5.38 | 4.24 | No | No | No | No | No |
| | | | 2.00 | 0.73 | 0.63 | 0.45 | 0.32 | 0.24 | 10.86 | 9.71 | 7.58 | 5.69 | 4.54 | No | No | No | No | No |
| | | | 4.00 | 1.47 | 1.30 | 0.98 | 0.71 | 0.56 | 10.96 | 10.03 | 8.19 | 6.43 | 5.29 | No | No | No | No | No |
| | | | 7.00 | 2.60 | 2.38 | 1.95 | 1.52 | 1.25 | 11.10 | 10.54 | 9.32 | 7.98 | 7.01 | No | No | No | No | No |
| | | | 10.00 | 3.75 | 3.59 | 3.22 | 2.78 | 2.45 | 11.25 | 11.10 | 10.79 | 10.50 | 10.39 | No | No | No | No | No |
| Indonesia | 4.04 | 4.50 | 1.00 | 0.32 | 0.19 | 0.09 | 0.05 | 0.03 | 9.07 | 5.65 | 2.74 | 1.47 | 0.97 | No | No | No | No | No |
| | | | 2.00 | 0.65 | 0.39 | 0.18 | 0.10 | 0.06 | 9.11 | 5.71 | 2.78 | 1.50 | 0.99 | No | No | No | No | No |
| | | | 4.00 | 1.30 | 0.80 | 0.38 | 0.20 | 0.13 | 9.18 | 5.82 | 2.87 | 1.56 | 1.03 | No | No | No | No | No |
| | | | 7.00 | 2.29 | 1.44 | 0.71 | 0.38 | 0.25 | 9.29 | 6.01 | 3.02 | 1.66 | 1.11 | No | No | No | No | No |
| | | | 10.00 | 3.31 | 2.13 | 1.07 | 0.59 | 0.39 | 9.40 | 6.21 | 3.18 | 1.77 | 1.19 | No | No | No | No | No |
| Israel | 3.57 | 2.10 | 1.00 | 0.28 | 0.21 | 0.13 | 0.08 | 0.05 | 10.23 | 7.95 | 4.94 | 3.10 | 2.23 | No | No | No | No | No |
| | | | 2.00 | 0.57 | 0.43 | 0.26 | 0.16 | 0.11 | 10.27 | 8.03 | 5.05 | 3.19 | 2.30 | No | No | No | No | No |
| | | | 4.00 | 1.15 | 0.88 | 0.53 | 0.33 | 0.24 | 10.34 | 8.21 | 5.27 | 3.38 | 2.46 | No | No | No | No | No |
| | | | 7.00 | 2.02 | 1.59 | 1.00 | 0.64 | 0.46 | 10.45 | 8.50 | 5.64 | 3.71 | 2.73 | No | No | No | No | No |
| | | | 10.00 | 2.91 | 2.35 | 1.54 | 1.01 | 0.74 | 10.56 | 8.80 | 6.07 | 4.10 | 3.07 | No | No | No | No | No |
| Korea | 3.85 | 4.84 | 1.00 | 0.29 | 0.17 | 0.08 | 0.04 | 0.03 | 8.92 | 5.42 | 2.56 | 1.36 | 0.88 | No | No | No | No | No |
| | | | 2.00 | 0.57 | 0.34 | 0.16 | 0.08 | 0.05 | 8.95 | 5.46 | 2.60 | 1.38 | 0.90 | No | No | No | No | No |
| | | | 4.00 | 1.16 | 0.69 | 0.32 | 0.17 | 0.11 | 9.02 | 5.56 | 2.67 | 1.43 | 0.93 | No | No | No | No | No |
| | | | 7.00 | 2.04 | 1.24 | 0.59 | 0.31 | 0.21 | 9.11 | 5.71 | 2.79 | 1.50 | 0.99 | No | No | No | No | No |
| | | | 10.00 | 2.93 | 1.82 | 0.88 | 0.48 | 0.31 | 9.21 | 5.88 | 2.91 | 1.59 | 1.05 | No | No | No | No | No |

Notes: $\sigma_v$ refers to the standard deviation of the consumption growth rate. $g$ is the trend growth rate in consumption. $\gamma$ denotes the paramter of constant relative risk aversion. The intertermporal elasticity of substition is given by $1/\theta$.

Table 4.7: Cost of valuation-effect volatility (Epstein-Zin preferences) – PC-Countries (ctd.).

| | | | | Cost of Valuation-Effect Volatility (in Percent) | | | | | Cost of Foregone 0.5% Trend Growth (in Percent) | | | | | Cost of Valuation-Effect Volatility exceeding Cost of Foregone Trend growth? | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\theta$ | | | | | $\theta$ | | | | | $\theta$ | | | | |
| Country | $\sigma_v$ | $g$ | $\gamma$ | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 |
| Malaysia | 5.55 | 4.20 | 1.00 | 0.62 | 0.38 | 0.18 | 0.10 | 0.07 | 9.24 | 5.92 | 2.95 | 1.61 | 1.07 | No | No | No | No | No |
| | | | 2.00 | 1.24 | 0.78 | 0.38 | 0.21 | 0.14 | 9.31 | 6.04 | 3.04 | 1.68 | 1.12 | No | No | No | No | No |
| | | | 4.00 | 2.51 | 1.62 | 0.82 | 0.45 | 0.30 | 9.45 | 6.29 | 3.26 | 1.82 | 1.23 | No | No | No | No | No |
| | | | 7.00 | 4.46 | 3.03 | 1.60 | 0.91 | 0.62 | 9.67 | 6.71 | 3.63 | 2.09 | 1.43 | No | No | No | No | No |
| | | | 10.00 | 6.49 | 4.64 | 2.60 | 1.53 | 1.06 | 9.90 | 7.19 | 4.10 | 2.43 | 1.69 | No | No | No | No | No |
| Pakistan | 3.94 | 2.18 | 1.00 | 0.34 | 0.26 | 0.15 | 0.09 | 0.06 | 10.20 | 7.86 | 4.83 | 3.01 | 2.16 | No | No | No | No | No |
| | | | 2.00 | 0.69 | 0.52 | 0.31 | 0.19 | 0.13 | 10.24 | 7.96 | 4.96 | 3.12 | 2.24 | No | No | No | No | No |
| | | | 4.00 | 1.39 | 1.06 | 0.65 | 0.40 | 0.28 | 10.32 | 8.18 | 5.22 | 3.34 | 2.42 | No | No | No | No | No |
| | | | 7.00 | 2.46 | 1.94 | 1.23 | 0.78 | 0.57 | 10.46 | 8.52 | 5.67 | 3.74 | 2.76 | No | No | No | No | No |
| | | | 10.00 | 3.54 | 2.89 | 1.92 | 1.27 | 0.94 | 10.59 | 8.89 | 6.21 | 4.24 | 3.19 | No | No | No | No | No |
| Philippines | 1.60 | 1.47 | 1.00 | 0.06 | 0.05 | 0.03 | 0.02 | 0.01 | 10.56 | 8.80 | 6.07 | 4.10 | 3.08 | No | No | No | No | No |
| | | | 2.00 | 0.12 | 0.09 | 0.06 | 0.04 | 0.03 | 10.56 | 8.82 | 6.10 | 4.13 | 3.10 | No | No | No | No | No |
| | | | 4.00 | 0.24 | 0.19 | 0.12 | 0.08 | 0.06 | 10.58 | 8.86 | 6.16 | 4.19 | 3.15 | No | No | No | No | No |
| | | | 7.00 | 0.41 | 0.33 | 0.22 | 0.14 | 0.10 | 10.60 | 8.92 | 6.26 | 4.29 | 3.23 | No | No | No | No | No |
| | | | 10.00 | 0.59 | 0.48 | 0.32 | 0.21 | 0.15 | 10.62 | 8.99 | 6.35 | 4.38 | 3.32 | No | No | No | No | No |
| Poland | 4.87 | 2.62 | 1.00 | 0.51 | 0.37 | 0.20 | 0.12 | 0.08 | 9.98 | 7.37 | 4.28 | 2.57 | 1.80 | No | No | No | No | No |
| | | | 2.00 | 1.03 | 0.74 | 0.42 | 0.25 | 0.17 | 10.04 | 7.50 | 4.43 | 2.69 | 1.90 | No | No | No | No | No |
| | | | 4.00 | 2.09 | 1.55 | 0.91 | 0.55 | 0.38 | 10.17 | 7.80 | 4.76 | 2.96 | 2.11 | No | No | No | No | No |
| | | | 7.00 | 3.70 | 2.88 | 1.79 | 1.13 | 0.81 | 10.37 | 8.29 | 5.36 | 3.46 | 2.52 | No | No | No | No | No |
| | | | 10.00 | 5.36 | 4.39 | 2.94 | 1.94 | 1.44 | 10.57 | 8.83 | 6.12 | 4.16 | 3.12 | No | No | No | No | No |
| Paraguay | 5.26 | 2.18 | 1.00 | 0.62 | 0.46 | 0.27 | 0.16 | 0.12 | 10.23 | 7.94 | 4.92 | 3.09 | 2.22 | No | No | No | No | No |
| | | | 2.00 | 1.24 | 0.94 | 0.57 | 0.35 | 0.25 | 10.30 | 8.12 | 5.16 | 3.28 | 2.38 | No | No | No | No | No |
| | | | 4.00 | 2.51 | 1.98 | 1.26 | 0.80 | 0.58 | 10.46 | 8.53 | 5.69 | 3.75 | 2.77 | No | No | No | No | No |
| | | | 7.00 | 4.47 | 3.75 | 2.61 | 1.78 | 1.34 | 10.70 | 9.22 | 6.72 | 4.75 | 3.65 | No | No | No | No | No |
| | | | 10.00 | 6.49 | 5.83 | 4.58 | 3.45 | 2.76 | 10.96 | 10.03 | 8.19 | 6.43 | 5.29 | No | No | No | No | No |

Notes: $\sigma_v$ refers to the standard deviation of the consumption growth rate. $g$ is the trend growth rate in consumption. $\gamma$ denotes the paramter of constant relative risk aversion. The intertermporal elasticity of substition is given by $1/\theta$.

Table 4.7: Cost of valuation-effect volatility (Epstein-Zin preferences) – PC-Countries (ctd.).

| | | | | Cost of Valuation-Effect Volatility (in Percent) | | | | | Cost of Foregone 0.5% Trend Growth (in Percent) | | | | | Cost of Valuation-Effect Volatility exceeding Cost of Foregone Trend growth? | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\theta$ | | | | | $\theta$ | | | | | $\theta$ | | | | |
| Country | $\sigma_v$ | $g$ | $\gamma$ | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 | 1.25 | 2 | 4 | 7 | 10 |
| Syria | 9.88 | 1.91 | 1.00 | 2.24 | 1.81 | 1.19 | 0.78 | 0.57 | 10.58 | 8.85 | 6.15 | 4.18 | 3.14 | No | No | No | No | No |
| | | | 2.00 | 4.56 | 3.98 | 2.96 | 2.13 | 1.65 | 10.87 | 9.74 | 7.62 | 5.74 | 4.59 | No | No | No | No | No |
| | | | 4.00 | 9.50 | 9.95 | 11.44 | 15.37 | 36.82 | 11.50 | 12.14 | 14.42 | 21.96 | | No | No | No | No | |
| | | | 7.00 | 17.69 | 27.51 | | | | 12.60 | 19.17 | | | | Yes | Yes | | | |
| | | | 10.00 | 26.94 | 91.55 | | | | 13.93 | 44.57 | | | | Yes | Yes | | | |
| Thailand | 3.71 | 3.55 | 1.00 | 0.28 | 0.18 | 0.09 | 0.05 | 0.03 | 9.49 | 6.38 | 3.33 | 1.87 | 1.26 | No | No | No | No | No |
| | | | 2.00 | 0.57 | 0.37 | 0.19 | 0.10 | 0.07 | 9.53 | 6.44 | 3.38 | 1.91 | 1.29 | No | No | No | No | No |
| | | | 4.00 | 1.15 | 0.76 | 0.39 | 0.22 | 0.15 | 9.59 | 6.56 | 3.49 | 1.99 | 1.35 | No | No | No | No | No |
| | | | 7.00 | 2.02 | 1.36 | 0.72 | 0.41 | 0.28 | 9.69 | 6.76 | 3.68 | 2.12 | 1.45 | No | No | No | No | No |
| | | | 10.00 | 2.91 | 2.01 | 1.08 | 0.62 | 0.42 | 9.80 | 6.97 | 3.88 | 2.27 | 1.56 | No | No | No | No | No |
| Venezuela | 7.05 | 1.67 | 1.00 | 1.15 | 0.92 | 0.60 | 0.39 | 0.29 | 10.58 | 8.86 | 6.16 | 4.20 | 3.16 | No | No | No | No | No |
| | | | 2.00 | 2.31 | 1.94 | 1.34 | 0.91 | 0.68 | 10.73 | 9.29 | 6.84 | 4.88 | 3.77 | No | No | No | No | No |
| | | | 4.00 | 4.72 | 4.29 | 3.45 | 2.65 | 2.15 | 11.03 | 10.29 | 8.75 | 7.16 | 6.07 | No | No | No | No | No |
| | | | 7.00 | 8.53 | 8.95 | 10.36 | 14.03 | 29.54 | 11.53 | 12.25 | 14.89 | 24.81 | | No | No | No | No | |
| | | | 10.00 | 12.57 | 15.77 | 66.18 | | | 12.07 | 15.11 | 56.99 | | | Yes | Yes | Yes | | |
| South Africa | 2.59 | 1.25 | 1.00 | 0.16 | 0.13 | 0.09 | 0.06 | 0.04 | 10.70 | 9.21 | 6.71 | 4.74 | 3.64 | No | No | No | No | No |
| | | | 2.00 | 0.31 | 0.26 | 0.18 | 0.12 | 0.09 | 10.72 | 9.27 | 6.81 | 4.84 | 3.74 | No | No | No | No | No |
| | | | 4.00 | 0.63 | 0.53 | 0.37 | 0.25 | 0.19 | 10.76 | 9.40 | 7.01 | 5.06 | 3.94 | No | No | No | No | No |
| | | | 7.00 | 1.11 | 0.94 | 0.67 | 0.47 | 0.36 | 10.82 | 9.59 | 7.35 | 5.43 | 4.29 | No | No | No | No | No |
| | | | 10.00 | 1.59 | 1.38 | 1.01 | 0.72 | 0.55 | 10.88 | 9.78 | 7.71 | 5.85 | 4.70 | No | No | No | No | No |

Notes: $\sigma_v$ refers to the standard deviation of the consumption growth rate. $g$ is the trend growth rate in consumption. $\gamma$ denotes the paramter of constant relative risk aversion. The intertermporal elasticity of substition is given by $1/\theta$. No estimates are reported when the welfare cost explodes.

Overall, the cost estimates increase with the representative consumer's degree of risk aversion and willingness to substitute over time. However, this relationship holds only for countries where the risk-adjusted trend growth rate is positive. When it is negative, the welfare loss increases as the as the agent's elasticity of intertemporal substitution (the higher $\theta$) decreases. The intuitive reason behind this is that the marginal utility rises more rapidly over time for consumers who are less willing to substitute over time because an agent with the prospect of negative consumption growth and high $\theta$ does not wish to shift his consumption forward as much in the face of greater consumption growth uncertainty (Obstfeld, 1994b; Pallage and Robe, 2003).

Apart from slight differences due to the separation of $\gamma$ from $\theta$, compared to the CRRA economy, the cost estimates are qualitatively very similar in the sense that valuation-effect volatility imposes a welfare loss that is rarely above 1 percent of permanent consumption for countries with a robust consumption trend growth rate such as Indonesia, Korea, or Thailand. For Venezuela and Syria on the other hand, the cost of rising valuation-effect volatility again clearly exceeds 1 percent of permanent consumption. If agents are sufficiently risk-averse in these countries, a representative consumer may even strictly prefer being stripped of 0.5 percentage points of consumption growth forever, rather than to incur the increase in consumption fluctuations brought about by valuation effects.

To summarize, the exercise in this section has shown that the increase in valuation-effect volatility, as witnessed over the past two decades, may inflict substantial welfare costs in PC-countries. For a more risk-averse representative agent in countries with already high consumption uncertainty, this cost may be high enough for her to strictly prefer foregoing 0.5 percentage points consumption growth forever, rather than see consumption volatility rising due to valuation effects. This seems, however, to be the exception. In most PC-countries the welfare cost associated with a doubling of valuation effect volatility rarely exceeds 1 percent of permanent consumption. The reason is that either the consumption trend growth rate is robust, or consumption paths are relatively stable for the majority of PC-countries in the sample. Nonetheless, the cost estimates in this section should be viewed as the lower bound since valuation effect volatility in many countries has in fact quadrupled since the 1980s. This means that the welfare cost due to valuation effect may in fact be well above 1 percent of permanent consumption, even in countries such as Indonesia or Korea.

## 4.6 Conclusion

This study has empirically examined the link between the observed increase in the size of "valuation effects" and risk sharing. Recent models of portfolio choice, such as the one of Devereux and Sutherland (2010), suggest that

valuation effects are an important channel of the risk sharing mechanism in that they help bring about external adjustment. The indirect approach to test this is by examining whether an increase in the size of the valuation channel is associated with improved risk sharing. My econometric results suggest that this relationship indeed holds for high income countries. For emerging and developing countries the results are mixed. Theory implies that the relationship between valuation adjustments and risk sharing for these countries depends on the sign of the correlation between domestic consumption growth and valuation effects. For the set of EMEs where this correlation is negative, I find some, albeit weak, evidence that risk sharing improves as the scope of the valuation channels increases. However, the opposite seems to be the case in economies for which consumption growth and valuation effects co-vary positively: the greater the size of valuation adjustments, the worse the extent of risk sharing becomes. Consequently, the degree of-risk sharing in those countries has deteriorated sharply over the last two decades.

Motivated by these findings, this paper has also estimated the extent to which the valuation channel amplifies consumption volatility in EMEs, where valuation effects are pro-cyclical with respect to domestic consumption growth (PC-economies). The econometric results suggest that for every doubling of the size of the valuation channel, consumption volatility increases by about 10 percent in PC-countries. The resulting welfare loss may be substan-

tial. Depending on specific country characteristics, the welfare cost may be well in excess of one percent of permanent consumption. Future work could address the question of which factors are driving the differences between NC and PC countries.

# Appendix

Table 4A.1: Country list.

*High income countries (18)*

| | |
|---|---|
| Australia | Netherlands |
| Austria | New Zealand |
| Canada | Norway |
| Denmark | Portugal |
| Finland | Spain |
| France | Sweden |
| Germany | Switzerland |
| Italy | United Kingdom |
| Japan | United States |

*Emerging market economies (EMEs) (35)*

| | | | |
|---|---|---|---|
| Argentina | Honduras | Morocco | Thailand |
| Bangladesh | Hungary | Pakistan | Tunisia |
| Bolivia | India | Paraguay | Turkey |
| Botswana | Indonesia | Peru | Uruguay |
| Brazil | Israel | Philippines | Venezuela |
| Chile | Jamaica | Poland | |
| China | Jordan | Singapore | |
| Colombia | Korea | South Africa | |
| Egypt | Malaysia | Sri Lanka | |
| Guatemala | Mexico | Syria | |

Table 4A.2: Data Appendix Table – Data sources and definitions.

| Variable | Description | Source |
|---|---|---|
| Consumption Growth Volatility | Ten-year rolling standard deviation of the growth rate of real private consumption per capita. Calculated as the product of PPP converted GDP per capita consumption share times real PPP converted GDP per capita. | PWT 7.1 |
| Valuation-Effect Volatility | Ten-year rolling standard deviation of valuation terms scaled by GDP. Valuation effects are calculated indirectly using Eq. 4.4. | Lane and Milesi-Ferretti (2007) and IMF BOP Statistics |
| GDP per capita growth volatility | Ten-year rolling standard deviation of real PPP converted GDP per capita. | PWT 7.1 |
| Inflation Volatility | Ten-year rolling standard deviation of the inflation rate measured as the annual percentage growth rate of the ratio of GDP in local current currency. | WDI |
| Nominal Exchange Rate Volatility | Ten-year rolling standard deviation of the nominal exchange rate (domestic currency per US dollar). | PWT 7.1 |
| Trade Openness | Constructed as the ratio of the sum of the total value of exports (X) plus the total value of imports (M) relative to GDP (at constant prices). | PWT 7.1 |

# Bibliography


Abida, Z., 2011. Real exchange rate misalignment and economic growth: An empirical study for the Maghreb countries. *International Journal of Economics and Finance*, 3, 3 (2011), 190–201. (cited on pages 41 and 62)

Ades, A.; Masih, R.; and Tenengauzer, D., 1999. GSDEEMER: Third edition. Goldman Sachs Economic Research Group. (cited on page 34)

Aguirre, A. and Calderón, C., 2005. Real exchange rate misalignments and economic performance. Documentos de Trabajo No 315, Banco Central de Chile. (cited on pages 2, 6, 17, 22, 29, 41, 58, and 62)

Ahmed, S., 2009. Are Chinese exports sensitive to changes in the exchange rate? International Finance Discussion Papers 987, Board of Governors of the Federal Reserve System. (cited on page 110)

Aizenman, J. and Lee, J., 2007. International reserves: Precautionary versus mercantilist views, theory and evidence. *Open Economies Review*, 18, 2 (2007), 191–214. (cited on pages 7, 8, 75, 82, 83, 111, and 113)

Aizenman, J. and Marion, N., 2003. The high demand for international reserves in the Far East: What is going on? *Journal of the Japanese and*

*International Economies*, 17, 3 (2003), 370 – 400. (cited on pages 7, 74, 82, and 111)

ANDREWS, D. W. K., 1993. Tests for parameter instability and structural change with unknown change point. *Econometrica*, 61, 4 (1993), 821–56. (cited on page 32)

ARELLANO, M. AND BOVER, O., 1995. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68, 1 (1995), 29–51. (cited on pages 18 and 39)

ATHUKORALA, P.-C., 2009a. The rise of China and East Asian export performance: Is the crowding-out fear warranted? *World Economy*, 32, 2 (2009), 234–266. (cited on page 128)

ATHUKORALA, P.-C., 2009b. Trends and patterns of foreign direct investments in Asia: A comparative perspective. *The Journal of Applied Economic Research*, 3, 4 (2009), 365–408. (cited on page 128)

ATHUKORALA, P.-C., 2014. Sri Lanka's post-conflict development challenge: Learning from the past. Departmental Working Papers 2014-05, The Australian National University, Arndt-Corden Department of Economics. (cited on page 85)

ATHUKORALA, P.-C. AND WARR, P. G., 2002. Vulnerability to a currency crisis:

Lessons from the Asian experience. *World Economy*, 25, 1 (2002), 33–57. (cited on page 85)

BAFFES, J.; ELBADAWI, I. A.; AND O'CONNELL, S. A., 1997. Single-equation estimation of the equilibrium real exchange rate. Policy Research Working Paper Series 1800, The World Bank. (cited on page 25)

BAFFES, J.; ELBADAWI, I. A.; AND O'CONNELL, S. A., 1999. Single-equation estimation of the equilibrium exchange rate. In *Exchange rate misalignment: Concepts and measurement for developing countries* (Eds. L. E. HINKLE AND P. J. MONTIEL), 405–464. A World Bank Research Publication, Oxford University Press. (cited on pages 7, 23, 24, 28, 31, 34, 62, and 78)

BAI, Y. AND ZHANG, J., 2012. Financial integration and international risk sharing. *Journal of International Economics*, 86, 1 (2012), 17–32. (cited on page 135)

BALASSA, B., 1964. The purchasing-power parity doctrine: A reappraisal. *Journal of Political Economy*, 72, 6 (1964), pp. 584–596. (cited on pages 20 and 27)

BALLI, F.; KALEMLI-OZCAN, S.; AND SØRENSEN, B. E., 2012. Risk sharing through capital gains. *Canadian Journal of Economics*, 45, 2 (2012), 472–492. (cited on pages 5 and 134)

BANERJEE, A.; DOLADO, J. J.; GALBRAITH, J. W.; AND HENDRY, D. F., 1993. *Co-*

*integration, Error Correction, and the Econometric Analysis of Non-Stationary Data*. Oxford University Press. (cited on page 31)

BANISTER, J., 2013. ChinaŠs manufacturing employment and hourly labor compensation, 2002-2009. International labor comparisons, U.S. Bureau of Labor Statistics. (cited on page 128)

BARRO, R. J. AND LEE, J.-W., 2010. A new data set of educational attainment in the world, 1950-2010. Working Paper 15902, National Bureau of Economic Research. (cited on page 64)

BAXTER, M., 2012. International risk-sharing in the short run and in the long run. *Canadian Journal of Economics*, 45, 2 (2012), 376–393. (cited on page 151)

BÉREAU, S.; VILLAVICENCIO, A.; AND MIGNON, V. ., 2009. Currency misalignments and growth: A new look using nonlinear panel data methods. CEPII Document de Travail, No 2009-17. (cited on pages 2, 6, 17, and 62)

BERG, A. AND MIAO, Y., 2010. The real exchange rate and growth revisited: The Washington Consensus strikes back? IMF Working Paper, WP/10/58. (cited on pages 17 and 62)

BLANCHARD, O.; GIAVAZZI, F.; AND SA, F., 2005. International investors, the U.S. current account, and the dollar. *Brookings Papers on Economic Activity*, 36, 1 (2005), 1–66. (cited on pages 132 and 138)

BLUNDELL, R. AND BOND, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87, 1 (1998), 115 – 143. (cited on pages 18 and 39)

BOND, S.; HOEFFLER, A.; AND TEMPLE, J., 2001. GMM estimation of empirical growth models. Economics Papers 2001-W21, Economics Group, Nuffield College, University of Oxford. (cited on page 43)

BOND, S. AND WINDMEIJER, F., 2005. Reliable inference for GMM estimators? Finite sample properties of alternative test procedures in linear panel data models. *Econometric Reviews*, 24, 1 (2005), 1–37. (cited on page 46)

BRACKE, T. AND SCHMITZ, M., 2011. Channels of international risk-sharing: capital gains versus income flows. *International Economics and Economic Policy*, 8, 1 (2011), 45–78. (cited on pages 5 and 134)

BROWN, B. W. AND NEWEY, W. K., 2002. Generalized method of moments, efficient bootstrapping, and improved inference. *Journal of Business & Economic Statistics*, 20, 4 (2002), pp. 507–517. (cited on page 46)

CABALLERO, R. J.; FARHI, E.; AND GOURINCHAS, P.-O., 2008. An equilibrium model of "global imbalances" and low interest rates. *American Economic Review*, 98, 1 (2008), 358–93. (cited on page 127)

CALVO, G. A., 1998. Capital flows and capital-market crises: The simple eco-

nomics of sudden stops. *Journal of Applied Economics*, 1, 1 (1998), 35–54. (cited on pages 74 and 81)

CARROLL, C. D. AND JEANNE, O., 2009. A tractable model of precautionary reserves, net foreign assets, or sovereign wealth funds. Working Paper 15228, National Bureau of Economic Research. (cited on page 127)

CHAMON, M.; LIU, K.; AND PRASAD, E., 2013. Income uncertainty and household savings in China. *Journal of Development Economics*, 105 (2013), 164 – 177. (cited on page 127)

CHEUNG, Y.-W., 2012. Exchange rate misalignment - the case of the Chinese renminbi. CESifo Working Paper Series 3797, CESifo Group Munich. (cited on page 92)

CLINE, W. R. AND WILLIAMSON, J., 2007. Estimates of the equilibrium exchange rate of the renminbi: Is there a consensus and, if not, why not? Policy Brief PB10-2, Peterson Institute for International Economics. (cited on pages 79, 92, 104, 106, and 128)

COLEMAN, S., 2008. Estimating equilibrium real exchange rates in the Franc Zone. *Journal of African Economies*, 17, 4 (2008), 600–634. (cited on pages 30 and 34)

CORDEN, M. W., 1981. Exchange rate protection. In *The International Monetary System under Flexible Exchange Rates: Global, Regional and National. Essays in*

*honor of Robert Triffin* (Eds. R. N. Cooper and R. Triffin), 17–34. Ballinger. (cited on page 16)

Corden, M. W., 2009. China's exchange rate policy, its current account surplus and the global imbalances. *The Economic Journal*, 119, 541 (2009), F430–F441. (cited on pages 91 and 129)

Corden, W. M., 2007. Those current account imbalances: A sceptical view. *World Economy*, 30, 3 (2007), 363–382. (cited on page 129)

Cottani, J. A.; Cavallo, D. F.; and Khan, M. S., 1990. Real exchange rate behavior and economic performance in LDCs. *Economic Development and Cultural Change*, 39, 1 (1990), pp. 61–76. (cited on page 16)

Delatte, A.-L. and Fouquau, J., 2012. What drove the massive hoarding of international reserves in emerging economies? A time-varying approach. *Review of International Economics*, 20, 1 (2012), 164–176. (cited on pages 8, 75, and 83)

Devarajan, S., 1997. Real exchange rate misalignment in the CFA Zone. *Journal of African Economies*, 6, 1 (1997), 35–53. (cited on page 30)

Devereux, M. B. and Sutherland, A., 2010. Valuation effects and the dynamics of net external assets. *Journal of International Economics*, 80, 1 (2010), 129–143. (cited on pages 3, 132, 133, 135, 140, 141, 143, 148, 150, and 188)

DI GIOVANNI, J. AND LEVCHENKO, A. A., 2009. Trade openness and volatility. *The Review of Economics and Statistics*, 91, 3 (2009), 558–585. (cited on page 165)

DOOLEY, M.; FOLKERTS-LANDAU, D.; AND GARBER, P., 2005. Direct investment, rising real wages and the absorption of excess labor in the periphery. *Proceedings*, , Feb (2005). (cited on pages 2 and 80)

DOOLEY, M. P.; FOLKERTS-LANDAU, D.; AND GARBER, P., 2004. The revived Bretton Woods system. *International Journal of Finance and Economics*, 9, 4 (2004), 307–313. (cited on pages 2, 74, 80, and 127)

DURDU, C. B.; MENDOZA, E. G.; AND TERRONES, M. E., 2009. Precautionary demand for foreign assets in sudden stop economies: An assessment of the new mercantilism. *Journal of Development Economics*, 89, 2 (2009), 194 – 209. (cited on page 82)

DURLAUF, S. N.; JOHNSON, P. A.; AND TEMPLE, J. R., 2005. Growth econometrics. In *Handbook of Economic Growth* (Eds. P. AGHION AND S. DURLAUF), vol. 1 of *Handbook of Economic Growth*, chap. 8, 555–677. Elsevier. (cited on page 38)

EDWARDS, S., 1989. *Real exchange rates, Devaluation, and Adjustment*. The MIT Press. (cited on pages 7, 16, 20, 21, 23, 24, 27, 51, 62, 78, and 94)

EDWARDS, S., 1995. Trade policy, exchange rates, and growth. In *Reform,*

*Recovery, and Growth: Latin America and the Middle East*, NBER Chapters, 13–52. National Bureau of Economic Research, Inc. (cited on page 52)

EDWARDS, S. AND LEVY YEYATI, E., 2005. Flexible exchange rates as shock absorbers. *European Economic Review*, 49, 8 (2005), 2079–2105. (cited on page 165)

ÉGERT, B.; LAHRÈCHE-RÉVIL, A.; AND LOMMATZSCH, K., 2005. The stock-flow approach to the real exchange rate of CEE transition economies. Money Macro and Finance (MMF) Research Group Conference 2005, Money Macro and Finance Research Group. (cited on page 22)

EICHENGREEN, B., 2008. The real exchange rate and economic growth. Commission on Growth and Development, Working Paper No. 4. (cited on pages 15 and 61)

EICHENGREEN, B. AND HAUSMANN, R., 1999. Exchange rates and financial fragility. NBER Working Papers 7418, National Bureau of Economic Research, Inc. (cited on pages 4 and 133)

EICHENGREEN, B.; HAUSMANN, R.; AND PANIZZA, U., 2003. Currency mismatches, debt intolerance and original sin: Why they are not the same and why it matters. Working Paper 10036, National Bureau of Economic Research. (cited on page 133)

ELBADAWI, I. A., 1994. Estimating long-run equilibrium exchange rates. In

*Estimating equilibrium exchange rates* (Ed. J. Williamson), 93–132. Institute for International Economics, Washington D.C. (cited on pages 7, 24, 62, and 78)

Elbadawi, I. A. and Soto, R., 1997. Real exchange rates and macroeconomic adjustment in Sub-Sahara Africa and other developing countries. *Journal*, 6, 3 (1997), 74–120. Supplement. (cited on page 27)

Epstein, L. G. and Zin, S. E., 1989. Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework. *Econometrica*, 57, 4 (1989), pp. 937–969. (cited on page 176)

Faruqee, H., 1995. Long-run determinants of the real exchange rate: A stock-flow perspective. *Staff Papers - International Monetary Fund*, 42, 1 (1995), pp. 80–107. (cited on pages 20, 22, 24, and 94)

Flood, R. P.; Marion, N. P.; and Matsumoto, A., 2012. International risk sharing during the globalization era. *Canadian Journal of Economics*, 45, 2 (2012), 394–416. (cited on pages 154 and 160)

Forbes, K. J., 2010. Why do foreigners invest in the United States? *Journal of International Economics*, 80, 1 (2010), 3–21. (cited on pages 3 and 141)

Gala, P. and Lucinda, C. R., 2006. Exchange rate misalignment and growth: Old and new econometric evidence. *Economia*, 7, 4 (2006), 165–187. (cited on page 62)

GAN, C.; WARD, B.; TING, S. T.; AND COHEN, D. A., 2013. An empirical analysis of China's equilibrium exchange rate: A co-integration approach. *Journal of Asian Economics*, 29 (2013), 33 – 44. (cited on pages 78, 94, 104, and 105)

GANG, F., 2008. Comment. Renminbi reavaluation and US dollar depreciation. In *Debating China's Exchange Rate Policy* (Eds. M. GOLDSTEIN AND N. R. LARDY), 70–76. Peterson Institute for International Economics. (cited on page 84)

GHOSH, A. R.; OSTRY, J. D.; AND TSANGARIDES, C. G., 2012. Shifting motives: Explaining the buildup in official reserves in emerging markets since the 1980s. IMF Working Papers 12/34, International Monetary Fund. (cited on pages 8, 75, 82, 83, 111, 112, and 117)

GHOSH, A. R.; OSTRY, J. D.; AND TSANGARIDES, C. G., 2014. Accounting for emerging market countries' international reserves: Are Pacific Rim countries different? *Journal of International Money and Finance*, (2014). (cited on pages 8, 75, 79, 82, 83, 111, and 125)

GHURA, D. AND GRENNES, T. J., 1993. The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of Development Economics*, 42, 1 (1993), 155 – 174. (cited on page 16)

GOURINCHAS, P.-O., 2008. Valuation effects and external adjustment: A review. In *Current Account and External Financing* (Eds. K. COWAN; S. ED-

WARDS; R. O. VALDÉS; N. L. S. EDITOR); AND K. SCHMID), vol. 12 of *Central Banking, Analysis, and Economic Policies Book Series*, chap. 6, 195–236. Central Bank of Chile. (cited on pages 3, 10, 132, 133, 135, 138, 141, 143, and 149)

GOURINCHAS, P.-O. AND JEANNE, O., 2013. Capital flows to developing countries: The allocation puzzle. *Review of Economic Studies*, 80, 4 (2013), 1484–1515. (cited on page 128)

GOURINCHAS, P.-O. AND REY, H., 2007. International financial adjustment. *Journal of Political Economy*, 115, 4 (2007), 665–703. (cited on pages 3, 4, 132, 138, and 141)

GOURINCHAS, P.-O.; REY, H.; AND GOVILLOT, N., 2010. Exorbitant privilege and exorbitant duty. IMES Discussion Paper Series 10-E-20, Institute for Monetary and Economic Studies, Bank of Japan. (cited on pages 3 and 141)

GRANGER, C. W. J. AND NEWBOLD, P., 1974. Spurious regressions in econometrics. *Journal of Econometrics*, 2, 2 (1974), 111–120. (cited on page 96)

HALL, P. AND HOROWITZ, J. L., 1996. Bootstrap critical values for tests based on Generalized-Method-of-Moments estimators. *Econometrica*, 64, 4 (1996), pp. 891–916. (cited on page 46)

HANSEN, B. E., 1992. Tests for parameter instability in regressions with I(1) processes. *Journal of Business & Economic Statistics*, 10, 3 (1992), 321–35. (cited on pages 32 and 98)

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IMF, 2011. Assessing reserve adequacy. Staff report, International Monetary Fund. (cited on pages 7, 77, 78, 79, 85, 86, 87, 88, 90, 122, and 123)

JOHANSEN, S., 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12, 2-3 (1988), 231–254. (cited on pages 31 and 32)

JOHANSEN, S., 1992. Cointegration in partial systems and the efficiency of single-equation analysis. *Journal of Econometrics*, 52, 3 (1992), 389–402. (cited on page 32)

KAO, C. AND CHIANG, M.-H., 2000. On the estimation and inference of a cointegrated regression in panel data. *Advances of Econometrics: Nonstationary Panels, Panel Cointegration and Dynamic Panels*,, 15 (2000), 179–222. (cited on page 166)

KEJRIWAL, M. AND PERRON, P., 2008. Data dependent rules for selection of the number of leads and lags in the dynamic OLS cointegrating regression. *Econometric Theory*, 24, 05 (2008), 1425–1441. (cited on pages 32 and 98)

KINKYO, T., 2008. Disorderly adjustments to the misalignments in the Korean won. *Cambridge Journal of Economics*, 32, 1 (2008), 111–124. (cited on page 34)

KOSE, M. A.; PRASAD, E. S.; AND TERRONES, M. E., 2009. Does financial global-

ization promote risk sharing? *Journal of Development Economics*, 89, 2 (2009), 258–270. (cited on pages 10, 135, 150, 151, 153, 154, 159, and 160)

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*, 73, 2 (2007), 223–250. (cited on pages xvii, 3, 63, 88, 90, 132, 138, 139, 143, 144, 147, and 192)

LANE, P. R. AND SHAMBAUGH, J. C., 2010. Financial exchange rates and international currency exposures. *American Economic Review*, 100, 1 (2010), 518–40. (cited on page 143)

LEVY-YEYATI, E. L. AND STURZENEGGER, F., 2007. Fear of floating in reverse: Exchange rate policy in the 2000s. Mimeo. (cited on page 15)

LEWIS, K. K., 1996. What can explain the apparent lack of international consumption risk sharing? *Journal of Political Economy*, 104, 2 (1996), 267–97. (cited on pages 10, 151, and 152)

LI, X., 2004. Trade liberalization and real exchange rate movement. *IMF Staff Papers*, 51, 3 (2004), 553–584. (cited on page 51)

LUCAS, R. E., 1987. *Models of Business Cycles*. Basil Blackwell. (cited on pages 11, 136, 174, and 181)

MACDONALD, R. AND RICCI, L. ., 2003. Estimation of the equilibrium real

exchange rate for South Africa. IMF Working Paper WP/03/44. (cited on pages 22 and 34)

MacDonald, R. and Vieira, F., 2010. A panel data investigation of real exchange rate misalignment and growth. CESifo Working Paper No. 3061. (cited on pages 2, 6, 17, 41, and 62)

Maddala, G. S. and Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61, S1 (1999), 631–652. (cited on page 165)

Mankiw, N. G.; Romer, D.; and Weil, D. N., 1992. A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107, 2 (1992), pp. 407–437. (cited on page 36)

Mark, N. C. and Sul, D., 2003. Cointegration vector estimation by panel DOLS and long-run money demand. *Oxford Bulletin of Economics and Statistics*, 65, 5 (2003), 655–680. (cited on pages 32, 166, and 167)

Mendoza, E. G.; Quadrini, V.; and Ríos-Rull, J.-V., 2009. Financial integration, financial development, and global imbalances. *Journal of Political Economy*, 117, 3 (2009), pp. 371–416. (cited on page 127)

Mongardini, J. and Rayner, B., 2009. Grants, remittances, and the equilibrium real exchange rate in Sub-Saharan African countries. IMF Working Paper WP/09/75. (cited on page 29)

MONTALVO, J. G., 1995. Comparing cointegrating regression estimators: Some additional Monte Carlo results. *Economics Letters*, 48, 3-4 (1995), 229–234. (cited on pages 31 and 98)

MONTIEL, P., 1999a. The long-run equilibrium real exchange rate: Conceptual issues and empirical research. In *Exchange rate misalignment: concept and measurement in developing countries* (Eds. L. E. HINKLE AND P. J. MONTIEL), 219–263. A World Bank Research Publication, Oxford University Press. (cited on pages 23, 24, and 29)

MONTIEL, P. J., 1999b. Determinants of the long-run equilibrium real exchange rate. In *Exchange rate misalignment: concepts and measurement for developing countries* (Eds. L. E. HINKLE AND P. J. MONTIEL), 264–290. A World Bank Research Publication, Oxford University Press. (cited on pages 20, 21, and 94)

MONTIEL, P. J., 2007. Equilibrium real exchange rates, misalignment and competitiveness in the Southern Cone. CEPAL, Economic Development Division, United Nations, Santiago de Chile. (cited on pages 22, 29, 32, 33, 34, and 105)

NEWEY, W. K. AND WEST, K. D., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55, 3 (1987), 703–08. (cited on page 31)

NICKELL, S., 1981. Biases in dynamic models with fixed effects. *Econometrica*, 49, 6 (1981), pp. 1417–1426. (cited on page 39)

NOUIRA, R. AND SEKKAT, K., 2012. Desperately seeking the positive impact of undervaluation on growth. *Journal of Macroeconomics*, 34, 2 (2012), 537 – 552. (cited on pages 16 and 62)

NURKSE, R., 1945. *Conditions on International Monetary Equilibrium. Essays in International Finance*. Princeton University Press. (cited on pages 14, 17, 19, 61, 64, 92, and 94)

OBSTFELD, M., 1994a. Are industrial-country consumption risks globally diversified? NBER Working Papers 4308, National Bureau of Economic Research, Inc. (cited on page 152)

OBSTFELD, M., 1994b. Evaluating risky consumption paths: The role of intertemporal substitutability. *European Economic Review*, 38, 7 (1994), 1471 – 1486. (cited on pages 11, 136, 174, 175, 176, 177, 178, and 187)

OBSTFELD, M., 2004. External adjustment. *Review of World Economics (Weltwirtschaftliches Archiv)*, 140, 4 (2004), 541–568. (cited on pages 132 and 138)

OBSTFELD, M.; SHAMBAUGH, J. C.; AND TAYLOR, A. M., 2010. Financial stability, the trilemma, and international reserves. *American Economic Journal: Macroeconomics*, 2, 2 (2010), 57–94. (cited on pages 7, 82, 86, 111, and 118)

Ogaki, M.; Ostry, J. D.; and Reinhart, C. M., 1996. Saving behavior in low- and middle-income developing countries: A comparison. *Staff Papers - International Monetary Fund*, 43, 1 (1996), pp. 38–71. (cited on page 180)

Pagan, A., 1984. Econometric issues in the analysis of regressions with generated regressors. *International Economic Review*, 25, 1 (1984), pp. 221–247. (cited on page 45)

Pallage, S. and Robe, M. A., 2003. On the welfare cost of economic fluctuations in developing countries. *International Economic Review*, 44, 2 (2003), pp. 677–698. (cited on pages 11, 137, 173, 174, 176, 180, and 187)

Peng, T.; Lee, M.; and Gan, C., 2008. Has the Chinese currency been undervalued? *Journal of Chinese Economic and Business Studies*, 6, 1 (2008), 49–66. (cited on pages 93 and 104)

Pesaran, M. H., 2004. General diagnostic tests for cross section dependence in panels. CESifo Working Paper Series 1229, CESifo Group Munich. (cited on pages 40, 165, and 168)

Pesaran, M. H., 2007. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22, 2 (2007), 265–312. (cited on pages 165 and 166)

Phillips, P. C. B. and Durlauf, S. N., 1986. Multiple time series regression

with integrated processes. *The Review of Economic Studies*, 53, 4 (1986), pp. 473–495. (cited on pages 31, 98, and 166)

PHILLIPS, P. C. B. AND HANSEN, B. E., 1990. Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies*, 57, 1 (1990), pp. 99–125. (cited on page 31)

PHILLIPS, P. C. B. AND LORETAN, M., 1991. Estimating long-run economic equilibria. *The Review of Economic Studies*, 58, 3 (1991), pp. 407–436. (cited on pages 31 and 97)

POLLOCK, D. S. G., 2000. Trend estimation and de-trending via rational square-wave filters. *Journal of Econometrics*, 99, 2 (2000), 317–334. (cited on page 43)

PRASAD, E. AND WEI, S.-J., 2007. The Chinese approach to capital inflows: Patterns and possible explanations. In *Capital Controls and Capital Flows in Emerging Economies: Policies, Practices and Consequences*, NBER Chapters, 421–480. National Bureau of Economic Research, Inc. (cited on page 109)

QIN, D. AND HE, X., 2011. Is the Chinese currency substantially misaligned to warrant further appreciation? *The World Economy*, 34, 8 (2011), 1288–1307. (cited on pages 78, 93, and 104)

RADELET, S. AND SACHS, J. D., 1998. The East Asian Financial Crisis: Diagno-

sis, remedies, prospects. *Brookings Papers on Economic Activity*, 29, 1 (1998), 1–90. (cited on page 81)

RAWSKI, T., 2011. Human resources and china's long economic boom. *Asia Policy*, 12 (2011), 33–78. (cited on page 129)

RAZIN, O. AND COLLINS, S., 1997. Real exchange rate misalignments and growth. NBER Working Paper No. 6174. (cited on pages 17, 41, and 62)

RIEDEL, J.; JIN, J.; AND GAO, J., 2007. *How China Grows: Investment, Finance, and Reform*. Princeton University Press. (cited on page 129)

RODRIK, D., 2008. The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 2008 (2008), pp. 365–412. (cited on pages 2, 6, 15, 16, 18, 41, 52, 53, 54, 55, 57, and 62)

ROODMAN, D., 2009a. How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal*, 9, 1 (2009), 86–136. (cited on page 39)

ROODMAN, D., 2009b. A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, 71, 1 (2009), 135–158. (cited on page 40)

ROUDET, S.; SAXEGAARD, M.; AND TSANGARIDES, C. G., 2007. Estimation of equilibrium exchange rates in the WAEMU: A robustness analysis. IMF Working Paper, WP/07/94. (cited on pages 30 and 34)

SAIKKONEN, P., 1991. Asymptotically efficient estimation of cointegration re-

gressions. *Econometric Theory*, 7, 1 (1991), pp. 1–21. (cited on pages 31 and 97)

SAMUELSON, P. A., 1964. Theoretical notes on trade problems. *The Review of Economics and Statistics*, 46, 2 (1964), pp. 145–154. (cited on page 20)

SCHNATZ, B., 2011. Global imbalances and the pretence of knowing fundamental equilibrium exchange rates. *Pacific Economic Review*, 16, 5 (2011), 604–615. (cited on pages 93, 106, and 128)

SØRENSEN, B. E.; WU, Y.-T.; YOSHA, O.; AND ZHU, Y., 2007. Home bias and international risk sharing: Twin puzzles separated at birth. *Journal of International Money and Finance*, 26, 4 (2007), 587 – 605. (cited on pages 10, 153, and 154)

STOCK, J. H. AND WATSON, M. W., 1993. A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica*, 61, 4 (1993), 783–820. (cited on pages 31, 97, and 98)

THORBECKE, W., 2013. Investigating China's disaggregated processed exports: Evidence that both the RMB and exchange rates in supply chain countries matter. *The World Economy*, 36, 10 (2013), 1245–1260. (cited on pages 106 and 128)

TILLE, C., 2003. The impact of exchange rate movements on U.S. foreign debt.

*Current Issues in Economics and Finance*, 9, 1 (2003), 1–7. (cited on pages 132 and 138)

WAGNER, M. AND HLOUSKOVA, J., 2009. The performance of panel cointegration methods: Results from a large scale simulation study. *Econometric Reviews*, 29, 2 (2009), 182–223. (cited on page 166)

WEI, S.-J. AND ZHANG, X., 2011. The competitive saving motive: Evidence from rising sex ratios and savings rates in China. *Journal of Political Economy*, 119, 3 (2011), 511 – 564. (cited on page 127)

WEIL, P., 1990. Nonexpected utility in macroeconomics. *The Quarterly Journal of Economics*, 105, 1 (1990), 29–42. (cited on page 176)

WHELAN, K. AND MCQUINN, K., 2006. Conditional convergence revisited : Taking Solow very seriously. Central Bank of Ireland Research Technical Paper 7/RT/06, Central Bank of Ireland. (cited on page 36)

WILLIAMSON, J., 1990. What Washington means by policy reform. In *Latin American Adjustment: How Much Has Happened?* (Ed. J. WILLIAMSON), 5–20. Peterson Institute for International Economics. (cited on pages 6, 14, and 84)

WINDMEIJER, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126, 1 (2005), 25–51. (cited on pages 40, 42, 44, 46, 49, 56, and 67)

XING, Y., 2012. Processing trade, exchange rates and China's bilateral trade balances. *Journal of Asian Economics*, 23, 5 (2012), 540 – 547. (cited on pages 106 and 128)