Working Papers in Trade and Development

Real exchange rate misalignment in developing countries: the role of exchange rate flexibility and capital account openness

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May 2020

Working Paper No. 2020/07

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Real exchange rate misalignment in developing countries: the role of exchange rate flexibility and capital account openness

This paper examines the association between the real exchange rate (RER) misalignment, exchange rate flexibility, and capital account openness using a panel dataset for 60 developing countries over the period 1980 – 2014. The analysis is based on an alternative measure of RER that is more consistent with the theoretical concept of RER than the commonly used index, and misalignment estimates that account for country-specific underlying factors. The results suggest that the exchange rate regime and capital account policy are significantly related to the degree of persistence and the magnitude of RER misalignment.

Keywords: Real exchange rate; exchange rate regime; capital account openness

JEL Classifications: F31, F38, F41, O24

Forthcoming in *International Economics*, Volune 163, October 2020, pages 1-24

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1. Introduction

The real exchange rate (RER), defined as the relative price between tradable and non-tradable goods, is one of the key variables of an open economy. Given the increasing interconnectedness of economic activity across borders in this era of financial globalisation, a thorough understanding of RER behavior is crucial for macroeconomic policy formulation (Edwards, 2018). RER undervaluation can accelerate economic growth by compensating for disadvantages in international competitiveness arising from poor institutional quality and market imperfections, which are common in developing economies (Rodrik 2008, Williamson 2009, Guzman et al., 2018). Alternately, overvalued RER has important implications for the economy, especially in regard to macroeconomic stability. A survey by Frankel and Saravelos (2012) has shown that RER overvaluation is one of the most accurate leading indicators of an economic crisis. Their finding is further confirmed by the work of Gnimassoun and Mignon (2015), who show that the persistence of current account disequilibria is related to the overvaluation of the real exchange rate. Further investigations into the relationship between RER misalignment and economic growth confirm that there is a negative and significant relationship between economic growth and substantial RER misalignments from the equilibrium value regardless of whether the misalignment takes the form of overvaluation or undervaluation (Aguirre and Calderón, 2005; Schröder, 2013).

There is a vast and growing literature on RER misalignment and its economic implications[1]. The purpose of this paper is to examine the implications of two important aspects of RER management that have so far received limited attention in this literature, namely exchange rate regime choice and the degree of capital account openness. The empirical analysis covers 60 developing economies for the period of 1980-2014[2]. When compared with previous studies, this paper has four methodological improvements. Firstly, the RER index is measured as the ratio of trade-weighted wholesale price index of trading partner countries expressed in domestic currency and the domestic GDP deflator. This formulation is more consistent with the original concept of RER compared to the commonly used consumer price index (CPI)-based RER index (Edwards 1989, Athukorala and Rajapatirana, 2003). Second, the RER misalignment is measured using individual country regression instead of the widely used panel or cross-section approach that uses a homogenous cross-country equation. This approach is considered to be less prone to producing an inconsistent proxy of RER misalignment since the underlying determinants of the real exchange rate movement are mostly country-specific (Schröder, 2013). Third, for estimating the RER function, the determinants considered not only real fundamental variables as mostly postulated in the particular strand of literature but also variables relating to the financial sector (Rey, 2015; Barbosa et al., 2018; Kaltenbrunner, 2015). Finally, in generating the sustainable values of the fundamentals, a modified HP filter procedure that endogenously determines the most appropriate smoothing parameter based on individual data characteristics is applied (Hanif et al., 2017).

Exchange rate movements and capital flows play an important role in RER dynamics. In a policy regime that limits the exchange rate movement in response to market forces, the process of RER adjustment relies on changes in relative prices, which most likely to occur slowly due to rigidities in the domestic economy (Corden, 1994). It is possible for the authorities to peg the exchange rate at a certain level and apply a sterilized-intervention strategy to manage domestic macroeconomic stability. However, there is evidence that this strategy is unsustainable (Calvo, 1991; Hellenier, 1997). As for the capital account

* This paper has benefited from the guidance, suggestions, and helpful comments of Prema-chandra Athukorala and two anonymous referees.
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[1] For comprehensive surveys of this literature see Burstein and Gopinath (2014), Chinn (2002), MacDonald and Taylor (1992).
[2] This focus on developing countries is due to the variation of institutional qualities, the stage of development of the financial markets, and their relatively limited level of integration in the international monetary system when compared to advanced economies.

policy, the degree of openness for capital flows is likely to have an effect on the RER adjustments through movements in the nominal exchange rate or by the changes in the non-tradable prices (Calvo et al., 1993; Calvo et al. 1996). Considering the possible implications of exchange rate and capital flows policies on the RER dynamics, it is important to evaluate both policies simultaneously, since evaluating the role of one policy without controlling the other may introduce bias to the interpretation of the association.

The existing empirical evidence on how the exchange rate regime and the capital account management interact with the RER misalignment is inconclusive. A study by Combes et al. (2012) covering 42 emerging and developing countries during 1980-2006 concludes that capital inflows appreciate the RER and that having a flexible exchange rate regime inhibits appreciation. Another empirical observation involving 51 developing countries over the period of 1980-2010 by Nouira and Sekkat (2015) found that both fixed and floating exchange rate regimes are associated with lower real exchange rate misalignment compared to the intermediate regime. Investigation using propensity score matching approach by Libman (2018) reach a conclusion that the pegged exchange rate regime is more likely to be associated with overvaluation of the real exchange rate. Montecino (2018) also explores this issue by focusing on the contribution of capital control on the persistence of RER misalignment using data for 77 developed and developing countries during the 1980-2011 period. His results suggest that capital controls exacerbate RER misalignment, especially under the pegged and managed floating exchange rate regimes.

There is strong evidence from the empirical analysis of this paper that a policy configuration with a relatively more flexible exchange rate and liberal capital account contributes significantly to limiting the persistence of RER misalignment and associated with a larger magnitude of misalignments, both in the form of undervaluation and overvaluation. This interpretation is robust to alternative specification of the model, time and sample coverage. The findings also confirm that estimating RER misalignment at the individual country level by paying attention to country-specific factors, rather than employing the widely used cross-country approach yields economically more plausible and consistent results.

The paper is structured as follows. Section two covers the RER misalignment estimation that includes discussions on the specification of the RER function, estimation method, data and comparison on the individual against the multi-country estimation results. The estimated RER misalignment is used in the third section to examine the association between RER misalignment with the exchange rate regime and capital flows management policy using alternative variables and specifications. The paper closes in the fourth section with a summary of the key findings.

2. The RER misalignment estimation

The RER misalignment is defined as the deviation of the observed RER from the path of equilibrium RER (ERER). Conceptually, the ERER is described as the RER level that maintains the economy in internal and external balance under the sustainable values of exogenous and policy variables. The internal balance is achieved when markets for nontraded goods clear under full employment. The external balance is related to the current account dynamics of the economy and the balance holds when the country's net creditor position in the global financial market has reached its steady state. In other words, the external balance is defined as a condition where the current account deficit is financed by sustainable capital flows.

2.1 The model of RER determinants

The RER (denoted here by e) is defined as the ratio of tradable and non-tradable goods prices. It measures a country's international competitiveness: the relative cost of producing tradable goods domestically compared to its trading partners. The level of e that maintains the economy in internal and external balance is defined as the ERER (e^*). The internal balance in the economy is achieved when the markets for nontraded goods clear as represented by the following equation:

$$y_N(e,\varepsilon) = c_N + g_N, \quad \partial y_N/\partial e < 0, \partial y_N/\partial \varepsilon < 0 \tag{1}$$

where y_N is the output of non-tradable goods when the economy is in full employment and c_N is the total private spending for non-tradables measured in tradable goods, while g_N is the portion of government expenditure for non-tradables. The supply of non-tradable goods is determined by the dynamics of the productivity variable (ε) for the tradable sector. A positive shock of ε increases the supply of tradable goods while decreasing the output of non-tradables at a given relative price. From equation (1), an increase in the demand for non-tradable goods will require the non-tradables price to increase relative to the tradables price (or RER appreciation) in order to increase the supply of non-tradables and/or increase the demand for tradables, hence maintaining the internal balance (Baffes et al. 1999).

The economy attains external balance when the current account balance matches with the country's net creditor position in the global financial markets. This equilibrium condition is given by the following equation:

$$\dot{f} = b + z + rf = y_T(e,\varepsilon) - g_T - \theta c + rf + z, \qquad \partial y_T/\partial e > 0, \partial y_T/\partial \varepsilon > 0 \tag{2}$$

where $\dot{f}$ represents the current account balance (defined as the changes in the net foreign assets), which consists of trade balance (b), net foreign transfer (z), and net income from the foreign asset f (the real yield on foreign asset is represented by r). g_T and θ are respectively government expenditure and the share of private expenditure for tradable goods from total private spending (c). The trade balance is defined as the difference between the total supply of tradable goods in the economy and the domestic absorption that consists of private and government expenditure on traded goods.

Assuming that the yield and the level of foreign assets are in the steady-state and by setting the left-hand side of equation (2) to zero and utilizing equation (1), the ERER (e^*) can be expressed in the following form:

$$e^* = e^*\left(g_{N,} g_{T,} [r^* f^* + z], \varepsilon\right) \tag{3}$$

where " * " represents the steady-state values of the variables. Based on the partial derivatives of equation (3), an increase (decrease) of government expenditure for non-tradables (or tradables) goods results in RER appreciation (or depreciation). Improvement in the net creditor position or productivity in the production of tradable goods is associated with RER appreciation. Equation (3) also shows that the ERER is a constant provided that the fundamental variables are stationary, which corresponds to the purchasing power parity approach where the ERER refers to a certain level in a certain period. However, if the fundamental variables are not stationary, then the ERER follows a certain path instead of a constant level. In general, as shown by Edwards (1989), Rogoff (1996), and Taylor and Taylor (2004),

theoretical and empirical approaches using different methods, sample periods and various price indices are more in support of a non-stationary path of equilibrium RER. In the following section, RER is used in place of *e* to be consistent with the standard practice in the empirical literature.

2.2 The RER function

In RER misalignment estimation, the ERER is estimated using parameters derived from a representative RER function and sustainable values of its determinants. Considering the observed RER index is based on the nominal exchange rate adjusted by the ratio of foreign price with the domestic price, it is important to consider the fundamental drivers that affect the nominal exchange rate and the domestic price (assuming foreign price exogeneity) in the RER function. The RER function specification in this study corresponds to the model discussed in the previous subsection that incorporates real fundamental factors represented by government expenditure, productivity, terms of trade, and trade openness (Edwards, 1989). To accommodate the influence of domestic and global monetary variables in the RER dynamics, the specification is enhanced with the inclusion of net foreign assets, financial sector openness, real interest rate gap between the domestic economy and the US, and domestic real interest rate (Barbosa et al., 2018 and Kaltenbrunner, 2015). The model can be specified as follows (with the expected sign of the coefficients in brackets)[3]:

$$RER = f(\underset{(+/-)}{GEXP}, \underset{(-)}{PROD}, \underset{(+/-)}{TOT}, \underset{(+)}{OPEN}, \underset{(+/-)}{NFA}, \underset{(+/-)}{RIR}, \underset{(+/-)}{DRIR}, \underset{(+/-)}{FINOP}), \quad (4)$$

where *RER* = the real exchange rate,
GEXP = government expenditure,
PROD = productivity,
TOT = terms of trade,
OPEN = trade openness,
NFA = net foreign asset,
RIR = real interest rate gap between the home country and the US,
DRIR = domestic real interest rate, and
FINOP = financial sector openness.

Government expenditure (GEXP) generally contains a larger non-tradable component compared to total domestic expenditure. Therefore, increase in government expenditure in the economy is hypothesised to exert demand pressure for the non-tradables causing their price to increase relative to the tradables (RER appreciation) (Edwards, 1989). In cases where expenditure is skewed towards imported or tradable goods, the RER will need to depreciate to maintain the sustainability of the external balance (Montiel, 1999).

Productivity (PROD) is included to capture the Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964). Based on the Balassa-Samuelson theorem, productivity growth is assumed to be higher in the tradable sector compared to the non-tradable sector. Under the assumption that the law of one price holds for tradables, the productivity improvements that occur under conditions of full employment and perfect labour mobility increase the absorption of workers from the non-tradables to the tradables sector (supply effect) and therefore drive-up real wages for all sectors of the economy. Hence, improvement in productivity is hypothesised to be associated with RER appreciation (Obstfeld et al., 1996).

The terms of trade (TOT) (the relative price of exports to imports) is included to account for the effect of exogenous adjustments in world prices that will influence the RER. Income growth generated by improvements in TOT leads to higher demand for non-tradables. To maintain the equilibrium, the price of non-tradables needs to increase thereby causing the RER to appreciate. However, it is possible to observe RER depreciation under this condition where the substitution effect is larger than the income effect (Edwards, 1989).

[3] A positive (+) direction of association indicates that an increase of a variable is expected to be followed by RER depreciation while a negative (-) direction indicates that an increase of a variable is expected to be followed by RER appreciation.

A higher degree of trade openness (OPEN) leads to greater demand for tradable goods. To restore equilibrium, the RER is required to depreciate in order to switch demand from tradable goods towards non-tradables. Therefore, under the assumptions that tradables and non-tradables are substitutes and the substitution effect is greater than the income effect, the RER is expected to be positively related with the degree of trade openness (Edwards, 1989).

To account for the external balance position of the economy, the net foreign assets (NFA) variable is included in the model. If a country is becoming increasingly reliant on international financing to cover its balance of payments deficit, it needs to generate a larger trade surplus to cover debt servicing for the financing at some point in the future. Therefore, a worsening net foreign assets position is associated with real depreciation (Aguirre and Calderón, 2005; Montiel, 2007). However, it is possible to find an opposite relationship in an economy that is in the process of achieving the desired stock of foreign assets to supplement the financing needed for the domestic economy. In this case, the country may experience RER appreciation alongside the growth of its foreign liabilities (Égert et al., 2004).

The real interest rate gap (RIR) and the domestic real interest rate (DRIR) is included to capture the effect of the foreign and domestic monetary policy stance. The increasing gap between the domestic real interest rate and the foreign real interest rate is expected to be associated with an appreciated RER due to inflows of capital. Higher domestic real interest rate is also expected to be associated with the appreciation of the RER. Aside from the nominal appreciation of the exchange rate from the increase of capital inflows, the higher real interest rate could also suppress the inflation of the non-tradables. However, for both variables, especially in the case of developing countries, it is possible to observe that higher real interest rate is associated with a more depreciated RER if the adjustment in the domestic interest rate is perceived to lead to a higher uncertainty that leads to negative market sentiment (Barbosa et al., 2018 and Kaltenbrunner, 2015).

The openness of the financial sector (FINOP) could affect the domestic intertemporal consumption decisions that affect the equilibrium relative prices with different directions. However, the sign of the coefficient of FINOP can go either way. A more open financial sector that provides easy access to external sources of financing could result in appreciation of the RER and hence the expected sign is negative (Lartey, 2011). By contrast, the expected sign is positive, if the openness of the financial sector tends to take the form of making investment abroad easier (i.e. encouraging capital outflows) compared to accessing international financing for domestic investment (Edwards, 2000).

2.3 Estimation of the RER function

Based on equation (4), the equivalent empirical specification for the RER function is expressed as follows:

$$\ln RER_{it} = \beta_i' F_{it} + u_{it} \quad (5)$$

where F_{it} is a vector of relevant fundamental variables for country i at time t, and u_{it} is assumed to be stationary and to have zero mean.

Most of the previous multi-country studies of RER misalignment have estimated RER function using data pooled for all countries. This approach assumes homogeneity of the coefficient across countries for the variables used in the equation. The adoption of the homogeneity assumption is prone to produce inconsistent fitted values due to the possibility of some fundamental variable to have a different direction of relationship with the RER, depending on the structure of individual economies (Schröder 2013). Therefore, in this study RER misalignment is calculated using RER equations estimated for each country.

The estimation method used is the dynamic ordinary least squares (DOLS) approach (Saikkonen, 1991; Stock and Watson, 1993). This method enables the use of variables with different unit root properties in estimating the cointegrating relationship[4] and is suitable for small- sample estimation. By including

[4] The cointegration approach is supported by the work of De Grauwe and Grimaldi (2006) based on a behavioural exchange rate model. One of the conclusions derived from their study is the changes in exchange rate is cointegrated with its fundamental value although the exchange rate changes are generally detached from the changes in the fundamentals.

the leads and lags of the differenced cointegrated variables in the estimation equation[5], the method addresses spurious regression problem and reduces endogeneity bias. The cointegrating relationship can be estimated efficiently and consistently by ordinary least squares (OLS) using Newey-West heteroscedasticity standard errors. With leads and lags, the estimation equation takes the following form:

$$\ln RER_{it} = \beta_{i1}' Z_{it} + \beta_{i2}' X_{it} + \sum_{l=-n_2}^{l=n_1} \tau_{il}' \Delta Z_{it+l} + u_{it} \quad (6)$$

where n_1 and n_2 are the leads and lags added to the equation and vectors Z_{it} and X_{it} are fundamental variables with I(1) and I(0) unit root characteristic respectively.

Given differences among countries in terms of data availability, estimation is done in two steps. The first step involved testing for unit root property of each variable in each country. Stationary (*I(0)*) variables are categorized as deterministic variables, while *I(1)* variables are categorized as cointegrating variables and their level and differenced leads and lags are added to the estimation. This was followed by estimating the equation using all possible unique combinations of variables[6] and selecting a representative equation that fulfils the following criteria (i) All the cointegrating and deterministic variables must be significant and have the correct signs consistent with the theoretical framework; (ii) The cointegration test (Engle-Granger ADF test and Hansen stability test) confirms a cointegration relationship; (iii) If there are multiple potential equations that meet the above criteria, the equation with the minimum value of the info criterion is chosen (Montiel 2007).

2.4 Estimation of the ERER path

After estimating the RER equation for individual economies, ERER is computed by using the estimated coefficients (β_i') on the sustainable (trend) component of each cointegrated variables (F_{it}^s), which is extracted using the Hodrick and Prescott (1997) filter (HP filter).

$$\ln ERER_{it} = \beta_i' F_{it}^s \quad (7)$$

In the HP filter procedure, the trend and cycle components from a time series are separated by applying a smoothing parameter (λ) to minimize the trade-off between goodness of fit and the degree of smoothness. The standard approach of applying the filter in empirical economic research is to assign a uniform λ across all series for all countries. However, assuming every series in each country has the same cyclical characteristics is very restrictive considering the significance of idiosyncratic shocks in individual countries (Aguiar and Gopinath, 2007; Benhamou, 2018). Another issue with the HP filter approach is the endpoint bias that relates to the specification of the HP filter. By construction, the trend and cycle component computation using the HP filter is sensitive to the start and the end of the series. Therefore, the filtering procedure in this paper applies the fully modified HP filter approach developed by Hanif et al. (2017) that addresses these issues. The procedure enables the determination of the lambda parameter endogenously, driven by the characteristic of each series while also minimizing the endpoint bias.

Using the ERER path and the observed RER, the misalignment of the RER for country *i* at time *t* (mis_{it}) is calculated as follows:

$$mis_{it} = \frac{ERER_{it} - RER_{it}}{RER_{it}} \quad (8)$$

where negative (or positive) value of mis_{it} implies undervaluation (or overvaluation).

[5] The selection for the length of the leads and lags is based on the minimum information criteria value.

[6] Due to the limitation of the data, the group of cointegrating variables being assessed consists of a combination of at least two variables and up to a maximum of five variables. As for the deterministic variable the maximum combination is limited to two variables at most. Constant and trend are included in the regression if the inclusion improves the information criterion.

2.5 Data

The RER index is constructed as the weighted average of main trading partners' wholesale (producer) price) indexes expressed in domestic currency relative to domestic price measured by the GDP deflator, using export shares as weights. The calculation for the RER index is expressed as follows[7]:

$$RER_{it} = \prod_{j=1}^{30} \left(\frac{NER_{ijt} \cdot WPI_{jt}}{GDP\ def_{it}} \right)^{w_j} \quad (9)$$

where RER_{it} is the RER index for country i at time t ; NER_{ijt} is the nominal exchange rate of country j in the currency of country i at time t; WPI_{jt} is the WPI of country j at time t; $GDP\ def_{it}$ is the GDP deflator of country i at time t; and w_j is the ratio of the export value of country i to j and the total export value of country i to its top 30 export partners using 5-years average. The base year chosen for the index calculation is 2010.

Previous studies have commonly used consumer price index to measure both world (trading partner) price and domestic price in constructing the RER index. The construction of the RER index based on this method is not consistent with the standard definition of the real exchange (Edwards, 1989). The use of CPI to measure foreign (trading partner) price is not theoretically consistent because it covers both tradable and non-tradable goods. Furthermore, in some developing countries, the CPI understates the rate of inflation because of political intervention in the construction of the index and price controls on some essential consumer goods. GDP deflator is a better indicator of domestic prices for two reasons: presumably it is less susceptible to political manipulations and it provides broader coverage of price movement in the economy (Athukorala and Rajapatirana, 2003). The choice of using the export share as the weight for the RER calculation is based on its superiority in representing the country's competitiveness compared to other alternatives such as import shares or total trade share (Warr, 1986).

The data are compiled from IMF's Direction of Trade Statistics (DOTS) and International Financial Statistics (IFS), World Bank's World Development Indicator (WDI), Penn World Table (PWT version 9) (Feenstra et al., 2015), and other sources covering 60 developing countries at yearly basis over the period 1980 - 2014. The list of variable description and sources are available in Table 1. A summary of descriptive statistics for the variables is available in Appendix 1. The list of countries included in the sample is presented in Appendix 2.

[7] The term real exchange rate (RER) used in this paper refers to the real effective exchange rate that is expressed in equation (9).

Table 1. RER function variables

Variable	Description	Sources
Real exchange rate index (RER)	The index is constructed using the cross-rate between the home country and trade partner, multiplied with the ratio of the trade partner's wholesale/producer price index and home country's GDP deflator. The index is then weighted geometrically using export weights of top 30 exports destinations. By this definition, an (a) increase (decrease) in the REER index indicates depreciation (appreciation).	DOTS (IMF) IFS (IMF) WDI (World Bank)
Government expenditure (GEXP)	There are 4 different definitions used to represent this variable: (1) Govt. consumption/GDP (current price) (2) Govt. consumption/GDP (constant price) (3) (2) + Govt. investment/GDP (constant price) (4) (1) + Govt. investment/GDP (current price)	WDI (World Bank) PWT (Feenstra et al., 2015) Investment and Capital Stock Dataset – (IMF)
Productivity (PROD)	The ratio of the country's GDP per capita with OECD's average GDP per capita. Calculated both in (1) the constant price, and (2) the current price.	WDI (World Bank)
Terms of trade (TOT)	The ratio between the price level of exports and price level of imports.	PWT (Feenstra et al., 2015)
Trade Openness (OPEN)	There are 3 different definitions used to represent this variable: (1) Imports/GDP (WDI – current price) (2) Exports + Imports / GDP (PWT constant price) (3) Exports + Imports / GDP (WDI – current price)	WDI (World Bank) PWT (Feenstra et al., 2015)
Net foreign assets (NFA)	Calculated as (1) net foreign assets / GDP, and (2) net foreign assets / imports.	Lane and Milesi-Ferretti (2018) WDI (World Bank)
Real interest rate gap (RIR)	The difference between domestic and US real interest gap.	WDI (World Bank)
Domestic real interest rate (DRIR)	The difference between the loan interest rate and inflation (GDP deflator).	WDI (World Bank)
Financial sector openness (FINOP)	Calculated using the NFA data based on the following formula (Saadma and Steiner, 2016): (Foreign asset – Reserves) + (Foreign liabilities – public loan) / GDP	Lane and Milesi-Ferretti (2018) WDI (World Bank)

Note: NFA and FINOP variables are included in the RER function with a 1-year lag to prevent bias from reverse causality.

2.6 RER misalignment

The estimated RER functions for individual countries are reported in Appendix 2. For the purpose of comparison, a panel DOLS regression estimation result is also provided. The signs of the estimated coefficients are all consistent with the theoretical expectation. Three variables that emerge statistically significant in the RER function for more than 40 countries in the sample are government expenditure, productivity, and trade openness. Net foreign asset, terms of trade, and financial openness also appear significant in more than half of the sample. Real interest rate gap and domestic real interest rate variables are only statistically significant for 12 and 8 countries. Note that there are notable differences among individual-countries in terms of the magnitude and the degree of statistical significance of regression coefficients. There are also some theoretically-consistent sign reversals of the coefficients of some variables. This notable structural heterogeneity of regression estimates supports the *a priori* reasoning for estimating RER misalignment by time-series regression at the country level rather than based on multi-country panel data regression.[8]

Figure 1 compares estimates of RER misalignment based on the panel DOLS regression and individual country regressions for three selected countries, China, Indonesia, and Malaysia. Based on the results, it can be concluded that the homogeneity assumption inherent in the panel regression can provide misleading misalignment estimates. In the case of China, the panel estimation indicates that the RER is more often experiencing significant overvaluation compared to undervaluation during the 1980-2014 period. For Indonesia and Malaysia, the panel regression results show that in the few years leading up to the 1998 Asian financial crisis, the two countries' RERs are not experiencing overvaluation but undervaluation. The highlighted cases are in sharp contrast with the results of RER estimates for individual countries, which are more consistent with the the general consensus based on available country-specific evidence (Chinn, 2000; Funke and Rahn, 2005; Athukorala, 2012). Therefore, the RER misalignment estimates based on individual regressions are used for analysis in the following section.

Note: Positive (negative) observations indicate overvaluation (undervaluation) of the RER.

Source: Author's calculation.

Figure 1. RER misalignment for China, Indonesia, and Malaysia

[8] A referee has correctly noted that regression coefficients of some variables (in particular for terms of trade and productivity) are seemingly abnormally large in a few cases, presumably driven by missing variables. We think that poor data quality and differences in variable measurement in original sources could have been other possible drivers. These are problems commonly encountered in a multi-country econometric analysis of developing countries of this nature.

3. RER misalignment, exchange rate regime and capital account openness

3.1 Model

To examine the relationship between the RER misalignment with the exchange rate regime and capital account openness, an empirical strategy combining approaches implemented by Nouira and Sekkat (2015) and Montecino (2018) is applied under a dynamic panel fixed effect regression setting. The use of the panel approach in this stage is driven by the low temporal variety characteristic of the exchange rate regime and capital account openness variables. The model is expressed as follows:

$$mis_{it} = \rho mis_{it-1} + \alpha ER_{it} + \beta KA_{it} + \gamma_1 RENT_{it} + \gamma_2 SOE_{it} + \gamma_3 BMO_{it} + \gamma_4 CRI_{it} + \theta_i + \vartheta_t + \tau_i \cdot trend + e_{it} \quad (10)$$

where mis_{it} = RER misalignment,
ER_{it} = exchange rate flexibility,
KA_{it} = capital account openness,
$RENT_{it}$ = ratio of resource rent over GDP,
SOE_{it} = social economic condition index,
BMO_{it} = ratio of broad money over GDP ,
CRI_{it} = economic crisis event dummy,
θ = country fixed effect,
ϑ = year fixed effect,
$\tau_i \cdot trend$ = country-specific trend, and
i and t denote country and time, respectively.

In equation (10), the coefficient ρ measures the degree of persistence of the RER misalignment. Coefficients α and β represents the association of the exchange rate flexibility and capital account openness with the level of misalignment. Control variables included in the estimation that accounts for country's reliance on natural resources (RENT), social economic condition (SOE) representing institutional quality, financial market development (BMO), and economic crisis events (CRI) are based on the work of Nouira and Sekkat (2015). Economies that rely on natural resources are expected to be associated with larger RER misalignment driven by changes in the commodity prices or new discovery of resources. Economies with better institutional quality and a more developed financial market are predicted to be better in managing surges and reversals of capital flows and therefore tend to be more tolerable to RER misalignments (Aizenman and Riera-Crichton, 2008; Aghion et al., 2009; and Elbadawi et al., 2012). The economic crisis dummy (which takes a value of 1 for crisis years and 0 otherwise) controls for extreme changes in the nominal exchange rate due to economic crisis events.

The misalignment persistence term (ρ) is elaborated further in equation (11). The model includes a constant ρ_0 to capture unobserved country and time-invariant components that affect the misalignment persistence. ρ_1 and ρ_2 denote the contribution of the exchange rate regime (ER) and capital account openness (KA) to the persistence of the misalignment.

$$\rho = (\rho_0 + \rho_1 ER_{it} + \rho_2 KA_{it}) \quad (11)$$

3.2 Data

Data on exchange rate regimes and capital account openness is from the database of Aizenman et al. (2013). Alternative exchange rate regime indicator and capital account openness indicator respectively compiled by Ilzetzski et al. (2017) and Fernandez et al. (2016) are used as alternative indices for

assessing the consistency of estimation results. A list for variable description and sources is available in Table 2[9].

Table 2. Misalignment regression variables

Variable	Description	Sources
RER misalignment (*mis*)	The gap between the estimated ERER and the observed RER index, as calculated in equation (8).	Own calculation
Exchange rate flexibility index (ER)	Measures the flexibility of the exchange rate based on the annual standard deviations of the monthly exchange rate between the home country and the base country. In this paper, the original index has been converted where a higher value indicates a more flexible exchange rate.	Aizenman et al. (2013)
Exchange rate regime category (ER_{fix}, ER_{int}, ER_{flex})	Ilzetzski et al. (2017) rank the de facto exchange rate flexibility of countries using 15 different categories. This paper applies the classification by Martin (2016) to group the categories into 3, namely fixed, intermediate and flexible exchange rate regime. Observations with parallel market data are not available (code 15), are excluded from the analysis.	Ilzetzski et al. (2017)
Capital account openness index (KA)	Standardized index based on the principal component of variables that indicate the presence of multiple exchange rates, restrictions on current account transactions, on capital account transactions, and the requirement of the surrender of export proceeds. The index is normalized between zero and one. A higher value indicates a more liberalized capital account.	Aizenman et al. (2013)
Capital account openness index - Schindler (KA_{Sch})	Originally constructed by Schindler (2009) based on the information on IMF's AREAR on capital flows management measures implemented by countries for a range of instruments in both directions of inflows and outflows. The country coverage has been expanded and updated in Fernandez et al. (2016). The index is normalized between zero and one. A higher value indicates a more liberalized capital account.	Fernandez et al. (2016)
Resource rent (RES)	The sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents as a percentage of GDP.	WDI (World Bank)
Socioeconomic condition score (SOE)	A proxy for the institutional factor of an economy that describes the socioeconomic pressures in society. The score is the sum of three subcomponents, each with a maximum score of 4 points and a minimum score of 0 points. A score of 4 points equates to very low risk and a score of 0 points to very high risk. The subcomponents are: unemployment, consumer confidence, and poverty.	International Country Risk Guide (PRS Group)
Broad money/GDP (BMO)	A proxy for financial market development represented by the ratio of broad money to GDP.	WDI (World Bank)
Crisis dummy (CRI)	Economic crisis events (including systemic banking, currency and sovereign crisis).	Laeven and Valencia (2018)

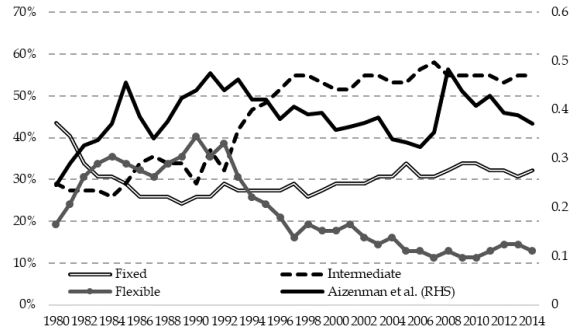
[9] A summary of descriptive statistics for the variables is available in Appendix 1 and the correlation table for the variables discussed in this section is available in Appendix 3.

3.3 Result

3.3.1 Trend and patterns of exchange rate flexibility and capital account openness

Figure 2 and Figure 3 plot the average of exchange rate flexibility and capital account openness based on different indices for the sample countries. The plot in Figure 2 suggests that there is a mild increasing trend in exchange rate flexibility in the early sample period. However, the trend has stagnated since the early 1990s as more countries have tended to manage the movement of their exchange rate, as confirmed by the increased number of countries classified under the intermediate exchange rate regime.

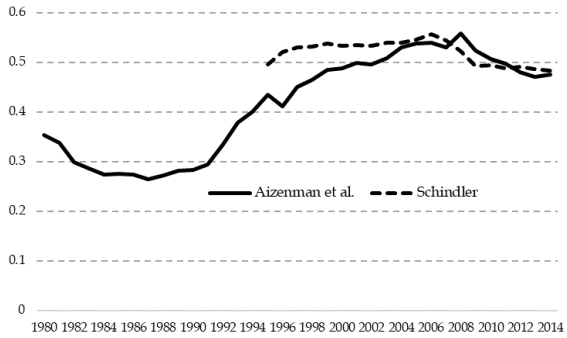
Figure 3 indicates an overall policy shift towards a more liberalized capital account regimes among the countries during the period under study. This is consistent with one of the policy reforms themes advocated for developing economies during the period in the form of financial market liberalization (Ghosh et al., 2018). However, in the more recent period after the global financial crisis in 2008, there is a slight decrease in the capital account openness among the sample countries.



Note: The solid line refers to the right-hand scale of the graph that indicates the average exchange rate flexibility index based on the data from Aizenman et al. (2013) for the sample where higher observations indicate higher exchange rate flexibility. The rest of the line refers to the left-hand scale of the graph that represents the proportion of sample countries that are included in the reclassified exchange rate regime of Ilzetzski et al. (2017).

Source: Aizenman et al. (2013) and Ilzetzski et al. (2017).

Figure 2. Exchange rate flexibility indicators

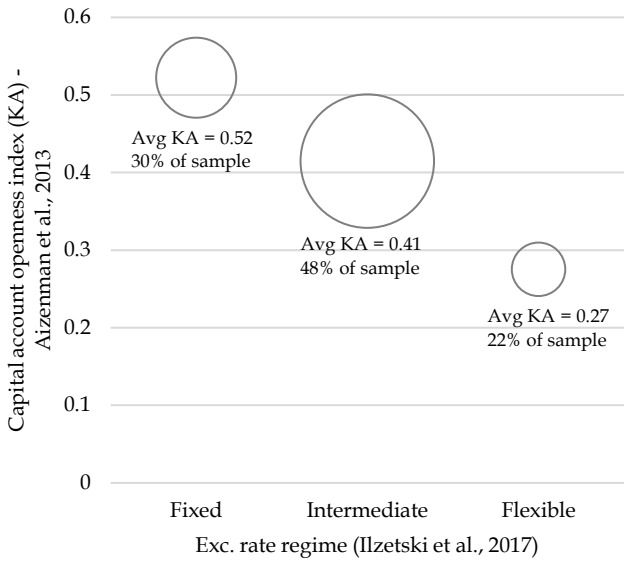


Note: The solid line refers to the average capital account openness index based on the data from Aizenman et al. (2013). The dashed line represents the average capital account openness index based on the data from Fernandez et al. (2016) for countries in the sample. A higher value indicates a more open capital account.

Source: Aizenman et al. (2013) and Fernandes et al. (2016).

Figure 3. Capital account openness indicators

Figure 4 depicts the distribution of policy configuration of the sample countries. The graph suggests that on average, there is a tendency that countries with a fixed exchange rate regime have a more open capital account and those with flexible exchange rate regime have a less liberalized capital account policy. One possible explanation for this pattern is that, as an economy opens up for foreign capital flows, it attempts to preserve its international competitiveness by intervening on the domestic foreign exchange market using the country's international reserves (Aizenman and Lee, 2007; Obstfeld et al., 2010; Aizenman et al., 2015). The graph also shows that most of the observation (48% of observations) are classified as having an intermediate exchange rate regime with a moderate degree of capital account openness.



Note: The size of the circle represents the proportion of each category in the sample. A higher value of capital openness index (KA) represents a more open capital account.

Source: Aizenman et al. (2013) and Ilzetzski et al. (2017).

Figure 4. Exchange rate regime and capital account openness

3.3.2 Benchmark results

The dynamic panel fixed-effect specification based on equations (10) and (11) are regressed using the generalized method of moments (GMM) estimator. The GMM estimation is chosen to treat the dynamic panel bias (Nickell, 1981) introduced by the use of lagged RER misalignment in the fixed-effect setting[10]. The test results of overidentifying restriction confirmed the validity of the estimated results of all equations[11].

The first row of Table 3 shows that the estimated coefficients of lagged misalignment (mis_{it-1}), which corresponds to the constant persistence factor (ρ_0- equation (11)) are statistically significant with the expected (positive) sign. This implies that holding other variables constant and under the regime of the fixed exchange rate (ER=0) and closed capital account (KA=0), around 74% to 88% of the previous year's RER misalignment (mis_{it-1}) contributes to the current misalignment (mis_{it}).

The regression in column 3.1 includes the exchange rate regime and capital account openness indicator. The contribution of the exchange rate regime on the persistence factor (ρ_1- equation (11)) corresponds to the coefficient of mis_{it-1}·ER. The negative coefficient, which is statistically significant, indicates that a more flexible nominal exchange rate regime is associated with a significantly less persistent RER misalignment. Under the free-floating exchange rate regime (ER=1), the persistence of the misalignment is reduced significantly by around 40%[12]. As for the contribution of capital account openness on the persistence factor (ρ_2-equation (11)) that is represented by the coefficient of mis_{it-1}·KA, the result indicates that capital account openness does not contribute significantly to the persistence of the RER misalignment. In terms of the level of misalignment, free-floating exchange rate regime (ER=1) is significantly associated with RER undervaluation of around 9% while there is no significant contribution to the level of misalignment from the capital account openness. The result also confirms the significant association of other control variables with the level of the RER misalignment. Reliance

[10] The two-step efficient GMM estimator is applied (Hayashi (2000)). The lagged RER misalignment is instrumented using a combination of further lags (2 and 3 years) of the misalignment with a 2-year lag of the US real interest rate and the same lag of a global liquidity indicator represented by the ratio of the sum of foreign asset and liabilities to the GDP of OECD countries.
[11] Estimation results using OLS method is provided in Appendix 4 for comparison.
[12] Calculated based on equation (11).

on the natural resources sector, social-economic condition, and the ratio of broad money to GDP are all significantly related to the level of misalignment, in-line with the previous finding of Nouira and Sekkat (2015)[13].

The model estimated by replacing the exchange rate regime indicator with the reclassified exchange regime of Ilzetzski et al. (2017) is reported in column 3.2. The results are consistent with those in column 3.1 where under flexible exchange rate regime ($ER_{flexible}$=1), the RER misalignment is lower in terms of persistence and tend to experience undervaluation compared to the fixed regime (used as the reference case) and the intermediate regime (ER_{inter}=1). As for the capital account policy, the result in the persistence term indicates that a liberalized policy is associated with a shorter period of RER misalignment. However, the result does not indicate that capital account openness has a significant association with the level of misalignment.

For estimations in columns 3.3 and 3.4, the empirical model is modified by replacing both ER and KA variables with the interaction of both variables (KA·ER). The regression in column 3.3 uses the exchange rate flexibility and capital account openness index by Aizenman et al. (2013) as was done in column 3.1. The result indicates that the interaction of both policies has a significant relationship both in terms of persistence and level of the misalignment. Under the maximum exchange rate flexibility and capital account openness (where ER = 1 and KA = 1), the adjustment period needed for the RER to converge to the equilibrium level is significantly faster and on average is associated with undervaluation of 6%.

The alternative estimate results of the model with categorical exchange rate regime variable (column 3.4) is broadly consistent with the results from previous regressions. Comparison of the coefficients of the interaction term between the capital account policy and fixed exchange rate (mis_{it-1}·KA·ER_{fix}=1) and the one with the flexible exchange rate (mis_{it-1}·KA·ER_{flex}=1) confirms that under the same degree of capital account openness, the misalignment persistence is lower under the flexible exchange rate regime. The results also indicate that the fixed exchange rate regime is associated with overvalued RER, while the flexible regime is associated with RER undervaluation.

[13] The result of the additional control variables (resource rent, social-economic condition, broad money to GDP ratio, and economic crisis) is consistent across estimations. Therefore, further discussions will be focused on exchange rate flexibility (ER) and capital account openness (KA).

Table 3. Benchmark estimation result (GMM estimates)

Dependent variable: RER misalignment (mis_{it})

	Singular specification		Interaction	
	3.1	3.2	3.3	3.4
mis_{it-1}	0.878***	0.828***	0.745***	0.764***
	(0.0477)	(0.0582)	(0.0259)	(0.0325)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term				
mis_{it-1}·ER	-0.350***			
	(0.0648)			
mis_{it-1}·ER_{inter}=1		-0.0137		
		(0.0496)		
mis_{it-1}·$ER_{flexible}$=1		-0.303***		
		(0.0666)		
mis_{it-1}·KA	-0.0774	-0.141**		
	(0.0571)	(0.0584)		
mis_{it-1}·KA·ER			-0.179**	
			(0.0896)	
mis_{it-1}·KA·ER_{fix}=1				-0.159**
				(0.0738)
mis_{it-1}·KA·ER_{inter}=1				-0.0527
				(0.0587)
mis_{it-1}·KA·ER_{flex}=1				-0.372***
				(0.1432)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level				
ER	-0.0868***			
	(0.01)			
ER_{inter}=1		-0.0244***		
		(0.0083)		
$ER_{flexible}$=1		-0.0999***		
		(0.0132)		
KA	0.0193	0.00769		
	(0.0133)	(0.013)		
KA·ER			-0.0603***	
			(0.0169)	
KA·ER_{fix}=1				0.0516***
				(0.0191)
KA·ER_{inter}=1				0.0114
				(0.0145)
KA·ER_{flex}=1				-0.0493**
				(0.0223)
Other controls				
Resource rent	0.00225***	0.00203**	0.00180**	0.00173**
	(0.0007)	(0.0008)	(0.0008)	(0.0008)
Social- economic condition	0.00672***	0.00506**	0.00442*	0.00514**
	(0.0021)	(0.002)	(0.0023)	(0.0021)
Broad money / GDP	-0.000847***	-0.000854***	-0.000956***	-0.00102***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Economic crisis	-0.0867***	-0.0886***	-0.0991***	-0.0973***
	(0.0099)	(0.0098)	(0.0109)	(0.0106)
Observations	1713	1713	1713	1713
Adjusted R-square	0.578	0.587	0.561	0.563
Test of overidentifying restriction; *p* - value	0.678	0.635	0.687	0.686

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regressions use the capital account openness index (KA) based on Aizenman et al.(2013). Regressions in columns 3.1 and 3.3 uses the exchange rate flexibility index (ER) based on Aizenman et al.(2013). Regressions in columns 3.2 and 3.4 uses the reclassified exchange rate regime of Ilzetzski et al.(2017). The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.

3.3.3 Asymmetries of the RER misalignment

The discussion so far has been based on the assumption that the relationship between RER misalignment, and exchange rate flexibility and capital account openness is symmetrical between RER undervaluation and overvaluation. The purpose of this section is to test the validity of this assumption.

The alternative estimates undertaken for this purpose are reported in Tables 4 and 5. The estimates reported in Table 4 correspond to those in columns 3.1 and 3.2 of Table 3, while the results in Table 5 correspond to columns 3.3 and 3.4. In these estimates, a binary dummy that distinguishes between RER undervaluation and overvaluation (1 for undervaluation and 0 for overvaluation) is interacted with exchange rate flexibility and capital account openness variables, in the persistence and the level components.

As the result reported in column 4.1 suggest, there is no significant difference in the constant persistence factor when the RER is undervalued as shown by the insignificant coefficient of $mis_{it-1} \cdot 1\{mis_{it-1}<0\}$ in the second row. In the persistence term, the result still confirms that the flexible exchange rate regime contributes to a faster adjustment of RER to its equilibrium value. However, when the RER is undervalued in the previous year, the speed of adjustment is not as fast as when the RER is overvalued. The asymmetry is indicated by the coefficient of $mis_{it-1} \cdot ER \cdot 1\{mis_{it-1}<0\}$, which is positive and significant at the 10% significance level, but smaller than the coefficient of $mis_{it-1} \cdot ER$ in absolute term. The result also indicates that capital account openness has a significant negative association with the misalignment persistence term, and there is no asymmetry detected. In terms of misalignment level, a higher degree of exchange rate flexibility and capital account openness are associated with a larger RER misalignment both in the form of overvaluation and undervaluation.

The results in column 4.2 with categorical exchange rate variable is generally consistent with the results in column 4.1. Unlike the equation in column 4.1, the one in column 4.2 does not find evidence of exchange rate regime asymmetric contribution in the persistence term. The result also suggests that capital account openness only has a significant association with the RER misalignment through the persistence term. As for the magnitude of misalignment, greater exchange rate flexibility is associated with deeper RER undervaluation.

Results using interaction specification reported in Table 5 also suggest there is no significant difference in the constant persistence factor during RER undervaluation episodes. The results in columns 5.1 and 5.2 suggest that countries with a liberalized policy configuration tend to have a shorter period of RER misalignment with no indication of asymmetric relationship. Related to the magnitude of misalignment, the results also suggest that a less restrictive policy setting in terms of exchange rate flexibility and the capital account is associated with larger overvaluation and undervaluation episodes.

Table 4. Asymmetric estimation results- singular specification (GMM estimates)

Dependent variable: RER misalignment (mis_{it})

	4.1	4.2
mis_{it-1}	0.908***	0.627***
	(0.087)	(0.1194)
mis_{it-1}·1{mis_{it-1}<0}	-0.209	0.0177
	(0.1533)	(0.1786)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term		
mis_{it-1}·ER	-0.641***	
	(0.1157)	
mis_{it-1}·ER_{inter}= 1		0.0667
		(0.1015)
mis_{it-1}·$ER_{flexible}$= 1		-0.501***
		(0.1256)
mis_{it-1}·KA	-0.241**	-0.216**
	(0.0984)	(0.0993)
mis_{it-1}·ER·1{mis_{it-1}<0}	0.338*	
	(0.1826)	
mis_{it-1}·ER_{inter}=1·1{mis_{it-1}<0}		-0.233
		(0.15)
mis_{it-1}·$ER_{flexible}$= 1·1{mis_{it-1}<0}		0.222
		(0.181)
mis_{it-1}·KA·1{mis_{it-1}<0}	-0.0195	0.0092
	(0.1723)	(0.1626)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level		
ER	0.0437***	
	(0.0154)	
ER_{inter}= 1		-0.0345***
		(0.0126)
$ER_{flexible}$= 1		-0.0146
		(0.0164)
KA	0.0540***	0.00613
	(0.0143)	(0.0152)
ER·1{mis_{it}<0}	-0.160***	
	(0.0115)	
ER_{fix}=1·1{mis_{it}<0}		-0.112***
		(0.0135)
ER_{inter}=1·1{mis_{it}<0}		-0.114***
		(0.0097)
$ER_{flexible}$= 1·1{mis_{it}<0}		-0.176***
		(0.0115)
KA·1{mis_{it}<0}	-0.0762***	0.00245
	(0.0102)	(0.0142)
Observations	1713	1713
Adjusted R-square	0.682	0.725
Test of overidentifying restriction; *p* - value	0.657	0.788

Table 5. Asymmetric estimation results - interaction specification (GMM estimates)

Dependent variable: RER misalignment (mis_{it})

	5.1	5.2
mis_{it-1}	0.769***	0.765***
	(0.0455)	(0.0539)
mis_{it-1}·1{mis_{it-1}<0}	-0.0877	0.0299
	(0.0852)	(0.1096)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term		
mis_{it-1}·KA·ER	-0.640***	
	(0.1428)	
mis_{it-1}·KA·ER_{fix}=1		-0.584***
		(0.1402)
mis_{it-1}·KA·ER_{inter}=1		-0.306***
		(0.0974)
mis_{it-1}·KA·ER_{flex}=1		-1.136***
		(0.2833)
mis_{it-1}·KA·ER·1{mis_{it-1}<0}	-0.0629	
	(0.2725)	
mis_{it-1}·KA·ER_{fix}=1·1{mis_{it-1}<0}		0.159
		(0.2308)
mis_{it-1}·KA·ER_{inter}=1·1{mis_{it-1}<0}		-0.209
		(0.1959)
mis_{it-1}·KA·ER_{flex}=1·1{mis_{it-1}<0}		0.233
		(0.3986)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level		
KA·ER	0.103***	
	(0.0231)	
KA·ER_{fix}= 1		0.131***
		(0.0242)
KA·ER_{inter}= 1		0.0759***
		(0.0169)
KA·ER_{flex}= 1		0.102***
		(0.0347)
KA·ER·1{mis_{it}<0}	-0.294***	
	(0.0193)	
KA·ER_{fix}= 1·1{mis_{it}<0}		-0.149***
		(0.0146)
KA·ER_{inter}= 1·1{mis_{it}<0}		-0.152***
		(0.0102)
KA·ER_{flex}= 1·1{mis_{it}<0}		-0.265***
		(0.0361)
Observations	1713	1713
Adjusted R-square	0.608	0.627
Test of overidentifying restriction; *p* – value	0.741	0.776

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regressions control for resource rent, social-economic condition, the ratio of broad money to GDP, and economic crisis events. The capital account openness index (KA) based on Aizenman et al.(2013) is used for all regressions. Regressions in columns 4.1 and 5.1 uses the exchange rate flexibility index (ER) based on Aizenman et al.(2013). Regressions in columns 4.2 and 5.2 uses the reclassified exchange rate regime of Ilzetzski et al.(2017).The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.

3.3.4 Capital inflow and outflow liberalization

Table 6 reports the equation in column 5.1 of Table 5 reestimated using a combination of Aizenman's exchange rate flexibility indicator with alternative measures of capital account openness. The capital account openness indicator (KA) compiled by Aizenman et al. (2013) is used in column 6.1, which act as the benchmark for other estimations in the rest of other columns using the Schindler (2009) index. In column 6.2 the capital account openness indicator is the overall index, followed by the index for capital inflows (column 6.3), and column 6.4 uses the indicator for capital outflows. The sample used for estimations in this table is adjusted to the coverage of Schindler index that consists of 50 countries covering a shorter period of 1995 to 2014[14].

There is no significant difference in terms of the direction of the estimated coefficients even when the capital account openness variable is replaced with the inflow and outflow indicator (columns 6.3 and 6.4). Results reported in Table 6 for different sub-sample and alternative indicators of capital account policy, reaffirm previous interpretations on the association of the exchange rate flexibility and the capital account openness with the RER misalignment. Relating to persistence of RER misalignment, countries that allow more flexibility in the exchange rate movement and more open capital account tend to have lower persistence RER misalignment. As for the misalignment level, the result implies that liberalized policy setting in terms of exchange rate flexibility and the capital account is associated with larger misalignments both in form of overvaluation and undervaluation.

[14] Countries not covered due to the use of the Schindler index are Albania, Cameroon, Congo, Gabon, Honduras, Jordan, Madagascar, Mongolia, Nepal, Sudan, Senegal, and Trinidad and Tobago.

Table 6. Asymmetric estimation results – alternative capital account policy indices (GMM estimates)

Dependent variable: Dependent variable: RER misalignment (mis_{it})

	6.1	6.2	6.3	6.4
mis_{it-1}	0.757***	0.763***	0.759***	0.771***
	(0.0655)	(0.0644)	(0.0677)	(0.0609)
mis_{it-1}·1{mis_{it-1}<0}	0.0942	0.07	0.0969	0.0289
	(0.1114)	(0.1137)	(0.1178)	(0.1101)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term				
mis_{it-1}·ER·KA_{Aiz}	-0.686***			
	(0.1515)			
mis_{it-1}·ER·KA_{Sch}		-0.822***		
		(0.182)		
mis_{it-1}·ER·$KA_{Sch\text{-}inflow}$			-0.855***	
			(0.1945)	
mis_{it-1}·ER·$KA_{Sch\text{-}outflow}$				-0.768***
				(0.1571)
mis_{it-1}·ER·KA_{Aiz}·1{mis_{it-1}<0}	-0.355			
	(0.2494)			
mis_{it-1}·ER·KA_{Sch}·1{mis_{it-1}<0}		-0.169		
		(0.2858)		
mis_{it-1}·ER·$KA_{Sch\text{-}inflow}$·1{mis_{it-1}<0}			-0.141	
			(0.2991)	
mis_{it-1}· ER·$KA_{Sch\text{-}outflow}$·1{mis_{it-1}<0}				-0.154
				(0.2619)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level				
ER·KA_{Aiz}	0.0390**			
	(0.0184)			
ER·KA_{Sch}		0.0587**		
		(0.0232)		
ER·$KA_{Sch\text{-}inflow}$			0.0469**	
			(0.0233)	
ER·$KA_{Sch\text{-}outflow}$				0.0708***
				(0.0221)
ER·KA_{Aiz}·1{mis_{it}<0}	-0.230***			
	(0.0158)			
ER·KA_{Sch}·1{mis_{it}<0}		-0.255***		
		(0.0183)		
ER·$KA_{Sch\text{-}inflow}$·1{mis_{it}<0}			-0.251***	
			(0.0173)	
ER·$KA_{Sch\text{-}outflow}$·1{mis_{it}<0}				-0.246***
				(0.0178)
Observations	940	940	940	940
Adjusted R-square	0.724	0.740	0.740	0.734
Test of overidentifying restriction; *p* – value	0.694	0.735	0.751	0.711

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regressions control for resource rent, social-economic condition, the ratio of broad money to GDP, and economic crisis events. The exchange rate flexibility index (ER) based on Aizenman et al. (2013) is used. KA_{Aiz} corresponds to the capital account openness indicator by Aizenman et al. (2013). KA_{Sch} refers to the overall capital account indicator by Schindler (2009) with the inflow/outflow subscript indicating the indicator for the degree of capital openness for capital inflows/outflows. The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.

4. Summary

This paper has examined the association of RER misalignment with the exchange rate flexibility and the capital account openness using a panel dataset covering 60 developing countries over the period 1980-2014. The analysis is based on an RER index which is more consistent with the theoretical concept of RER compared to the commonly used CPI-based index. The RER misalignment is estimated by taking into account the heterogeneity of underlying drivers of RER behaviour among countries. In calculating the equilibrium path of the RER, individual RER function has been estimated by applying the endogenous HP filter procedure on each variable in the function. The analysis paid proper attention to the sensitivity of results due the use of alternative measures of the exchange rate and capital account regimes and alternative specifications.

The results indicate that in general, exchange rate flexibility and capital account openness is associated with the degree of persistence and the magnitude of RER misalignment. A higher degree of exchange rate flexibility and openness to capital flows is associated with faster adjustment of the RER to its equilibrium value. This is consistent with the argument of Corden (1994) where the RER adjustment will most likely to be slow under the fixed exchange rate regime. The result is also in line with the conclusion of Montecino (2018) who asserts that countries with capital controls tend to have longer duration of RER misalignments. The asymmetric estimation results found limited evidence of asymmetry in the contribution of the exchange rate flexibility on the persistence term when the RER is undervalued. In terms of the magnitude of the RER misalignment, the result implies that liberalized policy configuration is associated with larger misalignments both in the form of overvaluation and undervaluation.

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Appendix 1.

Table A.1. Descriptive statistics

Variables	Remarks/units	Observations	Average	Standard Deviation	Minimum	Maximum
Real exchange rate index	Index (2010 = 100)	2,081	128.87	45.98	29.28	546.44
Misalignment	Decimal x 100 = Percent (%)	2,008	-0.47	15.72	-53.57	107.65
Financial sector openness (Saadma and Steiner 2016)	Ratio	2,035	1.06	2.77	-0.34	33.53
Govt. Expenditure 1 - Govt. consumption / GDP	Current price - Percent (%)	1,923	13.41	5.58	0.91	76.22
Govt. Expenditure 2 - Govt. consumption / GDP	Constant price - Percent (%)	2,100	18.22	10.00	1.66	177.64
Govt. Expenditure 3 - Govt. consumption & investment / GDP	Constant price - Percent (%)	2,100	23.39	11.35	2.37	181.75
Govt. Expenditure 4 - Govt. consumption & investment / GDP	Current price - Percent (%)	2,098	18.95	9.31	0.88	83.54
Net foreign asset 1 - Net foreign asset / Imports	Percent (%)	2,047	-48.71	144.15	-4573.60	550.62
Net foreign asset 2 - Net foreign asset / GDP	Percent (%)	1,967	-5.25	49.98	-1121.74	14.57
Openness 1 - Export + Import / GDP	Current price - Percent (%)	1,982	34.46	18.68	0.06	125.71
Openness 2 - Import / GDP	Current price - Percent (%)	2,100	36.12	26.81	0.27	161.21
Openness 3 - Export + Import / GDP	Constant price - Percent (%)	1,982	66.10	36.30	0.17	251.14
Productivity 1 - GDP per capita / Avg. GDP per capita of OECD	Constant price - Percent (%)	2,069	14.30	17.89	0.55	147.65
Productivity 2 - GDP per capita / Avg. GDP per capita of OECD	Current price - Percent (%)	2,058	14.11	19.48	0.00	211.23
Domestic real interest rate	Percent (%)	1,323	6.61	26.46	789.80	8749.50
Real interest rate gap	Percent (%)	1,303	2.51	26.20	-103.70	784.18
Terms of trades	Ratio	2,100	0.99	0.12	0.32	2.55
Exchange rate flexibility (Aizenman et al.,2013)	Index (0 to 1)	2,067	0.39	0.33	0	1
Exchange rate regime category (Ilzetzski et al., 2017)	Categorical (1 to 3)	2,057	1.93	0.72	1	3
Capital account openness (Aizenman et al., 2013)	Index (0 to 1)	2,051	0.41	0.34	0	1
Capital account openness (Fernandez et al., 2016)	Index (0 to 1)	960	0.52	0.35	0	1
Resource Rent	Percent (%)	2,059	9.30	11.51	0.00	72.17
Socioeconomic condition	Index (1 to 11)	1,822	5.08	1.75	1	11
Broad money/GDP	Percent (%)	2,023	43.59	28.03	7.29	192.24
Economic crisis	Dummy (0 & 1)	2,100	0.09	0.28	0	1

Appendix 2.

Table A.2. Individual country RER function

No	Country	Govt. expenditure	Productivity	Terms of trade	Trade openness	Net foreign asset	Real interest rate gap	Domestic real interest rate	Financial openness	[leads,lags]
1	Albania	-0.035 (1.85)* (2)	-0.144 (9.88)*** (2)	5.986 (16.16)***						[0,0]
2	Algeria	-0.034 (4.08)*** (4)	-0.012 (5.81)*** (2)		0.035 (4.87)***	-0.002 (5.32)***			1.367 (2.64)**	[1,1]
3	Argentina			2.596 (4.4)***	0.083 (2.9)*** (2)	-0.011 (3.04)***				[0,1]
4	Bahrain	-0.035 (18.29)*** (3)	-0.017 (15.12)*** (2)		0.001 (3.56)*** (2)	0.356 (26.15)*** (2)	0.003 (5.27)***		-0.026 (16.09)***	[1,0]
5	Bangladesh	0.417 (36.29)***		0.827 (12.99)***		-0.045 (62.09)***			5.119 (26.51)***	[3,3]
6	Bolivia	0.066 (7.09)*** (3)		0.791 (2.59)**	0.03 (16.44)*** (3)	-0.093 (15.49)*** (2)				[2,1]
7	Brazil	-0.021 (2.13)	-0.038 (5.94)*** (2)		0.007 (2.91)** (2)	-0.061 (7.84)*** (2)				[2,2]
8	Bulgaria		-0.049 (9.59)*** (2)	2.757 (2.21)**	0.004 (1.96)* (3)					[0,0]
9	Cameroon		-0.014 (1.95)* (2)		0.004 (8.94)*** (3)				0.378 (3.1)***	[2,0]
10	Chile	-0.031 (4.01)*** (3)	-0.054 (7.36)***	-0.714 (1.8)*			0.009 (1.9)*		0.156 (3.64)***	[1,2]
11	China	0.026 (3.33)*** (2)				-0.343 (5.57)*** (2)		-0.021 (2.28)**	-1.479 (1.78)*	[0,0]
12	Colombia	0.023 (3.1)** (4)				-0.022 (4.29)***	0.033 (4.11)***	-0.036 (4.26)***	1.419 (2.88)**	[1,2]
13	Congo, Dem. Rep	-0.021 (4.96)*** (2)	-0.067 (8.88)*** (2)	-1.947 (3.46)***	0.001 (3.32)** (3)	-0.001 (2.45)**				[1,1]
14	Costa Rica		-0.026 (13.74)*** (2)		0.003 (2.1)**	-0.003 (14.06)***	0.001 (2.42)**			[0,0]
15	Côte d'Ivoire	0.225 (33.14)***		-4.174 (15.7)***	0.014 (15.09)*** (3)	-0.015 (26.37)***			-0.314 (9.09)**	[2,2]
16	Dominican Republic	0.143 (7.15)*** (4)	-0.119 (13.89)*** (2)	4.861 (61.59)***					-1.927 (9.22)***	[2,2]
17	Ecuador	0.007 (6.58)*** (3)	-0.036 (23.48)*** (2)	0.338 (2.23)**					0.566 (5.05)***	[2,1]
18	Egypt	0.145 (12.74)***	-0.176 (10.85)*** (2)		0.016 (2.69)** (2)	-0.013 (5.41)***				[2,0]
19	El Salvador	0.076 (14.1)***	-0.109 (12.01)*** (2)			-0.065 (1.85)* (2)			-1.007 (17.16)***	[2,0]
20	Ethiopia	-0.027 (30.54)*** (3)	-0.124 (9.95)*** (2)	4.812 (576.35)***						[3,3]
21	Gabon	0.024 (8.65)***		0.161 (2.37)**	0.014 (8.75)***	-0.012 (32.66)***			-1.272 (24.63)***	[2,0]
22	Ghana		-0.377 (9.54)*** (2)	-1.52 (3.93)***	0.003 (3.09)** (3)				-0.914 (5.88)***	[2,2]
23	Guatemala	-0.05 (4.09)***	-0.102 (2.16)**	2.52 (5)***	0.015 (3.82)*** (3)					[1,0]
24	Honduras	-0.069 (7.01)*** (2)		0.658 (1.92)*	0.004 (5.09)*** (3)					[2,2]
25	India	-0.062 (6.23)*** (2)		-0.635 (3.52)***	0.035 (2.99)** (3)		0.005 (2.33)**		-3.745 (4.41)***	[2,2]
26	Indonesia	0.028 (25.71)** (3)	-0.055 (25.54)** (2)	0.878 (27)**		-0.03 (29.77)**			-3.362 (24.21)**	[2,2]
27	Iran	0.098 (25.55)** (2)	-0.495 (49.42)**	-0.839 (23.32)**	0.024 (8.89)*	0.018 (14.05)**				[2,2]
28	Jamaica	-0.029 (17.41)*** (3)	-0.017 (4.06)*** (2)		0.002 (1.94)* (3)		-0.012 (4.25)***	0.01 (3.14)***	-0.078 (4.01)***	[0,1]
29	Jordan	0.03 (9.95)***	-0.032 (4.97)*** (2)	2.788 (24.35)***	0.012 (4.78)***				0.146 (3.64)*** (2)	[0,2]
30	Kenya		-0.218 (29.91)*** (2)	-0.375 (2.45)**	0.008 (2.85)** (3)	-0.006 (8.3)***		0.002 (1.94)*		[1,0]
31	Kuwait	0.041 (55.99)*** (4)		-2.32 (14.14)***		0.091 (17)*** (2)			-0.254 (14.44)***	[2,2]
32	Madagascar		-0.247 (9.03)*** (2)	-1.018 (2.15)**		-0.027 (1.92)* (2)			-0.274 (3.79)***	[2,0]
33	Malaysia	-0.011 (3.09)*** (3)	-0.05 (7.93)***		0.005 (11.13)***		0.003 (2.91)***			[1,0]
34	Mexico	0.026 (4.99)*** (4)	-0.025 (6.15)*** (2)			-0.063 (6.35)*** (2)			-0.27 (3.33)***	[0,0]
35	Mongolia	0.006 (2.95)** (4)	-0.188 (2.51)**		0.013 (2.17)*					[3,2]
36	Morocco	-0.111 (4.01)** (3)		4.748 (6.99)***	0.077 (3.93)** (2)	-0.03 (2.22)*			-3.81 (4.22)**	[2,2]
37	Myanmar			4.329 (51.32)***		0.002 (3.64)***			0.545 (4.33)***	[0,0]
38	Nepal	-0.009 (2.25)** (3)	-0.236 (7.26)*** (2)	-0.448 (3.18)***	0.005 (2.08)**					[0,0]
39	Nicaragua	0.025 (14.87)***	-0.033 (3.2)*** (2)	-0.553 (2.05)*		0.00001 (2.4)**				[2,1]
40	Nigeria	-0.032 (3.89)*** (2)	-0.093 (4.08)*** (2)	2.946 (3.76)***	0.029 (1.97)*	0.033 (2.32)** (2)	-0.005 (8.95)***			[1,1]
41	Oman	0.155 (5.79)*** (2)		4.932 (5.67)***			0.13 (3.59)**	-0.135 (3.73)**	-1.984 (2.8)**	[2,3]
42	Pakistan		-0.113 (6.58)*** (2)	-0.419 (1.85)*	0.02 (5.87)*** (3)	-0.079 (4.04)*** (2)				[0,0]
43	Panama	-0.042 (4.08)***	-0.019 (6.09)*** (2)		0.002 (4.25)*** (2)	-0.004 (5.92)***			0.027 (2.69)**	[0,0]
44	Paraguay	-0.027 (1.9)* (4)			0.008 (22.39)*** (3)	-0.004 (2.27)**			-0.346 (1.72)*	[0,0]
45	Peru	0.131 (8.7)*** (4)	-0.037 (3.24)*** (2)	2.452 (26.11)***	0.011 (1.96)*	-0.071 (9.57)*** (2)				[1,1]

No	Country	Govt. expenditure	Productivity	Terms of trade	Trade openness	Net foreign asset	Real interest rate gap	Domestic real interest rate	Financial openness	[leads,lags]
46	Philippines			-1.509 (2.47)**	0.025 (4.52)*** (2)	-0.339 (3.94)*** (2)	0.021 (3.32)***	-0.025 (3.47)***	-1.933 (3.72)***	[1,1]
47	Saudi Arabia		-0.008 (2.42)*		0.06 (26.44)*** (3)	-0.052 (22.51)***			4.87 (35.73)***	[2,2]
48	Senegal	0.006 (2.17)** (2)			0.008 (6.63)*** (3)	-0.002 (3.18)***				[0,0]
49	Sri Lanka	-0.002 (2.39)** (2)	-0.079 (21.66)*** (2)		0.006 (4.4)***	-0.003 (1.93)*			1.281 (3.46)***	[1,1]
50	Sudan	0.071 (3.74)***	-0.256 (5.96)*** (2)	5.303 (19.95)***	0.007 (1.86)* (2)					[1,0]
51	Tanzania			4.026 (39.56)***	0.016 (2.29)** (2)	-0.011 (11.49)***			-1.498 (6.98)***	[0,1]
52	Thailand		-0.037 (15.42)*** (2)			-0.003 (8.47)***			-0.207 (5.55)***	[0,0]
53	Trinidad & Tobago	0.03 (5.05)** (3)	-0.028 (22.59)***		0.01 (14.62)*** (2)				0.609 (16.39)***	[2,2]
54	Tunisia	0.003 (2.32)** (2)	-0.061 (4.21)*** (2)		0.003 (3.23)*** (2)					[1,0]
55	Turkey	-0.039 (3.45)***		2.452 (3.79)***	0.014 (2.02)*	-0.262 (3.15)*** (2)			-1.267 (5.82)***	[0,0]
56	Uganda	0.118 (9.83)*** (2)		2.382 (23.07)***		-0.014 (16.6)***				[1,1]
57	Uruguay	0.07 (3.24)***	-0.04 (8.57)***		0.011 (3.54)*** (3)		0.016 (2.22)**	-0.018 (2.25)**		[0,0]
58	Venezuela	0.01 (2.93)**	-0.027 (21.59)***		0.008 (2.31)**	0.052 (3.33)***		-0.001 (3.99)***		[0,1]
59	Vietnam	-0.118 (4.49)*** (4)	-0.153 (4.01)*** (2)							[1,3]
60	Zambia	0.016 (7.25)*** (2)	-0.205 (7.69)*** (2)	-1.212 (6.92)***			0.001 (2.04)*		0.458 (5.9)***	[1,0]
	PANEL - DOLS	-0.009(5.89)*** (2)	-0.034 (5.68)***			-0.001 (8.99)***				[1,1]

Note: *,**, and *** represents the level of significance of 1%, 5%, and 10% respectively. Numbers in parentheses are t-statistics. Numbers in the superscript format indicate the n-th alternative variables used in the function. For example, the coefficient for Albania for government expenditure is estimated using the 3rd alternative variable used to represent the government expenditure, which is the ratio of government consumption and investment to GDP in current price. The definition of each variable used in the model is available in Table 1. The panel DOLS regression is estimated using data from 53 countries due to data availability.

Appendix 3.

Table A.3. Correlation of variables for the RER misalignment regressions

	RER misalign-ment	Exchange rate regime (Aizenman)	Exchange rate regime (Ilzetzski)	Capital account openness (Aizenman)	Capital account openness (Schindler)	Capital inflows openness (Schindler)	Capital outflows openness (Schindler)	Resource rent	Socio-economic condition	Broad money / GDP	Economic crisis event
RER misalignment	1										
Exchange rate regime (Aizenman)	-0.1093	1									
Exchange rate regime (Ilzetzski)	-0.0988	0.6538	1								
Capital account openness (Aizenman)	0.0389	-0.1501	-0.2588	1							
Capital account openness (Schindler)	0.0496	-0.1542	-0.1032	0.7294	1						
Capital inflows openness (Schindler)	0.0261	-0.1711	-0.1362	0.71	0.9564	1					
Capital outflows openness (Schindler)	0.0589	-0.1423	-0.0785	0.7024	0.9672	0.8542	1				
Resource rent	-0.0404	-0.1598	-0.2081	0.1503	-0.0071	-0.0244	0.0424	1			
Socioeconomic condition	-0.0346	-0.059	-0.1256	0.207	-0.0312	-0.0188	-0.0202	0.1465	1		
Broad money/GDP	0.0054	-0.0263	-0.126	0.1718	-0.2786	-0.2432	-0.2962	-0.0542	0.3519	1	
Economic crisis event	-0.0726	0.1268	0.1539	-0.1369	-0.0007	-0.0156	0.0094	-0.0406	-0.0465	-0.0939	1

Appendix 4.

Table A.4. Benchmark estimation result (OLS estimates)

Dependent variable: RER misalignment (mis_{it})

	Singular specification		Interaction	
	1	2	3	4
mis_{it-1}	0.718***	0.658***	0.651***	0.644***
	(0.0644)	(0.0629)	(0.0476)	(0.0609)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term				
mis_{it-1}·ER	-0.221*			
	(0.1201)			
mis_{it-1}·ER_{inter}=1		0.08		
		(0.0613)		
mis_{it-1}·$ER_{flexible}$=1		-0.206**		
		(0.0894)		
mis_{it-1}·KA	0.0517	-0.0136		
	(0.0841)	(0.0765)		
mis_{it-1}·KA·ER			-0.0204	
			(0.1348)	
mis_{it-1}·KA·ER_{fix}=1				-0.0508
				(0.1168)
mis_{it-1}·KA·ER_{inter}=1				0.104
				(0.0996)
mis_{it-1}·KA·ER_{flex}=1				-0.303*
				(0.1827)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level				
ER	-0.0980***			
	(0.0148)			
ER_{inter}=1		-0.0205*		
		(0.012)		
$ER_{flexible}$=1		-0.105***		
		(0.0175)		
KA	0.0099	0.00369		
	(0.0173)	(0.0167)		
KA·ER			-0.0766***	
			(0.0212)	
KA·ER_{fix}=1				0.0526**
				(0.0253)
KA·ER_{inter}=1				0.011
				(0.019)
KA·ER_{flex}=1				-0.0801***
				(0.0269)
Other controls				
Resource rent	0.00195**	0.00176*	0.00151	0.00153
	(0.001)	(0.0009)	(0.001)	(0.001)
Socioeconomic	0.00673**	0.00630**	0.00704**	0.00696**
	(0.0027)	(0.0026)	(0.0028)	(0.0027)
Broad money	-0.00101**	-0.000930**	-0.00105***	-0.00108***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Economic crisis	-0.0818***	-0.0803***	-0.0987***	-0.0947***
	(0.0126)	(0.0122)	(0.0143)	(0.0138)
Observations	1726	1726	1726	1726
Adjusted R-square	0.592	0.599	0.575	0.578

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regresions use the capital account openness index (KA) based on Aizenman et al.(2013). Regressions in columns 1 and 3 uses the exchange rate flexibility index (ER) based on Aizenman et al.(2013). Regressions in columns 2 and 4 uses the reclassified exchange rate regime of Ilzetzski et al.(2017). The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.

Appendix 4.

Table A.5. Asymmetric estimation results - singular specification (OLS estimates)

Dependent variable : RER misalignment (mis_{it})

	1	2
mis_{it-1}	0.633***	0.343***
	(0.1124)	(0.104)
mis_{it-1}·1{mis_{it-1}<0}	0.13	0.0984
	(0.1664)	(0.1403)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term		
mis_{it-1}·ER	-0.411**	
	(0.184)	
mis_{it-1}·ER_{inter}= 1		0.238**
		(0.1105)
mis_{it-1}·$ER_{flexible}$= 1		-0.262**
		(0.1303)
mis_{it-1}·KA	0.0189	0.0226
	(0.1323)	(0.1232)
mis_{it-1}·ER·1{mis_{it-1}<0}	0.0615	
	(0.2485)	
mis_{it-1}·ER_{inter}=1·1{mis_{it-1}<0}		-0.25
		(0.1583)
mis_{it-1}·$ER_{flexible}$= 1·1{mis_{it-1}<0}		0.222
		(0.1803)
mis_{it-1}·KA·1{mis_{it-1}<0}	-0.398**	-0.128
	(0.1975)	(0.1839)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level		
ER	0.0315	
	(0.0203)	
ER_{inter}= 1		-0.0433**
		(0.0185)
$ER_{flexible}$= 1		-0.0303
		(0.0194)
KA	0.0291	-0.0184
	(0.0209)	(0.0206)
ER·1{mis_{it}<0}	-0.182***	
	(0.0142)	
ER_{fix}=1·1{mis_{it}<0}		-0.158***
		(0.013)
ER_{inter}=1·1{mis_{it}<0}		-0.139***
		(0.0115)
$ER_{flexible}$= 1·1{mis_{it}<0}		-0.202***
		(0.0119)
KA·1{mis_{it}<0}	-0.0708***	0.0455***
	(0.0132)	(0.015)
Observations	1726	1726
Adjusted R-square	0.695	0.737

Table A.6. Asymmetric estimation results - interaction specification (OLS estimates)

Dependent variable : RER misalignment (mis_{it})

	1	2
mis_{it-1}	0.560***	0.553***
	(0.0916)	(0.115)
mis_{it-1}·1{mis_{it-1}<0}	0.188	0.23
	(0.1312)	(0.1609)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term		
mis_{it-1}·KA·ER	-0.204	
	(0.2365)	
mis_{it-1}·KA·ER_{fix}=1		-0.266
		(0.2224)
mis_{it-1}·KA·ER_{inter}=1		0.0117
		(0.1784)
mis_{it-1}·KA·ER_{flex}=1		-0.792**
		(0.3923)
mis_{it-1}·KA·ER·1{mis_{it-1}<0}	-0.713**	
	(0.3514)	
mis_{it-1}·KA·ER_{fix}=1·1{mis_{it-1}<0}		-0.336
		(0.3176)
mis_{it-1}·KA·ER_{inter}=1·1{mis_{it-1}<0}		-0.568**
		(0.2755)
mis_{it-1}·KA·ER_{flex}=1·1{mis_{it-1}<0}		-0.157
		(0.5023)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level		
KA·ER	0.0615**	
	(0.0299)	
KA·ER_{fix}= 1		0.0931***
		(0.0356)
KA·ER_{inter}= 1		0.0561**
		(0.0262)
KA·ER_{flex}= 1		0.0738*
		(0.0409)
KA·ER·1{mis_{it}<0}	-0.314***	
	(0.0198)	
KA·ER_{fix}= 1·1{mis_{it}<0}		-0.157***
		(0.0146)
KA·ER_{inter}= 1·1{mis_{it}<0}		-0.159***
		(0.0115)
KA·ER_{flex}= 1·1{mis_{it}<0}		-0.285***
		(0.0315)
Observations	1726	1726
Adjusted R-square	0.624	0.643

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regressions control for resource rent, social-economic condition, the ratio of broad money to GDP, and economic crisis events. The capital account openness index (KA) based on Aizenman et al.(2013) is used for all regressions. Regressions in the first column of tables A.5 and A.6 use the exchange rate flexibility index (ER) based on Aizenman et al.(2013). Regressions in the second column of tables A.5 and A.6 use the reclassified exchange rate regime of Ilzetzski et al.(2017).The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.

Appendix 4.

Table A.7. Asymmetric estimation results – alternative capital account policy indices (OLS estimates)

Dependent variable : RER misalignment (mis_{it})

	1	2	3	4
mis_{it-1}	0.652***	0.709***	0.704***	0.696***
	(0.0885)	(0.0859)	(0.0886)	(0.0811)
mis_{it-1}·1{mis_{it-1}<0}	0.156	0.0756	0.0628	0.0992
	(0.1296)	(0.1263)	(0.1296)	(0.119)
Exchange rate regime (ER) & capital account openness (KA) in the persistence term				
mis_{it-1}·ER·KA_{Aiz}	-0.514***			
	(0.1906)			
mis_{it-1}·ER·KA_{Sch}		-0.787***		
		(0.288)		
mis_{it-1}·ER·$KA_{Sch\text{-}inflow}$			-0.769***	
			(0.2831)	
mis_{it-1}·ER·$KA_{Sch\text{-}outflow}$				-0.719***
				(0.2463)
mis_{it-1}·ER·KA_{Aiz}·1{mis_{it-1}<0}	-0.435			
	(0.2983)			
mis_{it-1}·ER·KA_{Sch}·1{mis_{it-1}<0}		-0.0529		
		(0.3905)		
mis_{it-1}·ER·$KA_{Sch\text{-}inflow}$·1{mis_{it-1}<0}			-0.00535	
			(0.3749)	
mis_{it-1}· ER·$KA_{Sch\text{-}outflow}$·1{mis_{it-1}<0}				-0.138
				(0.3551)
Exchange rate regime (ER) & capital account openness (KA) in the misalignment level				
ER·KA_{Aiz}	0.0363			
	(0.0287)			
ER·KA_{Sch}		0.0683**		
		(0.0334)		
ER·$KA_{Sch\text{-}inflow}$			0.0636*	
			(0.0327)	
ER·$KA_{Sch\text{-}outflow}$				0.0747**
				(0.0313)
ER·KA_{Aiz}·1{mis_{it}<0}	-0.240***			
	(0.0198)			
ER·KA_{Sch}·1{mis_{it}<0}		-0.266***		
		(0.025)		
ER·$KA_{Sch\text{-}inflow}$·1{mis_{it}<0}			-0.260***	
			(0.0234)	
ER·$KA_{Sch\text{-}outflow}$·1{mis_{it}<0}				-0.259***
				(0.0238)
Observations	940	940	940	940
Adjusted R-square	0.732	0.745	0.747	0.740

Note: The RER misalignment variable used in the regression is based on the estimation discussed in Section 2 of this paper. All regressions control for resource rent, social-economic condition, the ratio of broad money to GDP, and economic crisis events. The exchange rate flexibility index (ER) based on Aizenman et al. (2013) is used. KA_{Aiz} corresponds to the capital account openness indicator by Aizenman et al. (2013). KA_{Sch} refers to the overall capital account indicator by Schindler (2009) with the inflow/outflow subscript indicating the indicator for the degree of capital openness for capital inflows/outflows. The country and year fixed effect, and country-specific trends are applied. ***,**, and * represents the level of significance of 1%, 5%, and 10% respectively. Robust standard errors to heteroscedasticity and autocorrelation are reported in the parentheses.