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Real financial market exchange rates and capital flows

Maria Gelman
(University of Kiel)

Axel Jochem
(Deutsche Bundesbank)

Stefan Reitz
(University of Kiel)

Discussion Papers represent the authors' personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank or its staff.

Editorial Board: Klaus Düllmann
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Mathias Hoffmann
Christoph Memmel

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

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Non technical summary

Nominal and real effective exchange rates have, to date, been calculated mainly from trade flows and goods market prices. With increasing financial market integration, however, the importance of international capital transactions has increased, and their value meanwhile far exceeds that of cross-border goods market transactions. This suggests that it would be appropriate to construct real exchange rates based not only on goods market equilibriums but also on capital market equilibriums. Although first approaches in the literature weight the currencies of partner countries that are included in the calculation of real effective financial market exchange rates according to financial ties, deflating is still based on goods price indices.

In this paper, a concept for real effective financial market exchange rates will be introduced, with both weighting and deflating based on financial variables. The underlying idea is to construct effective financial market exchange rates as an indicator of the relative attractiveness of different countries' assets. It emerges that the indicators of price competitiveness on the goods markets on the one hand and the corresponding financial market indicators on the other may diverge considerably at times. Consequently, they may well provide different information.

The correlation between the real effective financial market exchange rate and important fundamental variables is particularly interesting as an indicator of possible imbalances. A cointegration analysis examines the correlation of the real effective financial market exchange rate with net foreign holdings of domestic shares relative to domestic stock market capitalisation. The estimates demonstrate a significant positive correlation between both variables. Temporary deviations of the effective financial market exchange rate from its path predicted by fundamentals give hints to possible over- or undervaluation of asset prices

In addition, subsequent error correction analysis reveals that both, the real financial market exchange rate and international capital flows adjust to restore the long-run equilibrium. This is in contrast to the real effective exchange rates based on goods market prices, where the deviation from the long-run equilibrium fails to predict capital flows.

Nicht-technische Zusammenfassung

Die Berechnung nominaler und realer effektiver Wechselkurse basierte bislang überwiegend auf Handelsströmen und Gütermarktpreisen. Im Zuge der zunehmenden Finanzmarktintegration haben jedoch internationale Kapitalverkehrstransaktionen an Bedeutung gewonnen und übersteigen die grenzüberschreitenden Gütermarkttransaktionen bei Weitem. Diesem Trend folgend erscheint es sinnvoll, reale Wechselkurse nicht nur auf Basis von Gütermarktgleichgewichten, sondern auch auf Basis von Kapitalmarktgleichgewichten zu konstruieren. Erste Ansätze in der Literatur gewichten zwar die Währungen der Partnerländer, die in die Berechnung effektiver Finanzmarktkurse eingehen, auf der Grundlage der finanziellen Verflechtungen, die Deflationierung erfolgt aber weiterhin durch Güterpreisverhältnisse.

In diesem Papier wird ein Konzept realer Finanzmarktkurse dargestellt, bei dem nicht nur die Gewichtung, sondern auch die Deflationierung auf der Grundlage der internationalen Kapitalverflechtung vorgenommen wird. Dies beruht auf der Idee, reale effektive Finanzmarktkurse als Indikatoren für die Wettbewerbsfähigkeit auf den Finanzmärkten zu konstruieren. Es zeigt sich, dass die Indikatoren der preislichen Wettbewerbsfähigkeit auf den Gütermärkten einerseits und auf den Kapitalmärkten andererseits zeitweilig deutlich voneinander abweichen können. Mithin liefern sie durchaus unterschiedliche Informationen.

Von besonderem Interesse im Hinblick auf die Verwendung des effektiven Finanzmarktwechselkurses als Indikator für mögliche Ungleichgewichtssituationen ist seine Beziehung zu wichtigen Fundamentalvariablen. In einer Kointegrationsanalyse wird die Beziehung des effektiven Finanzmarktwechselkurses zu den von Ausländern gehaltenen Inlandsaktien in Relation zur inländischen Aktienmarktkapitalisierung untersucht. In den Schätzungen zeigt sich ein signifikant positiver Zusammenhang zwischen den beiden Größen. Temporäre Abweichungen des realen effektiven Finanzmarktwechselkurses von dem durch die Fundamentalvariablen erklärten Pfad geben Hinweise auf mögliche Über- bzw. Unterbewertungen von Vermögensanlagen.

Fehlerkorrekturuntersuchungen zeigen darüber hinaus, dass sowohl der Finanzmarktwechselkurs als auch die internationalen Kapitalströme auf Abweichungen von der Kointegrationsbeziehung reagieren und zur Wiederherstellung des langfristigen Gleichgewichts beitragen. Eine solche wechselseitige Abhängigkeit lässt sich für mit Gütermarktpreisen deflationierte Indizes nicht belegen, bei denen die Kapitalströme als schwach exogen anzusehen sind.

BUNDESBANK DISCUSSION PAPER NO 50/2013

Real Financial Market Exchange Rates and Capital Flows [1]

Maria Gelman
University of Kiel

Axel Jochem
Deutsche Bundesbank

Stefan Reitz
University of Kiel

Abstract

Foreign exchange rates and capital movements are expected to be closely related to each other as international capital markets become more and more integrated. To account for this fact we construct an index of real effective exchange rates as a weighted average of cross-country asset price ratios. The empirical analysis reveals that a country's real financial effective exchange rate is cointegrated with net foreign holdings of its assets. Comparing the empirical performance of the new index with a standard effective exchange rate deflated by goods prices we find that only the former exhibits an influence on the international flow of capital.

Keywords: Real Effective Exchange Rate, Capital Flows, Financial Markets

JEL-Classification: F31, G15, E58

[1] Contact address: Axel Jochem, Deutsche Bundesbank, Economics Department, Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main. Phone: 049 9566 2392. E-Mail: axel.jochem@bundesbank.de. The authors thank Karin Radeck, Ulrich Grosch, Christoph Fischer, Mathias Hoffmann and Georg Stadtmann for useful comments. Discussion Papers represent the authors' personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank or its staff.

1 Introduction

The real effective exchange rate (REER) is a pivotal variable in the open economy macroeconomics. With the expansion in trade in goods and services, the REER has emerged as a prime indicator of price competitiveness of economies in the economic policy arena. With its roots in the law of one price on integrated international goods markets REER's theoretical concepts, empirical applications and its impact on countries' output and wealth have been extensively studied in the literature. With ongoing globalisation and financial integration, however, capital flows now account for a major share of cross-border transactions (Hau and Rey, 2004). Given that expected future cash flows determine current asset prices it may be assumed that their cross-country ratios, computed in the same currency, provide a measure of price competitiveness of a country's assets relative to its foreign competitors, similar to the interpretation of standard real exchange rates. While permanent shocks to this real financial exchange rate (REFER) signal a fundamental reappraisal of future returns and indicate changing shares of a country's assets in the portfolio of international investors, temporary variations may be interpreted as over- or undervaluation of domestic asset prices relative to foreign assets.

Suggesting that the REFER reflects foreign investors' willingness to hold a country's assets and, in turn, capital movements exhibit a price impact on assets and/or nominal exchange rates, we may derive an equilibrium relationship between the REFER and foreign investors' holdings of a country's assets, net foreign holdings for short (NFH). By doing so, we explicitly consider Lane and Shambaugh's (2010) observation that the trade weighted exchange rate indices were insufficient to understand the financial impact of currency movements. They created a financially weighted exchange rate index based on the composition of foreign assets and liabilities in order to investigate an impact of currency movements on the capital gains and losses of foreign assets and liabilities. While we propose an index for effective exchange rate which is not only financially weighted but also deflated on the basis of financial market prices to fully reveal the causes and consequences of exchange rates in international capital market transactions. Thus, we obtain an index of the real effective financial exchange rate and exploit this index to reveal its relationship with capital flows. A panel of 15 leading stock markets is used to construct and empirically investigate the index of real effective financial market exchange rates. While at the first stage, nominal bilateral exchange rates are deflated by MSCI stock market indices to obtain real bilateral financial market exchange rates, weights based on bilateral cross-holdings of equity securities as reported in the IMF CPIS data set are used to calculate the REFER as a geometric average of bilateral values at the second stage. By doing so our indicator reflects the relative attractiveness of a country's financial assets as compared to its capital market competitors in the same way as we interpret standard real effective exchange rates based on goods market prices. The empirical results based on the

data set provided by Kubelec and Sa (2012) are encouraging at least in two important ways. First, we find that a country's net foreign asset position in equity securities is cointegrated with its REFER. Second, error correction analysis shows that both variables adjust to restore the long-run equilibrium. This is encouraging evidence in favour of the real effective exchange rate based on equity market prices.

The paper is organised as follows. Section 2 briefly reviews the literature on the relationship between exchange rates and capital flows. Section 3 offers a theoretical framework for the interlinkages between the REFER and net foreign assets. Section 4 describes the data, while section 5 describes the methodology for calculating the REFER. Section 6 contains a description of the econometric framework and reports the empirical results, before the finally section concludes.

2 Literature

The Numerous studies such as Portes and Rey (2005), Bekaert et al. (2001), and Brooks et al. (2004) analysed the linkage between exchange rate dynamics, capital flows and the asset prices. Based on the now widely accepted microstructure proposition that foreign exchange order flow drives exchange rates, the theoretical approach of Hau and Rey (2004, 2006) suggests that higher returns in the home equity market relative to the foreign equity market are associated with home currency depreciation. Subsequent empirical studies generally provide support for this negative relationship. For instance, Heimonen (2009) indicated that an increase in Euro area equity returns with respect to US equity returns causes an equity capital outflow from Euro area to US, and led to an appreciation of US Dollar. Investigating high frequency data from emerging Thailand Gyntelberg et al. (2009) are able to provide further support for this framework. Their results are based on two comprehensive, daily-frequency datasets of foreign exchange and equity market capital flows undertaken by nonresident investors in Thailand in 2005 and 2006. Net purchases of Thai equities by nonresident investors lead to an appreciation of the Thai baht. In addition, higher returns in the Thai equity market relative to a reference stock market are associated both with net sales of Thai equities by these investors and with a depreciation of the Thai baht. Chai-Anant et al. (2008) examine foreign investors' daily transactions in six emerging Asian equity markets and their relationship with local market returns and exchange rate changes over the period 1999-2006. In line with the above studies, the authors find that equity market returns matter for net equity purchases, and vice versa. In addition, while currency returns tend to show little influence over foreign investors' demand for Asian equities, net equity purchases do have some explanatory power over near-term exchange rate changes.

While these studies essentially concentrate on the short-run dynamics of bilateral exchange rate using country specific time series this paper aims at deriving a long-run equilibrium

relationship between the REFER and cross-country asset holdings based on a sufficiently large panel of countries. Thus, our analysis in more closely related to a strand of literature at least starting with the so-called stock-flow approach of Faruqee (1995), where the REER is explained by the stock and flow of assets across borders. Based on data for the United States and Japan since World War II the author revealed a cointegration relationship between the net foreign asset position and the REER for the US, but not for Japan. Aglietta et al. (1998) and Alberola et al. (1999, 2002) extended the model by including either non-price competitiveness or a non-tradables sector, respectively, and estimated the equilibrium REER for a panel of developed countries and found evidence for the fact that if a country has accumulated current account surpluses in the past, its net foreign position increases together with an appreciation of its REER. The relationship between net foreign asset positions and exchange rates was also investigated by means of Behavioural Equilibrium Exchange Rate (BEER) models popularised by MacDonald (1997) and Clark and MacDonald (1998). The BEER approach explains movements of the REER in short, medium and long-run equilibrium levels using net foreign assets and some other fundamentals as explanatory variables. Based on the data for US, Germany and Japan, Clark and MacDonald (1998) provide empirical evidence for the following equilibrating mechanism: A rise in net foreign assets implies an increase in the real exchange rate which will tend to counteract the change in net foreign assets via the deterioration in the trade balance, and vice versa. Bénassy-Quéré et al. (2004) follow the methodology of Alberola et al.(2002) and analyse the long-run effects of net foreign assets on the REER for the G-20 countries for the period 1980–2002. Using a panel cointegration approach, they find that a decrease in net foreign assets in emerging economies caused an appreciation of the REER in the second half of the sample. Using the same technique Égert et al. (2004) showed that an improvement in the net foreign asset position leads to a real appreciation in small open OECD economies. In contrast, in the case of transition economies the deterioration in the net foreign assets is consistently associated with a real appreciation. The authors suggest that the difference in the sign of the estimated coefficient may be due to the fact that the 30-year period used for the OECD countries captures the long run, while the decade of data available for the transition countries can only be informative about the medium run.[2]

The models could also differ by the types of the included capital flows. Hau and Rey (2006) related exchange rates to equity flows, while Siourounis (2004) conducted the empirical analysis also for the impact of bond flows on exchange rates. He revealed that net cross-border equity flows have a significant effect on the exchange rate movements

[2] This is in line with considerations that high expected returns in catching-up countries attract foreign capital which entails both, an accumulation of foreign liabilities and a currency appreciation. In the long run, however, a country having a negative value of net foreign assets must have a trade surplus to finance interest and dividend payments. This is delivered by a depreciation of the country's real exchange rate. For a theoretical foundation of this argument see Dornbusch and Fischer (1980), Hooper and Morton (1982) and Gavin (1992).

while bond flows are immaterial. Brooks et al. (2004) considered various kinds of capital flows, such as foreign direct investment flows, portfolio flows and debt flows for the euro and the yen against the dollar. The authors showed that net portfolio flows between the Euro area and the United States can closely track movements of their exchange rate, while foreign direct investment flows appear to be less significant for the exchange rate volatility. Movements in the yen versus the dollar can be explained more by the current account and interest differential.

More recently, Lane and Shambaugh (2010) indicated that the trade weighted exchange rate indices used in these studies were insufficient to fully understand the financial impact of currency movements. This is particularly true in the face of growing importance of the valuation effect in the recent years with rapid growth in cross-border financial holdings. The authors documented the diverse behaviour of trade-weighted and financially-weighted exchange rates generally indicating that trade weighted exchange rates were not informative with regard to the financial impact of the currency movements. Tille (2003) and Milesi-Ferretti (2007) also emphasised the role of financial-variable weights and their studies indicated that the trade weights and financial currency weights are quite different for the United States.

We contribute to this literature by moving this argumentation one step forward. While considering financial market weights to calculate an effective exchange rate as suggested in the above literature we also use financial market prices to deflate the incorporated nominal bilateral exchange rates. A panel of 15 countries, which account for more than 65% of global cross-border equity security holdings (assets and liabilities), is used to construct real effective financial exchange rates. This new indicator is evaluated analysing its relationship with capital flows among these countries.Heading second level second level second level second level second level second level

3 A Stylized Model of the Real Effective Financial Exchange Rate

In order to discuss the relationship between financial effective exchange rates and international capital flows we make use of the standard portfolio balance approach put forward in the seminal work of Branson (1983) and Branson and Henderson (1985). We consider a model in which there are N investors, one for each country, allocating their wealth to the real assets of *N* countries, including the real domestic assets of country *i,* $F_{i,t}^{i}$, and *N-1* real foreign assets denominated in foreign currency $F_{j,t}^{i}$. In contrast to the standard portfolio balance model we do not incorporate cash holdings of the investor. Moreover, we explicitly focus on short-run portfolio dynamics and do not consider a change of the real supply of foreign asset due to current account imbalances. As a result, the real supply of

domestic and foreign assets is assumed to be fixed. The nominal wealth of the country *i* investor defined in terms of the domestic currency is

$$W_t^i = \sum_{j=1}^{N} \frac{P_{j,t} \cdot F_{j,t}^i}{S_{ij,t}}, j = 1, .., i, .., N \qquad (1)$$

where $P_{i,t}$ and $P_{j,t}$ are the domestic currency price of the domestic asset and the foreign currency prices of the *N-1* foreign assets, respectively. The exchange rate $S_{ij,t}$ is defined as the price of the domestic currency in units of the foreign currency and $S_{ii,t} \equiv 1$. The nominal stock of country *i*'s assets F_i are either held by the domestic investor *i* or the *N-1* foreign investors:

$$P_{i,t} \cdot F_i = \sum_{j=1}^{N} P_{i,t} \cdot F_{i,t}^j, j = 1, .., i, .., N \qquad (2)$$

Within this short-run scenario it is assumed that investor *i* can only acquire additional foreign assets by selling domestic assets.[3] This is consistent with a trading protocol where at time *t* investors only hold domestic assets. After a round of asset trading each investor holds her portfolio for one period. Asset exposures are assumed to be fully unwound after returns on assets and exchange rates have been realized at the end of the period. As a result, each investor again only holds domestic assets at time t+1. This trading protocol rules out the accumulation of valuation effects implying that the foreign investors' holdings of domestic assets equal the domestic investor's foreign assets:

$$\sum_{j=1}^{N} P_{i,t} \cdot F_{i,t}^j = \sum_{j=1}^{N} \frac{P_{j,t} \cdot F_{j,t}^i}{S_{ij,t}}, \forall j \neq i \qquad (3)$$

The investors' portfolios are in equilibrium, if the domestic-currency nominal supplies of assets equal their efficient shares of nominal wealth. Thus, there are N^2 equilibrium conditions of the form:

$$\frac{P_{j,t} \cdot F_{j,t}^i}{S_{ij,t}} = \omega_{j,t}^i W_t^i, \forall i, j \qquad (4)$$

where $\omega_{j,t}^i$ denotes the efficient share of country *j*'s assets in investor *i*'s portfolio so that

$$\sum_{j=1}^{N} \omega_{j,t}^i = 1, \forall i.$$

[3] In contrast to this scenario, Hooper and Morton (1982) develop a model in which exogenous shocks to trade result in changes in net foreign assets and, in the long run, in a positive correlation between net foreign asset and real exchange rates. In a more complex theoretical model, Gavin (1992) shows that exogenous shocks to wealth entail a positive correlation between net foreign assets and real exchange rates, if the Marshall-Lerner condition is satisfied.

From rearranging equilibrium conditions for assets (eq. 4) we may write

$$\frac{P_{j,t}}{S_{ij,t}} = \frac{\omega_{j,t}^{i} W_t^i}{F_{j,t}^{i}}, \forall i, j. \qquad (4')$$

For each portfolio i there are N-1 ratios of cross-country holdings denominated in country j currency

$$\frac{P_{i,t} \cdot S_{ij,t}}{P_{j,t}} = \frac{\omega_{i,t}^{j} W_t^{\,j} S_{ji,t} / F_{i,t}^{j}}{\omega_{j,t}^{i} W_t^{i} / F_{j,t}^{i}}, \qquad (5)$$

where $S_{ij,t} = 1/S_{ji,t}$.

Equation (5) states that in equilibrium, the asset price ratio denominated in country-*j* currency equals the ratio of nominal demands per unit of real assets. The latter reflects the importance of market capitalization in the domestic as well as in the foreign asset market. For instance, if the number of domestic asset shares is large relative to the number of foreign asset shares, a given change in the portfolio composition should exhibit a lower price impact than a more balanced market capitalization across borders.

In the following, the asset price ratio on the left-hand side will be interpreted as currency *i*'s (asset-based) real bilateral exchange rate vis-á-vis currency *j*. An increase in the real exchange rate reflects a relative appreciation of country *i*'s asset. By weighting *N-1* real exchange rates we may calculate currency *i*'s real *effective* exchange rate as:

$$\prod_{j=1}^{N} \left(\frac{P_{i,t} \cdot S_{ij,t}}{P_{j,t}} \right)^{\theta_j^i} = \prod_{j=1}^{N} \left(\frac{\omega_{i,t}^{j} W_t^{\,j} S_{ji,t} / F_{i,t}^{j}}{\omega_{j,t}^{i} W_t^{i} / F_{j,t}^{i}} \right)^{\theta_j^i}, \qquad \forall j \neq i \qquad (6)$$

where the θs are constant weights derived from the cross-country holdings of investors *i* and *j* in a base period:[4]

$$\theta_j^i = \frac{\omega_{j,2004}^{i} W_{2004}^{i} + \omega_{i,t}^{j} W_{2004}^{j} / S_{ji,2004}}{\sum_{j=1}^{N} \omega_{j,2004}^{i} W_{2004}^{i} + \sum_{j=1}^{N} \omega_{i,2004}^{j} W_{2004}^{j} / S_{ji,2004}}, \forall j \neq i \qquad (7)$$

so that $\sum_{j=1}^{N} \theta_j^i = 1, \forall i$.

Because the weights θ incorporate both assets as well as liabilities of country *i* vis-á-vis country *j* relative to the sum of assets and liabilities they reflect the importance of country *j* in the portfolio of country *i*. Thus, the right-hand side of equation (6) represents the weighted average of net foreign holdings of country *i*'s assets in the portfolios of foreign investors corrected for capital market sizes, or net foreign holdings (*NFH*) for short.

[4] Constant weights help identifying the relationship between relative asset prices and cross-country holdings of assets and liabilities. The left-hand side of equation (6) is similar to the construction of CPI-based real effective exchange rates as comprehensively discussed in Buldorini et al. (2002) and updated by Schmitz et al. (2012). In contrast to the ECB construction of real effective exchange rates we do not consider any third market effects.

The log real effective exchange rate of country *i* is

$$\sum_{j=1}^{N} \theta_j^i \left(p_{i,t} + s_{ij,t} - p_{j,t}\right) = \sum_{j=1}^{N} \theta_j^i \left(d_{i,t}^j - d_{j,t}^i\right), \qquad \forall j \neq i \tag{8}$$

where $d_{i,t}^j \equiv log\left(\omega_{i,t}^j W_t^j S_{ji,t}/F_{i,t}^j\right)$ and $d_{j,t}^i \equiv log\left(\omega_{j,t}^i W_t^i/F_{j,t}^i\right)$. In the empirical part of the paper, we apply equation (6) as the standard definition of the variables, while log variables as defined in equation (8) are used as robustness checks.

4 Data

The data are constructed at annual frequency for the sample of periods 1993-2011 and include 15 countries: Australia, Brazil, Canada, Germany, Spain, France, Hong Kong, Italy, Japan, Korea, Mexico, Portugal, Singapore, United Kingdom, and United States. In this study, we apply data from cross-holdings of equities derived from Kubelec and Sa (2012) and the IMF's Coordinated Portfolio Investment Survey (CPIS). Unlike the database constructed by Lane and Milesi-Ferretti (2007), the data sets used in our study provide information on the equity stocks of bilateral cross-holdings of assets. The *Geographic Breakdown of Total Portfolio Investment* (Table 8 of CPIS) comprises data from the individual economy's residents holdings of securities issued by non-residents (reported data), and the data for non-residents' holdings of securities issued by residents (derived data), while Lane and Milesi-Ferretti database does not make the geographic breakdown of the portfolio of investments and only reports total portfolio equity assets of a country.

The data published by Kubelec and Sa in 2009 cover the periods 1993-2005 and data from CPIS cover the periods 2006-2011. While equity cross-holdings of major industrialized countries such as the US are the same across data sets, Kubelec and Sa fill gaps in the CPIS framework by estimated values from a gravity model. The CPIS survey covers equity assets of investors from currently roughly 75 countries. In our study data limitations did not allow us to include data about all countries. For instance, China does not report its outgoing investments. So, we narrowed down the sample to 15 leading countries, which still represent the majority of cross holdings. The circle of 15 countries used in our study reflects more than 65% of global equity securities documented in the CPIS. The CPIS data were also used to calculate constant country weights based on cross-holdings of 2004, as this year is associated neither with the new economy bubble nor with the current financial crisis. The weights are computed in a way, that they reveal the most important partner countries and existing financial ties. **Table 1** shows the overall weights at which the individual countries are included in the real effective financial market exchange rate.

Table 1: Countries' weights in the real effective financial exchange rate

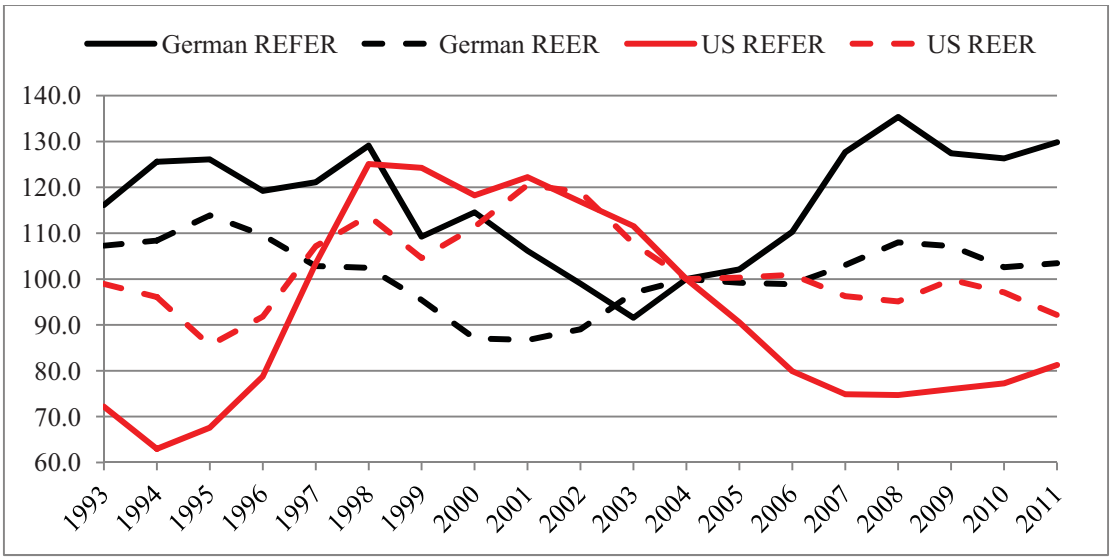
Investments in \ Investments from	Australia	Brazil	Canada	Germany	Spain	France	Hong Kong SAR	Italy	Japan	Korea	Mexico	Portugal	Singapore	United Kingdom	United States
Australia	0.0%	0.0%	3.4%	2.4%	0.6%	0.7%	1.6%	0.8%	9.0%	0.6%	0.0%	0.0%	1.4%	17.1%	62.4%
Brazil	0.0%	0.0%	2.3%	0.1%	3.2%	1.8%	0.0%	2.3%	0.3%	0.0%	0.0%	0.6%	0.2%	10.1%	79.1%
Canada	1.5%	0.3%	0.0%	1.8%	1.0%	3.1%	1.0%	1.2%	6.9%	0.7%	0.5%	0.1%	0.3%	5.3%	76.4%
Germany	1.0%	0.0%	1.6%	0.0%	5.9%	21.3%	0.4%	6.6%	5.3%	0.3%	0.0%	0.4%	0.2%	18.4%	38.5%
Spain	0.5%	0.9%	2.2%	13.9%	0.0%	21.4%	0.1%	4.7%	3.3%	0.0%	0.0%	2.8%	0.1%	14.7%	35.5%
France	0.2%	0.2%	2.4%	17.3%	7.4%	0.0%	0.7%	8.7%	6.4%	0.2%	0.1%	0.4%	0.2%	19.6%	36.1%
Hong Kong SAR	2.0%	0.0%	2.8%	1.2%	0.1%	2.7%	0.0%	0.8%	8.7%	1.5%	0.0%	0.0%	5.4%	43.7%	31.1%
Italy	0.6%	0.5%	2.0%	12.1%	3.7%	19.8%	0.4%	0.0%	6.8%	0.5%	0.1%	0.6%	0.2%	17.7%	35.0%
Japan	2.2%	0.0%	3.9%	3.2%	0.9%	4.8%	1.7%	2.2%	0.0%	0.2%	0.0%	0.1%	0.8%	17.1%	63.1%
Korea	1.0%	0.0%	3.1%	1.6%	0.0%	1.4%	2.3%	1.2%	1.4%	0.0%	0.0%	0.0%	3.4%	18.4%	66.1%
Mexico	0.0%	0.0%	4.2%	0.4%	0.1%	0.8%	0.0%	0.6%	0.2%	0.0%	0.0%	0.0%	0.1%	13.4%	80.0%
Portugal	0.3%	1.3%	1.5%	7.1%	22.9%	9.9%	0.0%	6.2%	1.9%	0.0%	0.0%	0.0%	0.0%	21.9%	26.8%
Singapore	3.8%	0.1%	2.1%	1.5%	0.2%	1.8%	11.4%	0.8%	8.5%	4.9%	0.1%	0.0%	0.0%	19.1%	45.8%
United Kingdom	2.6%	0.4%	1.9%	7.1%	2.4%	9.3%	5.3%	3.7%	10.8%	1.5%	0.5%	0.4%	1.1%	0.0%	52.8%
United States	4.9%	1.8%	14.1%	7.6%	3.0%	8.8%	2.0%	3.8%	20.6%	2.8%	1.6%	0.3%	1.4%	27.3%	0.0%

From the United States perspective, United Kingdom (27.3%), Japan (20.6%) and Canada (14.1%) are the most important for the stock market exchange rate. While for Germany the largest weights have the United States (38.5%), France (21.3%) and United Kingdom (18.4%). In general, the financial tie with United States is the most important for all countries, except for Hong Kong SAR, where United Kingdom is dominating with a weight of 43.7%.

Monthly bilateral exchange rates were obtained from the Deutsche Bundesbank's database. For the period from 1999 onwards, hypothetical exchange rates for DM, French Franc and other former EU currencies were derived based on euro-dollar rates. Afterwards, the average of these data was taken, in order to obtain annual data. To get the real effective financial exchange rates, the nominal bilateral exchange rates were deflated using Morgan Stanley Capital International (MSCI) stock market indices. **Figure 1** displays a comparison between the real effective financial exchange rates for Germany and United States and real effective exchange rates based on goods market prices for the same set of countries, where an increase in the real effective financial exchange rate implies a relative appreciation of the country's equities. The graph shows that, for instance, Germany entered European Monetary Union at a relatively high exchange rate, which devalued in the early 2000s. Subsequently, an increase of the German REFER can be observed until the recent crisis most likely reflecting increased price competitiveness of German firms due to decreasing unit labor costs. Regarding the US REFER, **Figure 1** shows a sharp appreciation between 1994 and 1998, which was associated with a strong influx of capital. The technology boom and expectations of higher US productivity growth led to elevated stock market valuations and a strong dollar appreciation[5]. Since 2001, however, the enthusiasm for US dollar investments substantially decreased accounting for a depreciation of the dollar's REFER of 35 percent by 2008.

[5] See Blanchard and Milesi-Ferretti (2009).

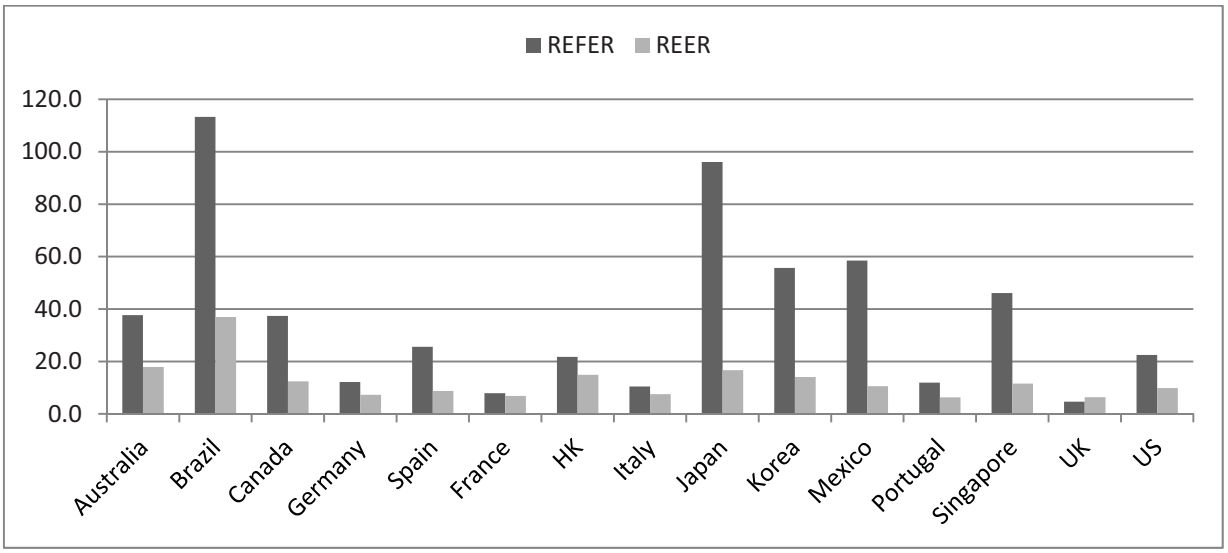
Figure 1: Real effective exchange rates deflated by MSCI and CPI values



Notes: REFER denotes the real effective financial exchange rate; REER denotes the standard real effective exchange rate based on CPI deflators

Figure 2 shows that real effective financial exchange rates exhibit strong fluctuations over time. Comparing time-series variances we find that, in general, the REFER of emerging market countries have greater variances than those of industrialized economies. Except for the Japanese Yen, which, according to the index, was relatively high in the beginning of 1990s, experienced a considerable decline of its REFER in mid-1990s and remained at the lower level afterwards. In contrast, the REER exhibits smaller fluctuations over time due to the stickiness of goods prices.

Figure 2: Standard deviations of real effective financial exchange rates



In order to control for the price impact of relative capital market sizes as documented in equation (6) we used the data on market capitalization obtained from the Worldbank database (World Development Indicators – WDI).

5 Estimation results

To analyze the long-term relationship between real financial exchange rates and net foreign holdings of stocks (NFH), we perform standard panel cointegration analyses.[6] As a starting point, panel unit root (Philipps-Perron) tests are applied to the levels of REFER and NFH, respectively. The Fisher χ^2 test statistics of 20.11 and 40.56 do not reject the null hypothesis of *non-stationarity* at conventional levels.[7] When looking at logs, test statistics of 20.59 and 31.08 do not reject the unit root behavior of both variables, either. Having established that both the variables were *I(1)* in logs and levels, we move on testing for cointegration. As suggested by Pedroni (2004) and Kao (1999) OLS regressions are estimated and stationarity of the resulting residuals are tested using the Engle Granger framework.[8] The associated panel ADF-statistics are significant at the one percent level rejecting the null hypothesis of no cointegration.[9]

The subsequent Error Correction Models are based on the long-run relationship (standard errors in brackets):

$$REFER_{i,t} = \underset{(8.42)^{***}}{82.83} + \underset{(5.19)^{***}}{25.83} \cdot NFH_{i,t} + u_{i,t}. \qquad (9)$$

The coefficients in equation (9) are derived from a Dynamic OLS (DOLS) estimation where the exchange rate is regressed on a constant, net foreign holdings, the current and lagged change of net foreign holdings, the lead change of net foreign holdings, and two AR terms. The computed variance-covariance matrices are robust against cross-section correlation and heteroskedasticity using panel corrected standard errors (PCSE). The resulting errors $u_{i,t}$ are used to analyse the error correction properties of the model along the following two equations:

$$\Delta REFER_{i,t} = \beta_{10} + \beta_{11} \cdot u_{i,t-1} + \beta_{12}\Delta REFER_{i,t-1} + \beta_{13}\Delta NFH_{i,t-1} + \varepsilon_{1i,t}. \qquad (10)$$

and

$$\Delta NFH_{i,t} = \beta_{20} + \beta_{21} \cdot u_{i,t-1} + \beta_{22}\Delta REFER_{i,t-1} + \beta_{23}\Delta NFH_{i,t-1} + \varepsilon_{2i,t}. \qquad (11)$$

[6] All estimates are conducted using EViews 7.1.
[7] See Fisher (1932) and Maddala and Wu (1999). The number of lags is automatically determined using the Schwarz info criterion. Furthermore, we allow for fixed effects in the individual cross sections.
[8] See Pedroni (2004) as well as Kao (1999).
[9] When looking at Phillips Perron statistics of the Pedroni test no-cointegration can also be rejected at the one percent level.

The estimation results represented in **Table 2** are based on OLS regressions with fixed cross section and fixed time effects. Panel A shows the parameter estimates of the model with the REFER and NFH variables. For comparison purposes we also estimated the model using a standard real effective exchange rate based on goods market prices (consumer price indices). The resulting coefficients of the empirical model are contained in Panel B of **Table 2**.

Table 2: Estimation results of the error correction models using levels

Panel A: Real Effective Financial Exchange Rate

Dependent Variable	$\Delta REFER_t$	ΔNFH_t
Constant	-0.48	0.014
	(0.941)	(0.073)
Error Correction	-0.223***	0.005**
	(0.032)	(0.002)
$\Delta REFER_{t-1}$	0.312***	0.002
	(0.055)	(0.004)
ΔNFH_{t-1}	0.838	-0.365***
	(0.918)	(0.071)
R^2-*adj*	0.44	0.16

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

Panel B: Real Effective CPI Exchange Rate

Dependent Variable	$\Delta REER_t$	ΔNFH_t
Constant	0.698	0.016
	(0.476)	(0.074)
Error Correction	-0.247***	-0.003
	(0.04)	(0.006)
$\Delta RECPIER_{t-1}$	0.334***	0.008
	(0.06)	(0.009)
ΔNFH_{t-1}	0.655	-0.452***
	(0.436)	(0.068)
R^2-*adj*	0.27	0.14

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

According to Panel A of **Table 2** both variables provide significant error correction. In case of a positive deviation from the long-run equilibrium implying that the current REFER is higher than its equilibrium value a depreciation of the real effective financial

exchange rate proportional to the current error can be expected to restore equilibrium. The adjustment is further enhanced by the autocorrelation of $\Delta REFER_t$. When looking at the error correction equation of net foreign holdings we also find a significant reaction of NFH to a given deviation from the long-run equilibrium. Here, a positive error is followed by capital flows into the appreciating currency. Obviously, a higher valuation of a country's assets as measured by the real effective financial exchange rate induces foreign investors to reallocate their portfolios at the benefit of domestic securities. This implies that a fraction of the observed change of the real exchange rate is perceived to be permanent. Rearranging the model (9) making NFH_t the left-hand variable allows for a more standard interpretation of the error correction coefficient, which is now estimated as -0.14. This implies that an excess world holding of a country's assets (in terms of the relative price of the country's assets) is corrected by subsequent capital outflows.

According to Panel B of **Table 2**, which refers to the CPI deflated REER, it is just the exchange rate, which provides the necessary error correction of the cointegration relationship. The estimated coefficient for ΔNFH is statistically insignificant indicating a lack of reaction of NFH to a given deviation from the long-run equilibrium.[10] While this represents a standard result in the literature it is evidence in favor of the real effective exchange rate based on asset prices.

The error term for REER is higher than the error term for REFER, but the total speed of adjustment in the REFER model exceeds the error correction for REER model, since in REFER model both variables adjust to restore the long run equilibrium.

6 Robustness checks

To provide insights into the robustness of the empirical findings we re-estimate the model using log variables, distinguish between pre-crisis and crisis observations, and, finally, look at the influence of capital market distances to account for gravity-type effects of international capital flows.

Log variables

It is standard practice in international finance to use log variables, because the resulting coefficients are interpretable in a convenient fashion. For instance, the error correction coefficient can be viewed as an elasticity with which the endogenous variables react to a

[10] In addition, the R^2-statistics are somewhat lower than those reported in the first model.

given deviation from the long-run equilibrium. When estimating the model using log variables the results do not change qualitatively.

Table 3: Estimation results of the error correction models using logs

Panel A: Real Effective Financial Exchange Rate

Dependent Variable	$\Delta REFER_t$	ΔNFH_t
Constant	0.001	0.008
	(0.001)	(0.031)
Error Correction	-0.169***	0.307***
	(0.036)	(0.117)
$\Delta REFER_{t-1}$	0.100	-0.564***
	(0.063)	(0.206)
ΔNFH_{t-1}	0.056**	0.009
	(0.022)	(0.073)
R^2-*adj*	0.25	0.02

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

Panel B: Real Effective CPI Exchange Rate

Dependent Variable	$\Delta REER_t$	ΔNFH_t
Constant	0.005	-0.001
	(0.004)	(0.032)
Error Correction	-0.233***	0.03
	(0.04)	(0.29)
$\Delta RECPIER_{t-1}$	0.265***	-0.461
	(0.06)	(0.446)
ΔNFH_{t-1}	0.023**	-0.079
	(0.01)	(0.075)
R^2-*adj*	0.26	-0.02

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

As reported in **Table 3** we still find that both variables adjust to restore a long-run equilibrium when the real effective financial exchange rate is incorporated. In case of the traditional REER the estimation results again reveal no reaction of the NFH to an exogenous shock. The R^2 statistic, however, is much lower than before indicating a less favorable fit of the model.

Sub-sample estimation

It might be argued that four out of 19 observations per country stem from the recent years when the global financial crisis unfolded and forced investors to behave in a nonstandard way. In fact, global liquidity shortages spurred a process of deleveraging, while diminishing risk appetite unfolded substantial safe haven flows. Since the time dimension of the data set is relatively short we stick to the full-sample estimation of the

cointegration relationship. The error correction equations are then re-estimated in samples ranging from 1993 to 2008 and from 2008 to 2011.

Table 4: Subsample Estimation of the error correction models

Panel A: Real Effective Financial Exchange Rate

Sample	1993 – 2008		2008 – 2011	
Dependent Variable	$\Delta REFER_t$	ΔNFH_t	$\Delta REFER_t$	ΔNFH_t
Constant	-0.076	0.001	-9.731**	1.243***
	(1.051)	(0.081)	(4.061)	(0.386)
Error Correction	-0.262***	0.008***	-0.275***	0.028***
	(0.036)	(0.003)	(0.083)	(0.008)
$\Delta REFER_{t-1}$	0.295***	0.0001	-0.012	-0.013
	(0.064)	(0.005)	(0.185)	(0.018)
ΔNFH_{t-1}	1.019	-0.203*	-1.164	-0.275*
	(1.552)	(0.12)	(1.587)	(0.151)
R^2-*adj*	0.48	0.03	0.46	0.70

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

Panel B: Real Effective CPI Exchange Rate

Sample	1993 – 2008		2008 – 2011	
Dependent Variable	$\Delta REER_t$	ΔNFH_t	$\Delta REER_t$	ΔNFH_t
Constant	0.637	0.033	0.698	-0.076
	(0.553)	(0.084)	(0.476)	(0.103)
Error Correction	-0.277***	-0.005	-0.247***	-0.106***
	(0.048)	(0.007)	(0.04)	(0.014)
$\Delta RECPIER_{t-1}$	0.345***	0.018	0.334***	0.031
	(0.073)	(0.011)	(0.06)	(0.022)
ΔNFH_{t-1}	0.428	-0.408***	0.655	0.149
	(0.783)	(0.119)	(0.436)	(0.126)
R^2-*adj*.	0.26	0.004	0.27	0.86

Notes: * (**,***) denote significance at the 10% (5%, 1%) level.

When looking at **Table 4** a number of interesting results can be observed. First, the important property of the full-sample estimation that both the $REFER_t$ and the NFH_t react to restore a long-run equilibrium remains valid in sub-samples. In case of the standard model incorporating the $REER_t$ we find that in times of financial crisis net foreign holdings also react to a disequilibrium situation. Given that consumer price indices did not change significantly during the late 2000s exchange rate dynamics in the error correction term seem to have captured a significant fraction of the current misalignment. Second, the reaction of net foreign holdings during the crisis is more than

three times stronger than in a regular investment environment. The need for deleveraging as well as lower investor risk appetite obviously led to faster portfolio rebalancing in the presence of perceived misalignments. According to the R^2 statistic, thirdly, the model fit substantially increased in the sample between 2008 and 2011.

It is quite obvious, that the fundamentally changed risk sentiment of investors and the need of banks to adjust their international portfolios according to new accountancy rules have triggered a deleveraging process that entailed a general withdrawal of investors from foreign markets, irrespective of expected earnings or the exchange rate. This might explain the rising significance of the constants as depicted in column three and four of **Table 4**.[11]

The influence of geographical distances between capital markets

In the literature, it is argued that the geography of information is one of the main determinants of international transactions while there is often weak support for the diversification motive, once controlled for the informational friction. Portes and Rey (2005) show that a gravity model explains international transactions in financial assets at least as well as goods trade transactions. The authors reveal that gross transaction flows depend on market size in source and destination country as well as trading costs, in which both information and the transaction technology play a role. Given that an information asymmetry between domestic and foreign investors or the efficiency of transactions can be approximated by the geographical distance between capital markets, the role of information costs may be investigated within the above framework by interacting the error correction term with an appropriate distance measure:

$$\Delta REFER_{i,t} = \beta_{10} + \beta_{11} \cdot u_{i,t-1} + \beta_{12} \cdot DIST_i \cdot u_{i,t-1} + \beta_{13} \cdot \Delta REFER_{i,t-1} + \beta_{14} \cdot \Delta NFH_{i,t-1} + \varepsilon_{1i,t} \quad (12)$$

and

$$\Delta NFH_{i,t} = \beta_{20} + \beta_{21} \cdot u_{i,t-1} + \beta_{22} \cdot DIST_i \cdot u_{i,t-1} + \beta_{23} \cdot \Delta REFER_{i,t-1} + \beta_{24} \cdot \Delta NFH_{i,t-1} + \varepsilon_{2i,t}. \quad (13)$$

The equations assume that the error correction coefficient is now a decreasing function of the distance between capital markets, where the latter is constructed as the weighted

[11] From a technical perspective, this may indicate a (temporary) change in the cointegration relationship between *REFER and NFH*.

average of air-line distances between a country's capital and all other countries' capitals in the sample.[12]

Table 5: Error correction of net foreign holdings considering distances

Sample	*1993 – 2011*	*1993 – 2008*
Constant	0.025	0.016
	(0.074)	(0.082)
Error Correction	0.009*	0.014**
	(0.005)	(0.006)
Error Correction · $DIST_i$	-0.0005	-0.0008
	(0.0006)	(0.0007)
$\Delta REFER_{t-1}$	0.002	-0.0003
	(0.004)	(0.005)
ΔNFH_{t-1}	-0.356***	-0.178
	(0.072)	(0.121)
R^2 *adj*	0.16	0.03

Notes: * (**, ***) denote significance at the 10% (5%, 1%) level.

Re-estimation of the model reveals no influence of the distance measure on the error correction of the exchange rate implying that the pricing of equities or exchange rates do not suffer from distance-approximated information costs.[13]

7 Conclusion

This paper proposes a new index of real effective exchange rates based on asset price deflators. While the standard assumption of traditional real effective exchange rates based on consumer price indices was that trade flows dominate the cross boarder international activities in the long run, capital flows now superseded trade flows by far. Given that the suggested index can be viewed as the price competitiveness of a country's assets a significant relationship with capital flows, an otherwise hard to explain macroeconomic variable, might be expected. The empirical results are encouraging in the sense that we find a country's net foreign holdings to be cointegrated with its real effective financial exchange rate. Importantly, subsequent error correction analysis reveals that both variables adjust to restore the long-run equilibrium. This is in contrast to the real effective exchange rates based on goods market prices, where the deviation from the long-run equilibrium fails to predict capital flows. A number of

[12] The weights to compute an arithmetic average are taken from the calculation of the real effective financial exchange rates. Thus, the variable $DIST_i$ (in thousands of Kilometers) varies across countries, but is constant over time.

[13] Results are available on request from the authors.

robustness checks such as sub-sample estimation or the consideration of information costs confirm the above results.

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