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# Effective exchange rates, current accounts and global imbalances\*

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## Abstract

This study analyzes the dynamics between real effective exchange rates and current account patterns from a novel perspective. We start by dissecting long-run and time-varying short-run dynamics between both variables. Following this, we extend our framework by including interest rates into our analysis. Finally, we examine common exchange rate and current account dynamics based on common factors derived from a principal components analysis. Our results show that a real appreciation is positively related to a worsening of the current account in most cases. The adjustment pattern is time-varying but suggests that the causality mainly runs from effective exchange rates to current accounts and occurs through valuation effects. However, an extension of our framework based on monthly data shows that trade balance adjustment is observed less frequently. From a global point of view, cross-country trends which drive exchange rates and current accounts also share similar dynamics over the long-run.

*Keywords:* current account, global imbalances, multivariate cointegration, real exchange rates

*JEL classification:* F31. F32

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# 1 Introduction

Current account imbalances are a key feature of the current international monetary system and have triggered controversial discussions among policymakers and economists in recent times. This is true not only for the origins and consequences but also for any potential mechanisms to reverse current account deficit or surpluses. Even the importance of the exchange rate as possibly the most intuitive adjustment tool is still subject to controversy.<sup>1</sup> For instance, the idea that a flexible exchange rate regime generally facilitates current account adjustment has yet to be convincingly demonstrated [Chinn and Wei, 2013]. A reacquisition aimed at generating an impact of exchange rate changes on the current account via trade effects is an exporters' producer-currency pricing (PCP) strategy [Campa and Goldberg, 2005]. However, increasing competition has led to local-currency pricing (LCP) by firms and an incomplete exchange rate pass-through [Brun-Aguerre, Fuertes and Phylaktis, 2012].<sup>2</sup>

This paper offers a comprehensive and novel analysis of the relationship between effective exchange rates and current accounts. We undertake several steps to clarify the issue of causality, both for a broad number of single countries and from a global perspective. More precisely, we make three key contributions: **firstly**, we dissect long-run and short-run relationships between real effective exchange rates and current accounts for eleven major economies. In the process we analyze monthly and quarterly data for both the current account relative to GDP and the real trade balances. This procedure provides an implicit robustness check for our results and a direct evaluation of the impact of exchange rate changes via the trade channel.<sup>3</sup>

Our **second** contribution stems from the consideration of time-varying short-run dynamics which are related to disequilibria from the underlying long-run relationships. Such a framework allows for the possibility that a stable relationship between current accounts and exchange rates exists while the causality is allowed to change over time. The degree and character of current account or trade balance adjustment allows an evaluation of the exchange rate channel for the correction of global imbalances. Leaving the country dimension to a later stage, our **third** contribution stems from focusing on the question of whether effective exchange rates and current accounts or trade balances

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<sup>1</sup>As an example, dollar adjustment has been discussed as a solution to the twin deficit in the federal budget and the current account that has been observed recently as well as during the eighties [Krugman, 1985; Obstfeld and Rogoff, 2009].

<sup>2</sup>This finding can be attributed to a price-setting mechanism based on time-varying mark-ups over marginal costs and other macro- and microeconomic factors such as monetary policy or market concentration [Brun-Aguerre *et al.*, 2012].

<sup>3</sup>Owing to the large numbers of estimated models, we focus solely on real effective exchange rates in the following, and so do not discriminate between nominal exchange rates and price dynamics. We leave this issue to further research.

share similar dynamics across all countries. This question has not been explicitly considered although it is important when it comes to (global) policy recommendations regarding the exchange rate and global imbalances. As a final step in our global analysis, we look at long-run and time-varying short-run dynamics of our global models in a similar fashion to that of the country models.

When discussing the links between exchange rates and current accounts, a distinction between positive understanding and normative evaluation is necessary [IMF, 2013]. In this paper, we are neither interested in calculating a “fair” exchange rate which is designed to “correct” global imbalances nor are we aiming at providing a general answer to the question of whether effective exchange rates should adjust or not. Conducting a positive rather than a normative approach, our key question is if, to what extent and during which times current accounts, relative to the GDP and/or trade balances, have been linked to effective exchange rates in the past. Our research therefore is in line with several studies which focus on the relationship between exchange rates and current accounts but use different frameworks or look at a different question [Lee and Chinn, 2006; Chinn and Lee, 2009; Chinn and Wei, 2013; Shibamoto and Kitano, 2012]. As mentioned above, a key difference is that the existing empirical literature, which will be classified later, is notably silent regarding nonlinearities in the in-sample relationship between current accounts and exchange rates.

The remainder of this paper is organized as follows. The following section discusses the motivation for our analysis from several perspectives: after a brief recap of the theoretical background, we categorize and summarize previous empirical findings and justify our own empirical approach. Our empirical section begins with an analysis of the relationship between current accounts and exchange rates for eleven major economies. We use a Markov-switching vector error correction model (MS-VECM) which is well-suited to our task, considering that the relationship between effective exchange rates and current accounts is not necessarily clear-cut and time-varying. After testing for a long-run relationship, a consideration of time-varying adjustment and short-run dynamics then allows us to look at time-varying causality patterns. As a next step, we analyze the common exchange rate and current account dynamics of a global model based on common factors derived from a principal components analysis (PCA). We then analyze the relationship between those common factors according to our time-varying Markov-switching model. As an extension and robustness check, we then repeat our analysis for a broader model at the monthly frequency including industrial production and interest rates. This step also includes an analysis in terms of long-run impacts of shocks between the variables and allows a direct assessment of the trade channel for exchange rate effects. Figure I presents an

overview of our modeling cycle.<sup>4</sup> Finally, we discuss the implications of our results for the reduction of global imbalances through changes in exchange rates. Section 4 concludes.

Figure I about here

## 2 Effective exchange rates and the current account: background, previous studies, and methodological issues

### 2.1 Background and previous studies

Various theoretical approaches suggest a link between the current account and effective exchange rate movements, with a possible causality going in both directions.<sup>5</sup> Regarding likely sources of adjustment, consider the following equation, which simply states that the current account can be written as the sum of trade balance ( $tb_t$ ), net exports of services ( $nse_t$ ), net receipts from interest, dividends and profits ( $nir_t$ ), and net unilateral receipts ( $nur_t$ )

$$ca_t = tb_t + nse_t + nir_t + nur_t. \quad (1)$$

If we disregard net exports of services and net unilateral receipts, since both are unlikely to be related to the exchange rate, the current account can be written as the sum of trade balance and net investment income which is driven by the interest rate differential between interest on domestic assets ( $a$ ) and loans ( $l$ ) [Milesi-Ferretti, 2008].

$$ca_t = tb_t + ir_t^a a_{t-1} - ir_t^l l_{t-1}. \quad (2)$$

The change in the net foreign asset position ( $\Delta b_t$ ) can be expressed as the sum of the current account, the capital gain or loss on the net foreign asset position ( $kg_t$ ), capital account transfers and measurement errors ( $v_t$ )

$$\Delta b_t = b_t - b_{t-1} = ca_t + kg_t + v_t. \quad (3)$$

Based on these definitions, an impact of the exchange rate on the evolution of the current account and the net foreign asset position can work through a trade channel and a valuation channel [Milesi-

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<sup>4</sup>It should be noted that the analysis of the trade balance is also considered as a sub-analysis of the current account.

<sup>5</sup>In our investigation, we rely on an external definition of the real exchange rate. Other studies correspond to the real exchange rate in internal terms as the ratio between prices of tradable and non-tradable goods with a relative increase in the price of tradable goods corresponding to a real depreciation of the domestic currency.

Ferretti, 2008]. On the one hand, an exchange rate appreciation could worsen the trade balance (possibly with a lag according to the J-Curve effect). In addition, the percentage change in the exchange rate influences the relative return earned on foreign assets, and can either worsen or improve the net external position through validation effects.<sup>6</sup>

In an early paper, Dornbusch and Fischer [1980] introduce the idea of a reversed causality by emphasizing the role of the current account within an asset market model of the nominal exchange rate. The main line of reasoning here is that asset markets determine the exchange rate at a point in time while the current account determines the path of the exchange rate through the net foreign asset position. Referring to an extension of the traditional monetary approach, Hooper and Morton [1982] provided the first empirical study that suggests that the current account is a useful determinant of the exchange rate.<sup>7</sup>

The recent theoretical literature based on a new open-economy macroeconomics framework in the spirit of Obstfeld and Rogoff [1996] also suggests that current account improvement should be associated with real exchange rate depreciation. However, clear empirical evidence for this has not been established, although some studies have found predictive power of the change in the U.S. current account for exchange rate movements [Gourinchas and Rey, 2005; Rogoff, 2007].<sup>8</sup> A simple empirical equation for the nominal exchange rate  $e^n$  could for example be written as

$$e_t^n = (m_t - m_t^*) - (y_t - y_t^*) + (i_t - i_t^*) + tb_t, \quad (4)$$

with  $m$  as money supply,  $y$  as industrial production,  $i$  as the interest rate, and  $tb$  as the trade balance [Beckmann, Belke and Kühn, 2011]. Variables with an asterisk refer to the foreign economy, whereas variables without refer to the domestic economy.<sup>9</sup>

On the whole, current accounts and real effective exchange rates should both be considered as endogenous in an empirical investigation. Both are simultaneously determined and a function of other variables such as interest rates or output gap [IMF, 2013]. In this vein, most recent literature has

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<sup>6</sup>If for example, U.S. foreign liabilities are mainly denominated in dollars, while most U.S. foreign assets are denominated in a foreign currency, a depreciation of the dollar will improve the net foreign asset position [Milesi-Ferretti, 2008]. Hence, trade and evaluation effects stemming from exchange rates should be qualitatively equivalent.

<sup>7</sup>In a parallel development, the class of portfolio balance models inspired by the work of Branson [1977] also emphasizes the role of the supply and demand of foreign and domestic assets, which are assumed to be imperfect substitutes for the path of nominal exchange rates.

<sup>8</sup>Dornbusch and Fischer [1980] show that such a framework allows for an overshooting behavior of real exchange rates, even if prices are fully flexible. They also argue that anticipated exchange rate depreciation may also result in a combination of exchange rate appreciation and current account adjustment.

<sup>9</sup>See also Pilbeam [1995] for an overview regarding different specifications of the monetary exchange rate model.

emphasized the importance of distinguishing between short-run and long-run shocks in modelling the real effective exchange rate, the current account and the relationship between them. The idea that the correlation between the real exchange rate and the current account depends on the source of shock mirrors the theoretical insights of Backus, Kehoe and Kydland [1994] and has been empirically analyzed by Chinn and Lee [2009] and Shibamoto and Kitano [2012]. Based on a structural VAR for the G7 economies, the former study argues that a theory-conform combination of real exchange rate depreciation and a current account surplus is more likely to be observed if temporary monetary policy shocks are the main driver of exchange rates.<sup>10</sup> Identifying a structural change during the nineties,<sup>11</sup> Shibamoto and Kitano [2012] report slightly different results for some G7 economies but share the finding that permanent shocks drive the U.S. current account while temporary shocks drive the real exchange rate of the dollar.<sup>12</sup>

As outlined in the Introduction, our study contributes to this literature by considering the role of shocks from a cross-country and time-varying perspective. Rather than focusing on the source of shocks in separate countries, we analyze whether common shocks to real exchange rates and current accounts across countries share similar long- and short-run dynamics. The application of a cointegration framework is motivated by the fact that we find current account (CA) imbalances to be sustainable. This result violates the long-run intertemporal budget constraint (solvency constraint), which implies a stationary current account, but it has been confirmed by other studies [Herwartz and Xu, 2008].

## 2.2 Exchange rates and global imbalances

The question of whether exchange rates bear the potential to remove current account imbalances is also controversially discussed. Once again, the origin of underlying shocks is considered to be crucial: exchange rate response to global imbalances is only likely to occur if the underlying shocks to exchange rates simultaneously lead to a closing of global imbalances [Rogoff, 2007]. In our framework, this issue boils down to the question of whether shocks to (global) real exchange rates and current account shocks share similar dynamics. However, it should be noted that our cross-section global

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<sup>10</sup>Against this background, the pattern of dollar depreciation and a worsening current account observed in the United States is due to mostly permanent factors driving the real exchange rate.

<sup>11</sup>The motivation for considering structural breaks comes from changes in the exchange rate pass-through mechanism [Shibamoto and Kitano, 2012].

<sup>12</sup>Using a VAR approach, Kim and Roubini [2008] focus on a broader question in analyzing the dynamics between the real exchange rate, the U.S. current account, and the fiscal deficit. They find that shocks to the government deficits improve the current account and depreciate the real exchange rate in the short-run.

perspective does not include the long-run constraint that the global sum of current account balances is zero.

In a series of papers, Obstfeld and Rogoff [2001, 2005, 2009] calibrate different scenarios of exchange rate and net foreign asset adjustments for reducing the U.S. current account deficit prior to the crisis based on a new open-economy macroeconomics framework. Depending on parameter choices such as the elasticity of substitutions between tradables and non-tradables, the effective dollar exchange rate is expected to fall between 21 and 33%, according to their calculations [Obstfeld and Rogoff, 2009]. A recent study by Fratzscher, Juvenal and Sarno [2010] also raises doubts regarding exchange rate adjustment: the results from a Bayesian structural VAR model suggest that equity market shocks and housing price shocks have been major determinants of the U.S. current account.<sup>13</sup> Hence, relative global asset prices rather than exchange rates are considered to be the key source of adjustment. Our framework does not allow direct predictions regarding the removal of imbalances but is nevertheless useful for providing policy implications against the background of the nonlinear and global dynamics between effective exchange rates and current accounts in the past.

## 2.3 Methodological issues and contribution

The empirical assessment of exchange rate behavior in general is an extensively studied topic and this section will only briefly review a small part of the literature that is relevant to our study. Unsurprisingly, nonlinearities are a key ingredient when it comes to modeling exchange rate behavior. In a nutshell, two different kinds of framework have turned out to be useful in the context of recurring regime switches and cointegration: smooth transition models and Markov-switching models.<sup>14</sup> Both frameworks focus on regime switches in the adjustment mechanism and the short-run dynamics while relying on a constant long-run relationship.

The key difference is that Markov-switching models apply a stochastic switching process, while smooth transition models rely on endogenously determined switching, which is, for example, triggered by the degree of deviations from a fundamental value such as purchasing power parity (PPP).<sup>15</sup> A distinction between different exchange rate regimes and adjustment patterns through Markov-switching models has, for example, been applied in the studies of Sarno, Valente and Wohar [2004] and Sarno and Va-

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<sup>13</sup>Their findings suggest that equity and housing shocks are responsible for up to 30% of the movements of the U.S. trade balance at a horizon of 20 quarters, while real exchange rate shocks explain only about 9%.

<sup>14</sup>As another alternative, models with structural breaks or time-varying coefficients, which allow for different regimes, have been applied, for instance, by Beckmann *et al.* [2011] and Goldberg and Frydman [2001, 2007].

<sup>15</sup>Models of this kind have been applied, for example, by Taylor, Peel and Sarno [2001] and Wu and Hu [2009].



lente [2006] when analyzing different exchange rate adjustment to fundamentals deviations according to the canonical monetary exchange rate model and PPP.<sup>16</sup> More generally, Cheung and Erlandsson [2005] provide unambiguous general evidence for the presence of Markov-switching dynamics in exchange rates.<sup>17</sup> As outlined in the previous sections, exchange rate and current account shocks might be triggered by several factors not included in our empirical setting, such as productivity shocks, changes in the exchange rate regime or demographical factors.<sup>18</sup> In this case, an endogenously determined switching approach seems inappropriate owing to the lack of an adequate transition variable. For these reasons, we adopt a Markov-switching approach which is, for example, able to disentangle periods with and without adjustment to long-run equilibrium. Similar to previous studies dealing with exchange rates, our analysis is based on a model with two regimes. Overall, such a choice seems appropriate from both an economic and econometric point of view.

The usefulness of our common factor approach in assessing cross-country dynamics applied in the second step of our analysis has also been verified in various studies. One frequent finding is that common factors in exchange rates and fundamentals are cointegrated, with their relationship even matching theoretical predictions [Beckmann, Belke and Dobnik, 2012]. Including current accounts and trade balances, respectively, into this approach is a natural extension of such frameworks, considering our investigation topic.

### 3 Data, empirical methodology and results

#### 3.1 Data and preliminary tests

Our sample contains quarterly and monthly data running from January 1980 to March 2013. We use trade weighted real effective exchange rates provided by the Bank for International Settlements (BIS).<sup>19</sup> The major advantage of this is that these series are available at a long frequency and that the corresponding time-varying weights are published. This allows the calculation of country-specific foreign quantities as a robustness check. The current-account-to-GDP ratio is taken from the World Bank, while short-term interest rates with a maturity of three months, industrial production indices,

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<sup>16</sup>In two related studies, Frömmel, MacDonald and Menkhoff [2005a,b] reformulate the monetary model in annual changes and allow for changes in the long-run coefficient itself through a Markov-switching process.

<sup>17</sup>The first study to adopt a Markov-switching model in the context of exchange rates is that of Engel [1994], which deals with exchange rate forecasting.

<sup>18</sup>Recent research has also emphasized the role of credit markets for the determination of current accounts [Kunieda and Shibata, 2005].

<sup>19</sup>See Chinn [2006] for a detailed overview of different calculations for real effective exchange rates and a comparison of different weighting criteria depending on the topics under investigation.

CPIs, and trade balances are taken from the OECD. We use nominal rather than real interest rates, since the former is directly influenced through monetary policy. For Hong Kong, industrial production is approximated by GDP through interpolation of the quarterly into a monthly series. In a similar fashion to Rose [1990], in order to obtain a measure of the real trade balance, we deflate the nominal trade balance by the product of the CPI and the nominal exchange rate. For our time series approach, we consider the following eleven economies, with the most of them being part of the G13: Australia, Canada, France, Germany, Hong Kong, Italy, Japan, Korea, Mexico, UK, and the USA.<sup>20</sup>

A crucial first step in our analysis is the conducting of unit root tests. While there is little doubt that real effective exchange rates, industrial production, trade balances, and interest rates are non-stationary, previous research has often considered the current account to be stationary. However, our results in most cases clearly suggest nonstationarity and therefore sustainability of current account imbalances.<sup>21</sup> Although this finding violates the theoretical intertemporal budget constraint, it is in line with the actual observations and with previous empirical findings [Herwartz and Xu, 2008]. The full results of the unit root tests for the current account and effective exchange rate data are presented in Table I. All remaining results are available upon request.

Table I about here

It should also be mentioned that the accumulated real trade balances, a possible proxy of the net foreign asset position, are integrated of order two. Hence, using changes in the accumulated real trade balances (i.e. the real trade balance) is an adequate procedure in the context of cointegration.

### 3.2 MS-VECM

Figure II provides both current accounts and effective exchange rates for each economy. A quick glance suggests that both series are related over the long-run in many cases. We now tackle this question empirically without pre-assuming any causality. The framework we apply for each economy is an  $M$ -regime  $p$ th order MS-VECM, which in general allows for discrete regime shifts in the vector of deterministic terms  $D_t$ , the autoregressive part  $\Gamma(L)(s_t)\Delta Y_{t-1}$ , the long-run matrix  $\Pi(s_t)$ , and the variance-covariance matrix of the errors:

$$\Delta Y_t = \Gamma(L)(s_t)\Delta Y_{t-1} + \Pi(s_t)Y_{t-1} + \Phi(s_t)D_t + \varepsilon_t, \quad t = 1, \dots, T, \quad (5)$$

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<sup>20</sup>We do not consider the terms of trade as a possible determinant of current accounts or trade balances. Such an analysis is beyond the scope of our study, since it would correspond to disentangling prices and nominal exchange rate dynamics.

<sup>21</sup>More precisely, in neither case the unit root null is rejected at the 1% level for each of the three tests conducted. At the 5% level the current account appears to be stationary for Mexico and the UK. See Table I for details.

where  $\Delta$  denotes the difference operator and  $Y_t$  represents a  $K$ -dimensional vector of the observed time series consisting of a subset of the following elements as a starting point:  $Y_t \subset [e_t, ca_t, ir_t]'$ , depending on the model under observation. Details are provided in the next subsection.  $\varepsilon_t = [\varepsilon_{1t}, \dots, \varepsilon_{Kt}]'$  describes a  $K$ -dimensional vector of error terms with regime-dependent variance-covariance matrix  $\Sigma(s_t)$ ,  $\varepsilon_t \sim NIID(0, \Sigma(s_t))$ . The  $K \times K$  matrix lag polynomial  $\Gamma(L)(s_t)$  of order  $p$  denotes the state-dependent short-run dynamics of the model.  $D_t$  gives the  $d$ -dimensional vector of deterministic terms (i.e. dummy variables). The stochastic regime-generating process is assumed to be an ergodic, homogenous, and irreducible first-order Markov chain with a finite number of regimes,  $s_t \in \{1, \dots, M\}$ , and constant transition probabilities

$$p_{ij} = Pr(s_{t+1} = j | s_t = i), \quad p_{ij} > 0, \quad \sum_{j=1}^M p_{ij} = 1 \quad \forall \quad i, j \in \{1, \dots, M\}. \quad (6)$$

The first expression of Equation (6) gives the probability for switching from regime  $i$  to regime  $j$  at time  $t + 1$ , which is independent of the history of the process.  $p_{ij}$  is the element in the  $i$ th row and the  $j$ th column of the  $M \times M$  matrix of the transition probabilities  $P$ .

The non-stationary behavior of the series is accounted for by a reduced rank ( $r < K$ ) restriction of the state-dependent  $K \times K$  long-run level matrix  $\Pi(s_t)$ , which can be fragmented into two  $K \times r$  matrices  $\alpha(s_t)$  and  $\beta$  such that  $\Pi(s_t) = \alpha(s_t)\beta'$ .  $\beta'$  gives the coefficients of the variables for the  $r$  long-run relations, which are assumed to be constant over the whole sample period, while  $\alpha(s_t)$  contains the regime-dependent adjustment coefficients describing the reaction of each variable to disequilibria from the  $r$  long-run relations given by the  $r$ -dimensional vector  $\beta'Y_{t-1}$ . Thus, in our model, the most interesting distinction between regimes is the speed at which deviations from long-run equilibria are corrected, given by  $\alpha(s_t)$ . This allows for the possibility of asymmetries and changes, respectively, in the adjustment process between exchange rates and current accounts, which is indicated in Figure II.

Figure II about here

Firstly, in order to identify the rank of  $\Pi(s_t)$ , i.e. the number of cointegrating relations  $r$ , and to estimate the coefficients of the  $r$  cointegrating vectors in  $\beta'$ , we employ the framework developed by Johansen [1988, 1991]. Secondly, conditional on these cointegrating vectors, the regime-dependent adjustment parameters  $\alpha(s_t)$ , deterministic terms  $\Phi(s_t)$ , autoregressive coefficients  $\Gamma(L)(s_t)$ , and variance-covariance matrix  $\Sigma(s_t)$  as well as the transition probabilities, are estimated using a multi-move iterative Gibbs sampling procedure.<sup>22</sup>

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<sup>22</sup>Saikkonen [1992] and Saikkonen and Luukkonen [1997] showed that the Johansen procedure provides consistent

In order to estimate our regime-dependent parameters, we define a  $(1 + Kp + r)M$ -dimensional vector:

$$Z_t = [\Delta Y_{t-1} \mathbb{1}(s_t = 1) \quad \dots \quad \Delta Y_{t-1} \mathbb{1}(s_t = M) \quad \dots \quad \Delta Y_{t-p} \mathbb{1}(s_t = 1) \quad \dots \quad \Delta Y_{t-p} \mathbb{1}(s_t = M) \\ \beta' Y_{t-1} \mathbb{1}(s_t = 1) \quad \dots \quad \beta' Y_{t-1} \mathbb{1}(s_t = M) \quad D_t \mathbb{1}(s_t = 1) \quad \dots \quad D_t \mathbb{1}(s_t = M)]', \quad (7)$$

where  $\mathbb{1}(s_t = i)$  denotes an indicator function which equals 1 for regime  $i$  and 0 otherwise. Therefore, Equation (5) can be written in compact form as:

$$Y = \Xi Z + \varepsilon, \quad (8)$$

with

$$Y = [\Delta Y_1 \quad \dots \quad \Delta Y_T], \quad Z = [Z_1 \quad \dots \quad Z_T], \quad \varepsilon = [\varepsilon_1 \quad \dots \quad \varepsilon_T]. \quad (9)$$

The coefficient matrix of order  $K \times (1 + Kp + r)M$  is given by

$$\Xi = [\mu(s_t) \quad \Gamma_1(s_t) \quad \dots \quad \Gamma_p(s_t) \quad \alpha_1(s_t) \quad \dots \quad \alpha_r(s_t)]. \quad (10)$$

Conditional on Equation (8), the cointegrating matrix  $\beta$ , and a series of states  $\tilde{s}_T = \{s_1, \dots, s_T\}$ , coefficient values are drawn from the posterior normal-inverse Wishart distribution with uninformative priors  $\nu_{01}, \dots, \nu_{0M}, N_0, F_0, W_{01}, \dots, W_{0M}$ . By applying uninformative priors, we model the cointegrating vectors explicitly and the parameter estimates do not depend on the prior information [Francis and Owyang, 2005].

At each iteration step,  $\Xi$  and  $\Sigma(s_t)$  for  $s_t \in \{1, \dots, M\}$  are drawn from a distribution with  $\nu$  degrees of freedom, precision matrix  $N$ , parameter means  $F$ , as well as variance-covariance matrices  $W_1, \dots, W_M$ , which are defined as follows for regime  $i$ :

$$\nu_i = \nu_{0i} + \hat{T}_i, \quad N = N_0 + Z'Z, \quad F = N^{-1} (N_0 F_0 + Z'Z \hat{F}), \\ W_i = \frac{\nu_0}{\nu} W_{0i} + \frac{\hat{T}_i}{\nu_i} \hat{\Sigma} + \frac{1}{\nu} (\hat{F} - F_0)' N_0 N^{-1} Z'Z (\hat{F} - F_0), \quad (11)$$

where  $\hat{F} = (Z'Z)^{-1} Z'Y$ ,  $\hat{\Sigma} = (Y - Z\hat{F})' (Y - Z\hat{F})$ , and  $\hat{T}_i$  denominates the number of periods in state  $i$ .

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estimates for the cointegrating vectors even in the presence of regime-switching. A related approach has been applied by Beckmann and Czudaj [2013] to examine the relationship between oil prices and effective dollar exchange rates.

Then, conditional on the data series  $\tilde{Y}_T$  and the drawn parameters  $\Xi$  and  $\Sigma(s_t) \forall s_t$ , the series of states  $\tilde{s}_T$  is drawn from the posterior distribution  $p\left(\tilde{s}_T|\tilde{Y}_T, \Xi, \Sigma(s_t)\forall s_t\right)$ , which is obtained from:

$$p\left(s_t|\tilde{Y}_t, \Xi, \Sigma(s_t)\forall s_t\right) = \frac{f\left(Y_t|\tilde{Y}_{t-1}, s_t, \Xi, \Sigma(s_t)\forall s_t\right) p\left(s_t|\tilde{Y}_{t-1}, \Xi, \Sigma(s_t)\forall s_t\right)}{\sum_{s_t} f\left(Y_t|\tilde{Y}_{t-1}, s_t, \Xi, \Sigma(s_t)\forall s_t\right) p\left(s_t|\tilde{Y}_{t-1}, \Xi, \Sigma(s_t)\forall s_t\right)}, \quad (12)$$

where

$$p\left(s_t|\tilde{Y}_{t-1}, \Xi, \Sigma(s_t)\forall s_t\right) = \sum_{s_{t-1}} p(s_t|s_{t-1}) p\left(s_{t-1}|\tilde{Y}_{t-1}, \Xi, \Sigma(s_t)\forall s_t\right), \quad (13)$$

and  $p\left(s_{t-1}|\tilde{Y}_{t-1}, \Xi, \Sigma(s_t)\forall s_t\right)$  is given by each previous iteration step [Hamilton, 1989; Kim and Nelson, 1999]. As is usual practice in such a case, the transition probabilities  $p_{ij}$  are also derived within this algorithm by drawing from posteriors formed from beta conjugate distributions [Kim and Nelson, 1999; Francis and Owyang, 2005].

### 3.3 Long-run and short-run dynamics from a country perspective

We start with the results of our bivariate models for all economies.<sup>23</sup> The main diagnostics for each model are shown in Table II.

Table II about here

According to the trace test described in Juselius [2006], a long-run relationship is detected in each case except for Canada. The findings also show that each configuration provides satisfying results in terms of autocorrelation tests. As a next step, the character of the long-run relationships is considered. The estimated coefficients are provided in Table III.

Table III about here

For each economy except Germany, real effective exchange rates and the current account are positively related. After rearranging, this implies that a real appreciation coincides with a worsening of the current account, which is in line with the theoretical considerations of Section 2. In some cases, even the hypothesis that both series are exactly inversely related in the long-run cannot be rejected. The findings for Germany might be the only exception, but the outcome might simply be driven by the fact that an appreciation of the euro has coincided with an improvement of the current account since the Millennium, as shown in Figure II. Considering that our framework considers all quantities to

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<sup>23</sup>In order to save space we do not report the skewness and kurtosis for the residuals of each equation, the tests for lag length determination, and the simulated values for the trace test statistic. All those diagnostics are available upon request.

be endogenous, the adjustment dynamics need to be assessed in the next stage to clarify the issue of causality for the other economies.

In most cases, the current account adjusts to disequilibrium in one regime while there is no theory-conform adjustment in the second regime. Hence, the causality runs from exchange rates to current accounts but is only observed during specific time periods. Exceptions are the United States and Hong Kong, where the exchange rate adjusts in one regime while the current account adjusts in the other. Although this result suggests a more complex nature of the underlying causalities, an encouraging finding is that adjustment is observed throughout the sample.

The approach up to this point has been restricted, owing to the fact that only effective exchange rates and current accounts have been considered. We now introduce domestic interest rates into our systems.<sup>24</sup> On the one hand, this step is useful as an implicit robustness check regarding the results obtained up to this point. In addition, previous findings suggest that monetary policy shocks influence the relationship between exchange rates and current accounts [Chinn and Lee, 2009]. From a theoretical point of view, the long-run relationships identified should continue to hold in larger systems [Juselius, 2006]. Except for France, where a cointegrating relationship is no longer detected,<sup>25</sup> the character of the relationship between current accounts and effective exchange rates and the time-varying causality pattern does not change. However, both the adjustment patterns and the effect of the interest rate suggest some differences: a rise in domestic interest rates either appreciates or depreciates the domestic exchange rate and improves or worsens the current account. For Korea and Mexico, current account adjustment now turns out to be insignificant. In the latter case, including interest rates increases the number of long-run relationships and provides evidence of exchange rate adjustment.

Summing up the results up to this point, we have shown robust evidence that exchange rates and current accounts share similar dynamics over the long-run in most economies. The fact that causality in terms of adjustment is only observed during specific periods mirrors the observation that countries might accumulate imbalances even if the exchange rate seems to move in the “correct” direction for removing imbalances.

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<sup>24</sup>Using the difference between domestic and foreign trade-weighted interest rates results in similar conclusions regarding the relationship between current accounts and effective exchange rates. The results are available upon request.

<sup>25</sup>If the interest rate is restricted to zero in the long-run relationship, the results for France are equivalent to the results explained before.

### 3.4 Common dynamics across countries

Having focused on the country perspective, we now turn to the global analysis of common dynamics across countries. Previous literature has focused on the question of whether the source of shocks drives the relationship between exchange rates and current accounts for particular economies. We focus on the more essential question of whether common exchange rate and current account shocks across countries are related in the long-run and in terms of causality.<sup>26</sup>

Once again, we consider a setting with two and three variables. Common factors for the effective exchange rate, the current account, and the interest rate are estimated by principal component analysis, according to Bai and Ng [2004]. As is common practice, each series is taken as (logarithmic) first difference and then standardized so that each has a zero mean and a variance of unity. Otherwise, the results would be systematically affected by cross-country differences in variability. The first principal component derived from all individual quantities for each country explains the largest fraction of the total variance of the dataset in comparison to the remaining principal components and, therefore, suitably qualifies as a factor capturing international co-movement.

At this stage, we no longer restrict our sample to the G13 economies that are included in our dataset.<sup>27</sup> Instead, we apply the common factor approach to all economies, where the BIS provides the data. Starting with the bivariate approach, the results mirror the findings obtained on a country base: common shocks to effective exchange rates and the current account are negatively related over the long-run. This implies that common exchange rate shocks triggering an appreciation are strongly related to common shocks which worsen the trade balance. Hence, a transmission of global common shocks between both series is likely to occur. Unsurprisingly, a clear adjustment pattern is not detected, so that the causality in terms of shocks cannot be dissected.<sup>28</sup>

Including common factors of interest rates again does not change the overall conclusion: the positive long-run relationship between the shocks of exchange rates and current accounts prevails, while interest rate shocks are also related to exchange rate shocks according to a second long-run relationship. Interestingly, exchange rate shocks react to interest rate shocks according to the adjustment coefficient. Hence, shocks introduced by monetary policy might influence the current account adjustment through exchange rates, although such an influence is unlikely to be systematic.

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<sup>26</sup>Previous estimations also aimed at distinguishing between fixed and flexible exchange rate regimes in the context of a global analysis in the spirit of Chinn and Wei [2013]. This part of the analysis has been dropped owing to the fact that the classification of countries frequently differs across time.

<sup>27</sup>The full list of economies is provided under <http://www.bis.org/statistics/eer/>. We use the narrow index.

<sup>28</sup>Further estimations are currently carried out to clarify this issue.

Altogether, our new perspective on shocks which drive exchange rates and current accounts provides some interesting insights: firstly, we find that global shocks are the main source of nonstationarity in current accounts and exchange rates. In line with the findings of Chinn and Lee [2009], the underlying shocks of exchange rates and current accounts are related. In terms of policy recommendations, the key question that arises is whether any systematic influence on those common factors can be obtained. In the best case, this is only possible through sustainable long-term global policies, which suggests that the exchange rate channel is unlikely to be a trigger of current account adjustment in the near future. In this regard, an important question is whether the observed effects occur through direct trade or valuation effects. We examine this question as a next step.

### 3.5 Monthly analysis and robustness checks

Up to this point, we have considered the current account relative to GDP. However, to dissect the underlying dynamics and shocks, a more in-depth analysis might be necessary. For this reason, we now consider, within our system, trade balances, industrial production, effective exchange rates, and interest rates. More precisely, we use interest rates relative to the United States and industrial production relative to OECD production.<sup>29</sup> As a robustness check, we also consider domestic interest rates and industrial production relative to a trade-weighted foreign measure. For our common factor analysis, we neglect industrial production and interest rates of the OECD and solely rely on country interest rates since drawing common factors for similar relative differentials is not plausible.

By analyzing this system, we are able to compare the impact of monetary policy and exchange rate changes on exchange rates and the trade balance. In addition, a distinction between trade and valuation channels, as briefly described in Section 2, might be provided. The opposite causality, from trade balances to exchange rates, can also be analyzed in a broader context, with industrial production and interest rates as possible exchange rate determinants also included. Finally, we also examine the long-run impact of interest rates and industrial production shocks on effective exchange rates and the current account. This enables us to compare our findings to the studies like the one provided by Chinn and Lee [2009] who have applied VAR models to analyze the impact of shocks.<sup>30</sup>

Similar to the analysis of quarterly data, we start our analysis with the results obtained for the individual economies. The findings are provided in Tables IV and V.<sup>31</sup>

<sup>29</sup>We only use the domestic interest rate for the United States.

<sup>30</sup>We do not report the results of a bivariate setting between trade balances and real exchange rates to keep the interpretation of our results transparent. However, these are available upon request.

<sup>31</sup>We solely present results for the full model in order to keep the presentation at a reasonable range. However, results



Tables IV and V about here

For Australia and Canada, no long-run relationship is found according to the results of the trace test. For this reason, we do not consider both economies from this stage on.<sup>32</sup> For France, Hong Kong, and Korea, two long-run relationships are identified. The estimates of the long-run coefficients are line with the results for the quarterly dataset. In most cases, a real domestic depreciation coincides with an improvement of the domestic trade balance in real terms. Only the findings for Germany and France suggest an inverse relationship. Naturally, the adjustment effects become increasingly complex, since we have added a fourth variable to our system. As a result, two long-run relationships are observed more frequently. For Mexico, Korea, Hong Kong, and the U.S., the trade balance adjusts to long-run deviations from the equilibrium condition including exchange rates and trade balances in one regime. For these economies, we can confirm the importance of allowing for regime-switching dynamics. Considering the finding for the remaining economies, the trade channel can only partly explain the adjustment of current accounts observed for quarterly data in the previous section. Exchange rate adjustment is only correctly signed and significant in case of Germany. While income drives the adjustment pattern for the UK, relative interest rates show a theory conform adjustment for most economies.

Finally, we turn to our global model derived from our common factor approach. Interestingly, exchange rate shocks adjust to deviations in the first regime while no adjustment of the trade balance is observed in one of the two regimes. The fact that industrial production adjusts in both regimes suggests that our previous finding that the current account relative to GDP adjusts might not be driven by the trade channel introduced in Section 2.1. Instead, valuation effects and production adjustment might be responsible for this finding.

As outlined previously, a great deal of research has focused on the source of shocks to effective exchange rates and current accounts/trade balances. As a final step, we therefore turn to the analysis of the driving forces of system. In doing so, the cointegrated VAR model is rearranged into its moving average (MA) representation given below

$$Y_t = C \sum_{i=1}^t \varepsilon_i + \tau_0 + A_t, \quad (14)$$

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for the bivariate settings are available upon request.

<sup>32</sup>These findings are somehow surprising, since both Canada and Australia are commodity currencies so that their exchange rate should fluctuate with their export prices. On the other hand, the failure to establish a long-run relationship does not imply that short-run impacts are not observed.

where

$$C = \beta_{\perp} \left[ \alpha'_{\perp} \left( -I + \sum_{i=1}^{p-1} \Gamma_i \right) \beta_{\perp} \right]^{-1} \alpha'_{\perp}, \quad (15)$$

$\tau_0 = C(Y_0 + \Phi D_t)$  depends on the initial values  $Y_0$ , and  $A_t = \alpha(\beta' \alpha)^{-1} \sum_{i=0}^{\infty} (I - \beta' \alpha)^i \beta' (\varepsilon_i + \Phi D_i)$  is a stationary moving average process. Also note that  $\alpha_{\perp}$  and  $\beta_{\perp}$  denote the orthogonal complements of  $\alpha$  and  $\beta$ . The MA representation of the cointegrated VAR model allows us to study the long-run impact of shocks or to conduct an analysis of the pushing forces of the system. Considering the several potential causalities that have been discussed in Section 2, such an analysis appears to be well suited to deliver further insights. Therefore, the long-run impact matrix  $C$  indicates how each variable is affected by accumulated shocks to other variables. Altogether, this part of the analysis provides a different representation of long-run causalities. Up to this point, we have adopted the switching adjustment coefficients as a measure of causality. At this stage, we draw conclusion based on the dissection of our linear benchmark model. The estimated coefficients of  $C$  are reported in Table VI.

Table VI about here

A first look at the main diagonal shows that the main underlying dynamics seem to be adequately specified, since nearly all elements turn out to be positive and significant. We now start with direct linkages between trade balances and exchange rates. For Korea, Mexico, and the U.S. a domestic appreciation worsens the trade balance in real terms. This pattern mirrors the overall findings in the previous section, where a theory-conform adjustment has been observed for those three economies. In most other cases, the exchange rate impact has the correct sign but turns out to be insignificant. For France, Italy, and the global model a reverse causality is observed: an improvement of the trade balance leads to a depreciation of the domestic economy. On the other hand, the findings for Germany and Korea suggest that an improvement of the trade balance leads to an appreciation of the economy. Those ambiguous findings reflect theoretical considerations which are not necessarily clear-cut regarding the impact of changes in the net foreign asset position on (nominal) exchange rates.

As a next step, it seems useful to consider the role of interest rates and productivity shocks for the path of exchange rates and trade balances. A first key finding is that trade balances are more frequently driven by production shocks while exchange rates are more often influenced by interest rates shocks. For Japan, Korea, UK, the U.S., and Germany, an increase in the interest rate differential appreciates the domestic currency. At first sight, this finding violates the implications of uncovered interest

rate parity (UIP). However, UIP can hardly be directly considered for real effective exchange rates and many studies have found that an increase in the relative interest rate appreciates the domestic exchange rate on a country level [Taylor and Sarno, 2004]. On the opposite, an impact of industrial production on exchange rates is only found for Korea and France. Interestingly, exchange rate shocks for their turn influence industrial production for all countries except for France, Italy, and Japan and also for the global model.

Trade balances are influenced by industrial production in case of Italy, the U.S., Korea, Mexico, and Japan with both negative and positive impacts observed. An impact of interest rates on the trade balance is found for the U.S., Mexico, and Korea. Hence, we can confirm previous findings that a theory conform relationship is mostly observed in cases where both exchange rates and trade balances are influenced by the same shocks. The finding that interest rate shocks negatively influence industrial production for most economies is also in line with theoretical considerations, since an expansive monetary policy should increase production. The impact of industrial production on interest rates is less clear-cut. Unsurprisingly, monetary policy plays a major role for both the path of exchange rate and trade balances. While the exchange rate is more often affected directly, effects on the trade balance might occur through second round effects via exchange rates and income.

At the global level, in terms of common shocks, interest rates and production shocks both also increase exchange rate shocks while they execute no influence on the trade balances. This pattern is in line with the results of Lee and Chinn [2006] that exchange rates are more influenced by long-run shocks compared to the current account. It is important to keep in mind that the common factors correspond to all economies provided by the BIS rather than the eleven economies we have analyzed on a country perspective. This might explain the different findings regarding the adjustment of industrial production.

## 4 Conclusion

Having analyzed, the relationship between exchange rates and current accounts from a broad perspective, we find that the relationship between current accounts and effective exchange rates significantly varies between countries. In most cases, the long-run relationship between effective exchange rates and current accounts is in line with theory: a real appreciation is positively related to a worsening of the current account relative to GDP. The causality mainly runs from the exchange rate to

the current account. However, we have also shown that short-run dynamics are characterized by regime-switching with the current account only adjusting during specific periods, which we label the “adjustment regime”. By contrast, there are also periods where no adjustment takes place. We also identify Germany and Canada as cases where the long-run relationship is either not in line with theory or no long-run relationship can be observed at all. Including interest rates into our analysis does not change the key results regarding the relationship between exchange rates and the current account. The findings for our monthly dataset still suggest a theory conform link between exchange rates and trade balances. However, the underlying causalities in terms of adjustment seem to be more complex with a response of trade balances to long-run deviations observed less frequently. This suggests that valuation effects are an important driver of current account responses to exchange rate changes. However, our conclusions regarding this issue are not based on a direct measure of the net foreign asset position, since the corresponding data is neither available for all economies nor the entire sample period under investigation.

Turning to a global perspective, we find that the cross-country trends, which drive exchange rates and current accounts, also share similar dynamics over the long-run. This finding also holds for the relationship between real trade balances and exchange rates. At first sight, this is an interesting finding in terms of global policy recommendations: if policymakers were able to influence the common trends which drive exchange rates, an impact on restoring global imbalances could be triggered. However, the simple and obvious problem is that policymakers are unable to systematically influence the trends that drive exchange rates. This is the lesson from various attempts at a coordinated exchange rate policy over recent decades. A reasonable aim of policymakers might be a volatility reduction of the underlying shocks, for example, through monetary policy shocks, which are an important driver of exchange rates according to our results. However, such a reduction would not guarantee any transmission to a reduction in global imbalances. On the whole, the exchange rate should obviously not be considered as a direct instrument but the current account in many cases seems likely to follow a depreciation or appreciation path. The general finding of country-specific regime switching patterns and the fact that trade balances do not respond to long-run deviations at a monthly frequency for many economies also underlines the complexity of the linkages between current accounts and exchange rates.

With regard to the correction of global imbalances, one should bear in mind that our approach enables an in-sample investigation without predicting future exchange rate movements. Several questions

remain on the agenda for further research: disentangling nominal exchange rates and price dynamics, country-specific case studies and the simulation of potential policy shocks are obvious examples. A promising framework is a global vector error correction model in the spirit of Pesaran and Smith [2006], which combines country-specific long-run and short-run dynamics into a global model. A detailed normative approach based on panel techniques has been provided by the external balance assessment (EBA) methodology of the IMF.

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# Tables

TABLE I: UNIT ROOT TESTS (QUARTERLY DATA)

Country	$e$				$ca$			
	ADF[Lags]	ADF-GLS[Lags]	NP[Lags]	KPSS[Lags]	ADF[Lags]	ADF-GLS[Lags]	NP[Lags]	KPSS[Lags]
Australia	-1.50[0]	-1.38[0]	-3.91[0]	30.96**[0]	-4.16**[0]	-1.83[0]	-6.38[0]	0.97**[0]
Canada	-1.59[1]	-1.62[1]	-5.63[1]	24.37**[1]	-2.29[0]	-2.18*[0]	-9.03*[0]	16.68**[0]
France	-3.50**[1]	-0.74[1]	-1.42[1]	26.50**[1]	-1.57[1]	-1.40[1]	-3.61[1]	25.70**[1]
Germany	-2.87[0]	-1.22[0]	-2.75[0]	3.46**[0]	1.12[0]	0.25[1]	0.53[1]	264.91**[1]
Hong Kong	-1.31[0]	-1.27[0]	-3.24[0]	46.75**[0]	-2.29[8]	-0.98[8]	-2.14[8]	30.14**[8]
Italy	-2.24[1]	-1.73[1]	-6.46[1]	6.76**[1]	-1.87[7]	-0.93[7]	-1.77[7]	17.07**[7]
Japan	-2.30[0]	-1.22[0]	-2.84[0]	16.69**[0]	-3.99**[0]	-0.80[0]	-1.25[0]	12.01**[0]
Korea	-2.53[0]	-1.16[0]	-2.96[0]	39.30**[0]	-3.51**[0]	-0.98[0]	-2.56[0]	9.48**[0]
Mexico	-2.99*[0]	-2.34*[0]	-10.20*[0]	7.69**[0]	-2.95*[2]	-2.76**[2]	-14.07**[2]	2.48**[2]
UK	-2.10[0]	-1.08[0]	-3.08[0]	29.88**[0]	-2.89*[1]	-2.55*[1]	-13.06*[1]	11.50**[1]
USA	-1.67[0]	-1.67[0]	-5.55[0]	35.00**[0]	-1.61[0]	-0.92[1]	-1.72[0]	131.35**[0]

*Note:* The table reports test statistics for three tests, viz. the augmented Dickey and Fuller [1979] test, the GLS-detrended version of the latter proposed by Elliott, Rothenberg and Stock [1996], the Ng and Perron [2001]  $MZ_\alpha$  test and the Kwiatkowski, Phillips, Schmidt and Shin [1992] stationarity test. In each case we have used a test regression with an intercept, but without trend. The 5% and the 1% critical values are as follows: 5% (ADF) -2.88, (ADF-GLS) -1.94, (NP) -8.10, and (KPSS) 0.46; 1% (ADF) -3.48, (ADF-GLS) -2.58, (NP) -13.80, and (KPSS) 0.74. The lag length has been chosen according to the Schwarz criterion and the maximum lag length has been set to 12. In case of NP and KPSS, the spectral density has been estimated using a GLS-detrended AR process. KPSS tests the null of stationarity while all other test the null of a unit root.  $e$  denotes the effective exchange rate and  $ca$  denominates the current account. \* denotes a rejection at a 5% level and \*\* at a 1% level.



TABLE II: TRACE TESTS AND AUTOCORRELATION TESTS (QUARTERLY DATA)

Country	Tests	$p$ -values bivariate	$p$ -values trivariate
Australia	Trace test	$H_0 : r = 0$	0.031
		$H_0 : r \leq 1$	0.675
	AC test	LM(1)	0.325
		LM(2)	0.202
		LM(3)	0.168
		LM(4)	0.942
Canada	Trace test	$H_0 : r = 0$	0.499
		$H_0 : r \leq 1$	0.666
France	Trace test	$H_0 : r = 0$	0.063
		$H_0 : r \leq 1$	0.065
	AC test	LM(1)	0.000
		LM(2)	0.013
		LM(3)	0.036
		LM(4)	0.000
Germany	Trace test	$H_0 : r = 0$	0.008
		$H_0 : r \leq 1$	0.111
	AC test	LM(1)	0.663
		LM(2)	0.779
		LM(3)	0.050
		LM(4)	0.352
Hong Kong	Trace test	$H_0 : r = 0$	0.001
		$H_0 : r \leq 1$	0.050
	AC test	LM(1)	0.106
		LM(2)	0.000
		LM(3)	0.026
		LM(4)	0.000
Italy	Trace test	$H_0 : r = 0$	0.000
		$H_0 : r \leq 1$	0.047
	AC test	LM(1)	0.200
		LM(2)	0.017
		LM(3)	0.513
		LM(4)	0.000
Japan	Trace test	$H_0 : r = 0$	0.014
		$H_0 : r \leq 1$	0.183
	AC test	LM(1)	0.722
		LM(2)	0.994
		LM(3)	0.843
		LM(4)	0.249
Korea	Trace test	$H_0 : r = 0$	0.000
		$H_0 : r \leq 1$	0.052
	AC test	LM(1)	0.0891
		LM(2)	0.372
		LM(3)	0.447
		LM(4)	0.786
Mexico	Trace test	$H_0 : r = 0$	0.007
		$H_0 : r \leq 1$	0.152
	AC test	LM(1)	0.296
		LM(2)	0.000
		LM(3)	0.577
		LM(4)	0.114
UK	Trace test	$H_0 : r = 0$	0.013
		$H_0 : r \leq 1$	0.189
	AC test	LM(1)	0.034
		LM(2)	0.711
		LM(3)	0.426
		LM(4)	0.188
USA	Trace test	$H_0 : r = 0$	0.071
		$H_0 : r \leq 1$	0.247
	AC test	LM(1)	0.664
		LM(2)	0.796
		LM(3)	0.427
		LM(4)	0.850
Global	Trace test	$H_0 : r = 0$	0.001
		$H_0 : r \leq 1$	0.050
	AC test	LM(1)	0.106
		LM(2)	0.000
		LM(3)	0.026
		LM(4)	0.000

*Note:* The table reports the  $p$ -values for testing the null hypotheses of no cointegration, of at most one cointegrating relationship, and of no serial correlation up to order four. The former two hypotheses are tested by the trace test proposed by Johansen [1988] and the latter by a Lagrange multiplier (LM) test.  $r$  denotes the cointegration rank.

TABLE III: COEFFICIENT ESTIMATES (QUARTERLY DATA)

Country	Analysis		Coefficients					
			bivariate			trivariate		
			<i>e</i>	<i>ca</i>	constant	<i>e</i>	<i>ca</i>	<i>ir</i> constant
Australia	Long-run coefficients		0.948 (14.145)	1	0	1	1	0.44 (0.805) -0.527 (-1)
	Adjustment coefficients	Regime 1	-0.001 (-0.179)	-0.183 (-1.410)		0.004 (1.406)	-0.280 (27.794)	-0.196 (-1.367)
		Regime 2	0.020 (1.040)	-0.579 (-1.835)		0 (0.065)	-0.253 (-2.525)	-0.021 (-0.247)
France	Long-run coefficients		-0.214 (-11.495)	-0.214 (-11.495)	1			
	Adjustment coefficients	Regime 1	0.005 (1.314)	0.994 (0.170)				
		Regime 2	-0.040 (-2.577)	4.170 (3.854)				
Germany	Long-run coefficients		1	-0.002 (-0.766)	-4.604 (-433.942)	1	-0.008 (-2.142)	-0.008 (-2.142) -4.541 (-176.002)
	Adjustment coefficients	Regime 1	-0.208 (-0.852)	-2.902 (-0.293)		-0.124 (2.156)	-0.778 (9.383)	-1.076 (-0.970)
		Regime 2	-0.266 (-0.913)	-1.985 (-0.146)		-0.317 (-2.954)	-6.823 (-1.678)	4.584 (1.189)
Hong Kong	Long-run coefficients		1	0.075 (5.587)	-5.046 (-46.743)	21.947 (4.649)	1	1.343 (6.538) -114.805 (-5.111)
	Adjustment coefficients	Regime 1	-0.017 (-2.233)	-4.801 (-4.612)		0 (-0.787)	0.006 (3.537)	-0.220 (-0.626)
		Regime 2	0.010 (0.625)	-0.574 (-1.648)		5.321 (-0.001)	-0.215 (15.080)	-0.013 (-0.765)
Italy	Long-run coefficients		11.313 (2.711)	1	-51.269 (-2.682)	14.551 (3.973)	1	0 (0) -65.870 (-3.928)
	Adjustment coefficients	Regime 1	0.001 (1.373)	-0.476 (-5.710)		-0.001 (1.892)	-0.444 (7.226)	-0.073 (-0.884)
		Regime 2	-0.000 (-0.036)	-0.244 (-1.056)		-0.003 (-0.344)	-0.362 (-1.100)	0.175 (0.615)
Japan	Long-run coefficients		1	0.458 (4.046)	-5.844 (-18.374)	1	1.137 (5.075)	0.195 (2.254) -8.279 (-10.887)
	Adjustment coefficients	Regime 1	0.018 (0.760)	0.098 (0.289)		0.010 (1.454)	-0.089 (3.183)	0.009 (-0.099)
		Regime 2	0.008 (0.570)	-0.442 (-1.635)		0.011 (2.095)	-0.125 (22.888)	0.060 (1.463)
Korea	Long-run coefficients		7.039 (-1.611)	1.000	-34.106 (-1.654)	1	1	0 -5.871 (-6.443)
	Adjustment coefficients	Regime 1	0.004 (2.599)	-0.201 (-3.840)		1	0	-0.039 (-7.537) -4.401 (-71.946)
		Regime 2	0.001 (0.653)	-0.142 (-1.465)		0.002 (-1.344)	-0.138 (-0.007)	4.868 (-0.061)
Mexico	Long-run coefficients		1	1	-2.990 (-5.974)	1	0.004 (3.529)	0.004 (3.529) -4.697 (-123.442)
	Adjustment coefficients	Regime 1	0.039 (1.839)	-0.171 (-0.853)		-0.207 (0.754)	-0.292 (-0.631)	-2.255 (-0.923)
		Regime 2	0.001 (0.567)	-0.142 (-2.906)		-0.248 (3.259)	-0.403 (-0.301)	3.227 (0.786)
UK	Long-run coefficients		1	1	-3.129 (-7.288)	0.535 (4.033)	1	-0.087 (-1.174) 0
	Adjustment coefficients	Regime 1	-0.003 (-1.202)	-0.364 (-2.655)		-0.002 (4.910)	-0.172 (-0.063)	-0.153 (15.788)
		Regime 2	-0.001 (-0.292)	-0.122 (-1.212)		-0.001 (1.986)	-0.336 (-3.257)	0.021 (0.551)
USA	Long-run coefficients		1	0.038 (1.755)	-4.522 (-69.223)	1	0.045 (4.427)	-0.024 (-5.192) -4.399 (-93.499)
	Adjustment coefficients	Regime 1	-0.695 (-1.792)	0.609 (0.088)		-0.015 (1.647)	-1.318 (10.862)	-1.976 (-1.292)
		Regime 2	-0.013 (-0.368)	-0.751 (-3.361)		-0.048 (-0.654)	-1.576 (-3.027)	-0.174 (-0.225)
Global	Long-run coefficients		0.171 (2.403)	1	-0.849 (-1.588)	0.215 (3.516)	1	0 -0.855 (-1.820)
	Adjustment coefficients	Regime 1	-0.057 (-0.111)	-0.330 (-0.829)		1	0	-0.914 (-3.898) 0
		Regime 2	-0.085 (-0.173)	-0.303 (-0.729)		0.015 (0.991)	-0.410 (-0.083)	-0.258 (11.513)
						-0.034 (0.151)	0.071 (1.004)	0.071 (0.117)
						0.144 (2.097)	0.134 (0.086)	3.161 (1.541)
						-0.142 (4.524)	-0.049 (-0.062)	-1.310 (-0.841)

Note: The table reports long-run and adjustment coefficients with *t*-statistics in parentheses. *e* denotes the effective exchange rate, *ca* denominates the current account, and *ir* gives the interest rate. The term global corresponds to the common factors of the variables.

TABLE IV: TRACE TESTS AND AUTOCORRELATION TESTS (MONTHLY DATA)

Country	Tests	$p$ -values
France	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.010
		$H_0 : r \leq 2$ 0.045
	AC test	LM(1) 0.000
		LM(2) 0.128
		LM(3) 0.110
		LM(4) 0.217
Germany	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.093
	AC test	LM(1) 0.003
		LM(2) 0.357
		LM(3) 0.156
		LM(4) 0.116
Hong Kong	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.000
		$H_0 : r \leq 2$ 0.352
	AC test	LM(1) 0.116
		LM(2) 0.000
		LM(3) 0.116
		LM(4) 0.104
Italy	Trace test	$H_0 : r = 0$ 0.014
		$H_0 : r \leq 1$ 0.349
	AC test	LM(1) 0.001
		LM(2) 0.017
		LM(3) 0.017
		LM(4) 0.210
Japan	Trace test	$H_0 : r = 0$ 0.031
		$H_0 : r \leq 1$ 0.233
	AC test	LM(1) 0.000
		LM(2) 0.009
		LM(3) 0.071
		LM(4) 0.228
Korea	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.000
		$H_0 : r \leq 2$ 0.009
	AC test	LM(1) 0.000
		LM(2) 0.153
		LM(3) 0.082
		LM(4) 0.408
Mexico	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.067
	AC test	LM(1) 0.000
		LM(2) 0.000
		LM(3) 0.029
		LM(4) 0.050
UK	Trace test	$H_0 : r = 0$ 0.001
		$H_0 : r \leq 1$ 0.059
	AC test	LM(1) 0.000
		LM(2) 0.074
		LM(3) 0.057
		LM(4) 0.958
USA	Trace test	$H_0 : r = 0$ 0.009
		$H_0 : r \leq 1$ 0.256
	AC test	LM(1) 0.000
		LM(2) 0.063
		LM(3) 0.137
		LM(4) 0.164
Global	Trace test	$H_0 : r = 0$ 0.000
		$H_0 : r \leq 1$ 0.735
	AC test	LM(1) 0.150
		LM(2) 0.021
		LM(3) 0.039
		LM(4) 0.164

Note: See Table II for details.

TABLE V: COEFFICIENT ESTIMATES (MONTHLY DATA)

Country	Analysis		Coefficients					
			$e_t$	$tb_t$	$\tilde{y}_t$	$\tilde{ir}_t$	constant	
France	Long-run coefficients		1		-0.486 (-5.849)	0.018 (5.379)	-4.233 (-57.259)	
			1	-0.039 (-4.231)			-3.659 (-16.633)	
	Adjustment coefficients	Regime 1	0.002 (0.147)	-1.031 (-0.472)	-0.024 (-1.795)	-3.045 (-2.421)		
			-0.001 (-0.170)	0.379 (0.547)	0.006 (1.391)	1.031 (2.400)		
		Regime 2	0.011 (0.691)	-3.424 (-1.182)	0.006 (0.279)	-1.541 (-1.438)		
			-0.004 (-0.717)	1.095 (1.155)	-0.004 (-0.595)	0.521 (1.436)		
Germany	Long-run coefficients		1	-0.003 (-2.971)		0.007 (2.251)	-4.562 (-353.995)	
	Adjustment coefficients	Regime 1	-0.015 (-1.054)	-0.521 (-0.322)	-0.075 (-3.680)	-3.177 (-3.622)		
		Regime 2	-0.024 (-2.149)	1.125 (0.407)	-0.016 (-0.955)	-0.509 (-1.368)		
	Hong Kong	Long-run coefficients		1	0.013 (2.351)		0.041 (8.022)	-5.013 (-130.267)
			22.167 (27.323)		1		-116.458 (-29.943)	
Adjustment coefficients		Regime 1	-0.001 (-1.548)	-8.453 (-1.599)	-0.000 (-1.582)	-0.017 (-1.117)		
			0.000 (0.615)	10.655 (0.926)	-0.001 (-3.797)	0.007 (0.599)		
		Regime 2	-0.000 (-0.153)	-3.399 (-0.853)	0.000 (0.186)	-0.001 (-0.255)		
			-0.000 (-0.463)	41.387 (2.022)	-0.001 (-2.400)	0.001 (0.141)		
Italy		Long-run coefficients		-0.043 (-3.116)	-0.043 (-3.116)	1	-0.048 (-7.344)	0.172 (2.551)
		Adjustment coefficients	Regime 1	0.003 (0.604)	-0.504 (-1.222)	0.003 (0.343)	1.424 (1.902)	
	Regime 2		0.001 (0.157)	-0.406 (-0.950)	0.014 (2.347)	0.599 (0.931)		
	Japan	Long-run coefficients		1	1		3.723 (7.289)	
Adjustment coefficients		Regime 1	0.000 (1.542)	-0.006 (-0.807)	0.000 (-2.322)	-0.023 (-2.375)		
		Regime 2	0.000 (1.963)	0.006 (0.637)	0.000 (0.295)	-0.003 (-0.755)		
Korea		Long-run coefficients		1		0.152 (5.413)		-4.709 (-158.448)
			1	0.234 (6.261)		0.073 5.259	-5.319 (-64.016)	
	Adjustment coefficients	Regime 1	-0.027 (-2.237)	0.040 (0.065)	-0.057 (-4.807)	0.224 (0.487)		
			0.009 (1.742)	-0.528 (-1.856)	0.000 (-0.005)	-0.103 (-0.376)		
		Regime 2	-0.015 (-1.612)	-0.268 (-1.061)	-0.031 (-3.148)	1.745 (2.768)		
			0.007 (1.736)	-0.014 (-0.076)	-0.013 (-2.388)	-1.074 (-3.122)		
Mexico	Long-run coefficients		1	0.238 (4.253)	-3.725 (-5.398)	-0.007 (-3.339)	-4.541 (-87.019)	
	Adjustment coefficients	Regime 1	0.010 (0.576)	-0.380 (-3.256)	0.008 (1.864)	-0.426 (-0.252)		
		Regime 2	0.023 (0.428)	-0.396 (-1.650)	0.025 (2.418)	-2.414 (-0.452)		
	UK	Long-run coefficients		-0.019 (-3.594)	-0.019 (-3.594)	1	-0.069 (-5.982)	0.047 (1.398)
Adjustment coefficients		Regime 1	0.003 (0.277)	0.319 (0.338)	-0.014 (-2.521)	0.089 (0.435)		
		Regime 2	-0.017 (-1.764)	-0.483 (-1.084)	0.003 (0.614)	1.697 (4.334)		
USA		Long-run coefficients		1	0.010 (3.265)		-0.104 (-5.426)	-3.708 (-20.810)
	Adjustment coefficients	Regime 1	-0.004 (-1.163)	-1.722 (-2.835)	0.001 (1.038)	-0.027 (-0.388)		
		Regime 2	-0.007 (-1.602)	-0.687 (-1.360)	0.006 (3.475)	0.314 (2.002)		
	Global	Long-run coefficients		-0.206 (-1.906)	-2.001 (-1.687)	0.198 (2.011)	1	-5.429 (-2.019)
Adjustment coefficients		Regime 1	0.017 (1.245)	0.000 (0.239)	-0.042 (-4.878)	-0.014 (-1.606)		
		Regime 2	0.030 (2.049)	0.002 (0.727)	-0.032 (-3.234)	0.007 (1.468)		

Note: See Table III for details. Moreover,  $tb$  gives the trade balance,  $\tilde{y}$  denotes industrial production relative to the OECD industrial production, and  $\tilde{ir}$  denominates the interest rate relative to the U.S. interest rate.

TABLE VI: MA REPRESENTATION (MONTHLY DATA)

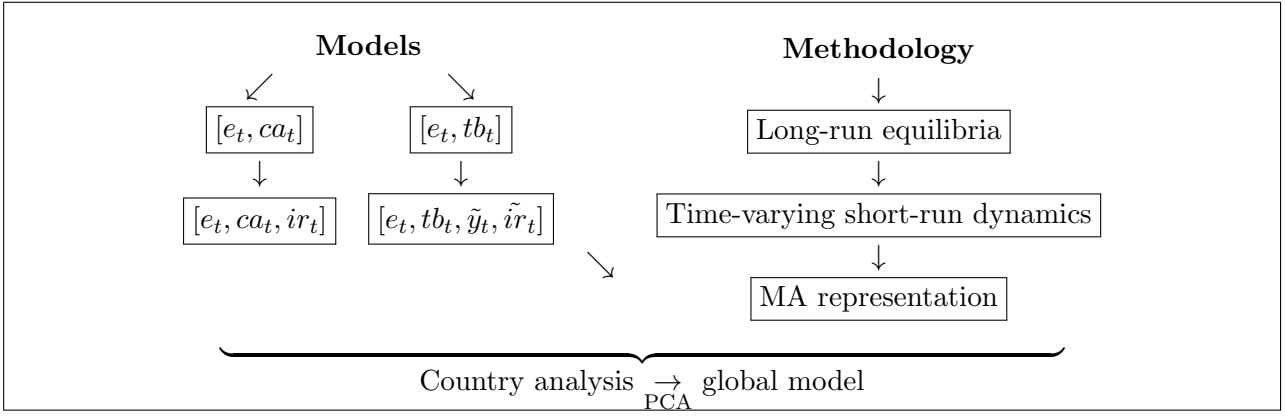
Country		Coefficients			
		$e_t$	$tb_t$	$\tilde{y}_t$	$\tilde{ir}_t$
France	$e_t$	-0.311 (-0.528)	-0.006 (-2.817)	0.267 (3.085)	0.000 (0.075)
	$tb_t$	-46.027 (-1.099)	0.359 (2.232)	3.571 (0.582)	-0.174 (-1.011)
	$\tilde{y}_t$	-2.089 (-1.192)	-0.008 (-1.225)	0.837 (3.260)	-0.004 (-0.570)
	$\tilde{ir}_t$	-11.807 (-0.528)	-0.242 (-2.817)	10.107 (3.058)	0.007 (0.075)
Germany	$e_t$	0.498 (3.120)	0.001 (4.200)	-0.006 (-0.296)	0.005 (-4.243)
	$tb_t$	4.798 (0.145)	0.635 (10.612)	4.203 (1.043)	-0.098 (-0.417)
	$\tilde{y}_t$	-1.024 (-2.599)	0.002 (2.256)	0.631 (13.180)	-0.005 (-1.709)
	$\tilde{ir}_t$	-64.984 (-3.472)	0.123 (3.693)	2.667 (1.172)	0.603 (4.546)
Hong Kong	$e_t$	0.760 (0.517)	-0.001 (-0.539)	-0.146 (-1.124)	0.002 (0.343)
	$tb_t$	57.571 ((0.510))	0.346 (2.414)	2.858 (0.288)	0.107 (0.271)
	$\tilde{y}_t$	-16.840 (-0.517)	0.022 (0.539)	3.227 (1.124)	-0.039 (-0.343)
	$\tilde{ir}_t$	-36.476 (-0.520)	-0.082 (-0.925)	2.688 (0.435)	-0.076 (-0.311)
Italy	$e_t$	1.523 (12.034)	-0.005 (-1.694)	0.074 (0.945)	-0.007 (-1.043)
	$tb_t$	4.256 (0.779)	0.699 (5.549)	-7.240 (-2.183)	0.383 (1.366)
	$\tilde{y}_t$	-0.031 (-0.279)	-0.004 (-1.664)	0.694 (10.335)	-0.009 (-1.564)
	$\tilde{ir}_t$	-5.854 (-0.901)	-0.712 (-4.763)	20.868 (5.301)	-0.522 (-1.571)
Japan	$e_t$	1.251 (9.787)	0.005 (2.049)	0.096 (0.572)	0.062 (2.326)
	$tb_t$	4.888 (1.759)	0.631 (11.045)	7.853 (2.155)	0.618 (1.072)
	$\tilde{y}_t$	-0.033 (-1.101)	0.000 (-0.030)	0.751 (19.313)	-0.003 (-0.508)
	$\tilde{ir}_t$	-0.895 (-2.153)	-0.093 (-10.856)	-1.159 (-2.126)	-0.099 (-1.149)
Korea	$e_t$	0.321 (2.474)	0.007 (2.013)	-0.098 (-3.715)	0.003 (1.892)
	$tb_t$	-9.334 (-2.198)	0.245 (2.292)	-2.309 (-2.662)	-0.132 (-2.282)
	$\tilde{y}_t$	-2.111 (-2.474)	-0.043 (-2.013)	0.648 (3.715)	-0.022 (-1.892)
	$\tilde{ir}_t$	25.719 (1.896)	-0.883 (-2.581)	8.810 (3.179)	0.381 (2.057)
Mexico	$e_t$	1.026 (15.618)	0.017 (1.421)	-0.256 (-1.073)	0.000 (0.010)
	$tb_t$	-3.073 (-7.974)	0.195 (2.711)	9.084 (6.262)	0.026 (4.528)
	$\tilde{y}_t$	0.105 (4.425)	0.020 (4.475)	0.437 (4.869)	-0.002 (-4.389)
	$\tilde{ir}_t$	-13.437 (-2.239)	-1.415 (-1.261)	37.137 (1.643)	1.636 (18.442)
UK	$e_t$	1.262 (12.779)	0.002 (1.223)	0.142 (1.021)	0.015 (1.910)
	$tb_t$	-4.654 (-1.375)	0.547 (12.727)	3.576 (0.750)	0.134 (0.500)
	$\tilde{y}_t$	-0.116 (-2.987)	0.000 (-0.324)	0.738 (14.354)	0.001 (0.370)
	$\tilde{ir}_t$	-0.739 (-0.732)	-0.125 (-11.863)	10.257 (7.214)	-0.024 (-0.305)
USA	$e_t$	0.774 (3.923)	-0.002 (-1.517)	0.077 (0.317)	0.035 (2.361)
	$tb_t$	-44.694 (-2.512)	0.461 (5.087)	91.534 (4.170)	3.378 (2.547)
	$\tilde{y}_t$	0.184 (2.380)	0.001 (2.042)	0.956 (10.033)	-0.011 (-1.908)
	$\tilde{ir}_t$	3.352 (1.228)	0.027 (1.969)	9.078 (2.696)	0.641 (3.149)

Note: The table reports the coefficient estimates for the long-run matrix  $C$  of the moving average (MA) representation of the cointegrated VAR model.  $e$  denotes the effective exchange rate,  $tb$  denominates the trade balance,  $\tilde{y}$  gives industrial production relative to the OECD industrial production, and  $\tilde{ir}$  represents the interest rate relative to the U.S. interest rate.

Table VI <i>continued</i>					
Country		Coefficients			
		$e_t$	$tb_t$	$\tilde{y}_t$	$\tilde{ir}_t$
Global	$e_t$	1.011 (5.578)	-1.428 (-1.960)	0.738 (3.023)	1.143 (2.527)
	$tb_t$	-0.009 (-0.760)	0.558 (11.949)	-0.013 (-0.848)	-0.009 (-0.295)
	$\tilde{y}_t$	0.552 (4.154)	1.838 (3.442)	0.345 (1.930)	-0.982 (-2.961)
	$\tilde{ir}_t$	0.057 (0.406)	0.133 (0.237)	0.064 (0.337)	1.677 (4.800)

## Figures

FIGURE I: MODEL CYCLE



*Note:*  $e$  denotes the effective exchange rate,  $ca$  denominates the current account, and  $ir$  gives the interest rate. Moreover,  $tb$  represents the trade balance,  $\tilde{y}$  denotes industrial production relative to the OECD industrial production, and  $\tilde{ir}$  denominates the interest rate relative to the U.S. interest rate. PCA stands for principal component analysis.

FIGURE II: EFFECTIVE EXCHANGE RATES AND CURRENT ACCOUNTS

