Equilibrium Real Exchange Rates and Real Exchange Rate Misalignments: Time Series vs. Panel Estimates

Oliver Hossfeld*

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PRELIMINARY

Abstract

This paper applies the Behavioral Equilibrium Exchange Rate Approach (BEER) developed by Clark and MacDonald (1998) to derive equilibrium exchange rates for the US and its major 16 trading partners over 1986Q1 to 2006Q4. Cointegration and panel cointegration techniques are applied to derive fully country-specific measures of misalignment and country-specific measures based on the panel estimates. Using estimates based on a restricted sample, forecasting tests are conducted to assess the relative forecasting performance of the two approaches. Based on these results, a final specification is estimated and real effective exchange rate misalignments are calculated.

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*Address: Sparkassen-Finanzgruppe-Lehrstuhl für Makroökonomie, HHL - Leipzig Graduate School of Management, Jahnallee 59, 04109 Leipzig, Germany. Email: oliver.hossfeld@hhl.de. I thank participants of the DIW macroeconometric workshop in Berlin for many helpful comments and discussions.

1 Introduction

Since its peak value in April 2002 the real value of the US-Dollar has declined steadily, reaching an overall decline of more than 20 percent in early 2008. The question naturally arises whether this drop of the US Dollar and the simultaneous rise and fall of other currencies are in line with underlying fundamentals (if there are any) and so represents movements of the equilibrium exchange rates, or whether they are caused by other factors such as currency speculation. The enormous increase of the US net foreign liabilities (see figure 2 in the appendix), turning the US from the world's largest creditor into the world's largest debtor, raised the question whether the real value of the US Dollar dropped in order to correct this global imbalance and if so, how much more there is to come.

An exchange rate is called 'misaligned' if its movements cannot be related to movements of the underlying 'fundamentals'. Sustained periods of real exchange rate misalignment (especially of overvaluation) have been shown to be detrimental to growth over the medium and long run.[1] Assessing periods of misalignments and identifying fundamental determinants of real effective exchange rate clearly is not only of interest for academics, but also for multilateral institutions, government agencies and the private sector (Edwards and Savastano, 1999). To assess the 'fundamentally justified' value of a specific currency, various concepts have been applied, the most popular being the Behavioural Equilibrium Exchange Rate (BEER) Approach developed by Clark and MacDonald (1998), the Fundemantal Equilibrium Exchange Rate (FEER) Approach by Williamson (1994) and the Natural Real Exchange Rate (NATREX) Approach by Stein (1994). Whereas the latter two concepts are normative and involve ad-hoc judgements on the size of central parameters, the BEER approach, which we will focus on, is rather statistical and free of normative elements.

However, overviewing the literature on the BEER approach reveals that there is quite a lot of discretion when it comes to selecting possibly relevant fundamentals. Commonly chosen determinants include net foreign assets,

[1] See Edwards and Savastano (1999) and the references therein.

measures of relative[2] productivity differentials, relative terms of trade, measures of the the openness of a country to account for trade-restrictions, the relative stock of government debt and real interest rate differentials[3].

Exisiting studies furthermore differ in the choice of the dependent variable (real exchange rate (RER) or real effective exchange rate (REER)), the time-frequency, and the applied estimation method. Until the mid 1990s authors have focused on cointegration analysis in a pure time series context to estimate the equilibrium REER for a specific country; recently, more authors have taken a panel perspective to identify the real determinants of the REER and to calculate country-specific misalignments. We examine whether the fully country-specific estimates or the country-specific estimates derived from a panel can be regarded as being 'more reliable' in assessing the 'fair' real value of a currency. In the context of the monetary model of exchange rate determination and therefore with respect to nominal exchange rates, Rapach and Wohar (2004) find out-of-sample forecasts obtained from a panel to be superior to those derived from country-specific estimates, although the poolability hypothesis is rejected. We check whether this result also holds in our case. Based on this reliability assessment we choose a final specification to calculate currency misalignments.

Apart from that issue we hope to shed new light on the fundamental determinants of real exchange rates in general, and be able to relate these to the recent sharp movements of the US Dollar.

This paper is structured as follows: Section 2 reviews the BEER concept and discusses the choice of the fundamental determinants. Section 3 presents the data and its univariate properties. Section 4 describes the estimation methodology. Section 5 summarizes the results obtained for the fully country-specific specifications over a restricted sample from 1986Q1 to 2002Q4. Section 6 presents the estimates for a 15-countries panel over the same sample. In Section 7 these results are used to conduct conditional forecasts within the reserved part of the sample (2003Q1 to 2006Q3) keeping

[2]The term 'relative' here means relative to the trade-weighted average of the respective variables of the partner countries.

[3]Less frequently, also the real oil price (especially for emerging market countries) has been considered. See Amano and van Norden (1997).

the estimated parameters fixed. Based on these results a final specification is chosen, which is re-estimated over the full sample to calculate REER misalignments. Estimated equilibrium exchange rates and misalignments are presented in section 8. Section 9 concludes.

2 The BEER Concept and the Choice of Fundamentals

In this section we will present some stylized facts about the origins of the BEER concept and shortly present its theoretical foundations. For extensive surveys on the BEER concept and related concepts (such as CHEER, FEER, ITMEER, NATREX) we refer to Driver and Westaway (2005) and MacDonald (2000). The BEER concept arised from the discomfort with Purchasing Power Parity (PPP) as a reasonable explanation for the observed real exchange rate behaviour. Shocks to the real exchange rate have been found to be too persistent to be accordant with PPP (the so called 'PPP-puzzle'[4]), 'typical' half-life estimates to shocks to PPP being around 4 years. The very slow mean reversion speeds therefore provide at best support for an "ultra-long-run" concept of equilibrium exchange rates.[5] Sometimes even no significant mean reversion has been found.[6] From a theoretical point of view PPP has been critized as a concept for determining the equilibrium exchange rate, because it completely ignores the role of capital flows and any real determinants of the real exchange rate[7]. The aim of the BEER approach is on the one hand to be better able to relate the observed exchange rate behaviour to movements in certain other variables, and on the other hand to correct the theoretical shortcomings of PPP as a method for determining equilibrium exchange rates. A general problem relating to equilibrium exchange rates is that this variable is not observable. Consequently, estimated long-run relationships between the *observed* real exchange rate and the fundamentals

[4]See Rogoff (1996).
[5]See Edwards and Savastano (1999).
[6]Surveys can be found in MacDonald (2000), Taylor and Taylor (2004).
[7]See MacDonald (2000).

are assumed to equal the equilibrium exchange rate[8], towards which the real exchange rate adjusts.[9]

The BEER approach is derived from the real interest parity condition (thereby accounting for capital flows) and – assuming that the expected future real exchange rate is a function of fundamental variables – also takes into account real determinants.

Following, we shortly present the theoretical concept based on MacDonald (2000):

Starting point is the risk-adjusted real UIP condition (which is totally disregarded in the concept of PPP):

$$\Delta q^{e}_{t+k} = -(r_t - r^*_t) + \lambda_t \tag{1}$$

where q_t denotes the real exchange rate, e the expectations operator, r_t the ex-ante real interest rate and λ_t a risk premium. The real exchange rate is expressed in foreign currency units per unit of domestic currency, so that an increase represents a (real) appreciation of the domestic currency.

Rearranged for the real exchange rate we have:

$$q_t = q^{e}_{t+k} + (r_t - r^*_t) - \lambda_t \tag{2}$$

As the expected real exchange rate is unobservable, this relationship is hard to test empirically; q^{e}_{t+k} is therefore interpreted as the fundamental or 'long-run' component of the real exchange rate, denoted $\overline{q}_t$. Substituting into (2) yields:

$$q_t = \overline{q}_t + (r_t - r^*_t) - \lambda_t \tag{3}$$

In a popular stock-flow consistent model of exchange rate determination, Faruqee (1995) identifies the stock of net foreign assets and a set of exogenous variables as fundamental determinants of the equilibrium (or 'long-run') ex-

[8]See Égert (2004).

[9]Funke and Rahn (2005) describe the BEER as the *data-determined systematic component of the exchange rate in the medium and long run.*

change rate. In an extension of this model, Alberola et al. (1999) decompose the real exchange rate into an external and an internal real exchange rate, both of which relating to one specific theory of exchange rate determination. The external rate is defined as the ratio of the price of domestic relative to foreign tradable goods and is connected to the notion of external balance, whereas the internal rate is defined as the relative price of non-tradable goods to tradable goods within each country and connected to the notion of internal balance. The equilibrium exchange rate is the one at which external and internal balance are achieved, i.e. the tradable goods market is cleared (and the desired net foreign asset position achieved), and there is no excess demand for non-tradable goods.[10]

We will not go into any model-specific details here, but instead give some comprehensive motivation for the inclusion of specific fundamentals, which are hypothesized to account for the time-varying value of the real exchange rate, and which are theoretically founded by one model or another or are commonly used in the literature in an ad-hoc style. For model-specific derivations we refer to Frenkel and Mussa (1985), Faruqee (1995), Chinn and Johnston (1997), Alberola et al. (1999) and MacDonald and Wójcik (2004).

Net Foreign Assets (+)

The effect of a country's net foreign asset position on the equilibrium exchange rate is expected to be positive. According to standard intertemporal macroeconomic models a higher stock of net foreign liabilities causes interest payments to increase, which ultimately have to be paid for by improved trade balances. In order to generate higher net exports, the competitiveness of the respective country has to improve, neccessitating a depreciation of the real exchange rate.

Productivity Bias (+)

According to the well-known Balassa-Samuelson (BS) hypothesis, relatively larger increases in productivity in the tradeable goods sector

[10]The BEER approach therefore includes the same set of fundamentals as the FEER approach. However, the latter implies the calibration of a sustainable current account and therefore follows a normative approach.

compared to the non-tradable goods sector are connected with a real appreciation of the domestic currency. The rise in relative productivity of the tradable goods sector causes wages in the tradable goods sector to increase. Wage equalisation across the sectors ensures that wages in the non-tradable sector also increase (which is not compensated for by an accordant rise in productivity). Consequently, the overall price level is higher and we observe a real appreciation of the equilibrium exchange rate.

Demand Side Bias (+/-)

According to Genberg (1978), Bergstrand (1991) and MacDonald (1998) the presence of non-traded goods can furthermore introduce a demand side bias, if the income elasticity of demand for non-traded goods is greater than 1. As government consumption is primarily devoted to non-traded goods (compared to private consumption), a rise in government consumption (or a redistribution of income towards the government) therefore increases the relative price of non-tradable goods and causes the equilibrium exchange rate to appreciate.[11] On the other hand, a growing budget deficit may also destabilize the economy and lead to a real depreciation.[12]

Relative Terms of Trade (+/-)

When traded goods are imperfect substitutes, their relative price might change due to changes in supply and demand caused by changes in underlying determinants such as consumer preferences or differing growth rates[13]. Import and export price indices will be affected differently across countries, thereby changing the relative terms of trade. The effect of terms of trade shocks to the real exchange rate is however ambiguous[14].

[11] See Chinn (1997) for a formal implementation of this argument in a real exchange rate model.

[12] See Melecký and Komárek (2007).

[13] See Nilsson (2004) and Edwards (1989).

[14] See Meleckỳ and Komárek (2005).

On the one hand, an increase in the (relative) prices of a country's export goods gives rise to a positive substitution effect, because domestic producers shift their production towards tradable goods. This will cause wages in this sector to increase relative to the ones in the non-tradable goods sector. If wages subsequently equalize across the sectors, this will push up the overall price level. On the other hand, an improved trade balance (generated by the more favorable terms of trade) will generate a positive wealth effect, and thereby induce an increase in the demand for non-tradable goods. In order to generate internal equilibrium, the real effective exchange rate has to depreciate.

Openness (-)

Openness is sometimes introduced as a proxy for trade liberalization. A higher degree of openness is expected to reflect a decrease in trade barriers, which is supposed to stimulate imports more than exports and consequently foster a real depreciation.[15] As emphasized by Dufrenot and Yehoue (2005) this variable is more likely to be relevant for developing or emerging countries than for industrial ones, since we would not expect the degree of openness to vary a lot for these countries.

3 Data Description and Univariate Properties

Our panel consists of the US and 16 of its major trading partners: Australia, Belgium, Canada, China, France, Germany, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Spain, Sweden, Switzerland and the UK. These countries either make up a a significant part of the trade of the US or are an issuer of a major currency, i.e. their currency circulates widely outside the country of issue. Some countries have not been included in the panel due to too much missing data for some of the relevant variables (Taiwan, Singapore, Hong Kong, Malaysia, and Brazil). The sample consists of quarterly data from 1986Q1 to 2006Q4. For some variables and countries, we had to use data interpolation techniques to obtain quarterly data. All variables except

[15] See Elbadawi (1994).

for the net foreign asset to GDP ratio, the trade balance to GDP ratio and the openness ratio are measured relative to the trade-weighted average of the respective variables of the trading partner countries. Trading weights are constant throughout the sample and are taken from Bayoumi et al. (2005). Reference period for calculating these weights was 2002/2003 and weights take into account direct bilateral competition as well as 'third-market competition'[16]. The trade-weights for the included countries (scaled to 100) are presented in table 1 of the appendix. Although the countries have been chosen with special regard to the US, table 2 shows that all countries included in the panel make up a significant proportion of trade for each of the other countries (ranging from 69 percent for Sweden to 90 percent for Mexico). So we believe that the results are meaningful for all countries.

Data is taken from IMF International Financial Statistics (IFS) unless stated differently. All series are depicted in figures 1 to 7 in the appendix. Exchange rates are defined in indirect quotation so that an increase in the exchange rate implies an appreciation of the domestic currency. Annual Consumer Price Inflation (CPI) for China has been obtained from national sources (National Bureau of Statistics of China), interpolated to quarterly frequency and updated with growth rates from IFS[17]. The **real effective exchange rate *(reer)*** is calculated as the geometric average of the 16 bilateral nominal exchange rate indices multiplied with the respective CPI ratio. Data on net foreign assets is taken from Lane and Milesi-Ferretti (2007) and updated by accumulating current account balances. To scale the variables, we divide these figures by GDP to obtain the **net foreign asset to GDP ratio *(nfa)***. Alternatively, we also use the **trade balance to GDP ratio *(tb)***, which is available at a higher frequency.[18] For China and Ireland annual GDP data had to be converted to quarterly frequency.[19] **Relative terms of**

[16]This term means that countries A and B do not only compete in A and B, but also in country C.

[17]We used the cubic-spline interpolation technique. However, results are robust to other interpolation techniques.

[18]*tb* has first been introduced as a 'substitute' for nfa by *MacDonald and Dias (2007)*. A positive long-run relationship between *nfa* and *reer* implies a negative long-run relationship between *tb* and *reer*.

[19]For Ireland until 1996Q4, for China until 1998Q4 using the quadratic match sum-

trade ***(tot)*** are defined as the ratio of the domestic export unit value and the domestic import unit value divided by the geometrically weighted (using the same weights as above) foreign ratios. The **relative productivity differential** ***(ntt)*** is proxied by the ratio of the domestic CPI to the domestic WPI divided by the geometrically weighted foreign ratios. The real interest rate is calculated as the difference between the nominal long-term interest rate and the percentage change of the CPI index compared to its value in the same quarter in the year before. Nominal long-term interest rates are partly taken from sourceOECD. For China the lending rate had to be taken instead, and for Mexico, the 3-month treasury bill rate until 1989Q4[20]. The **real interest rate differential** ***(rird)*** is then calculated as the difference between the domestic real interest rate and the trade-weighted arithmetic average real interest rate of the trading partners. **Relative government consumption** ***(gov)*** is defined as the domestic government consumption to GDP-ratio relative to the trade-weighted ratios of government consumption to GDP-ratios of the trading partners. **Openness** ***(open)*** is defined as the ratio of the sum of exports and imports (in absolute values) to GDP.

To assess the order of integration of the involved time series, we employ four different panel unit root tests: Levin et al. (2002), Im et al. (2003), Maddala and Wu (1999) and Choi (2001). The tests predominantly differ in their formulation of the alternative hypothesis. Whereas the test developed by Levin et al. (2002) assumes common unit root processes across the cross-section units, i.e. it implies that the autoregressive coefficient is the same for all cross section units, the others allow for cross-section heterogeneity and differing autoregressive coefficients across the units. In contrast to the other tests, the ones by Maddala and Wu (1999) and Choi (2001) combine the p-values of the individual unit root tests. For more details about panel unit root tests we refer to the extensive survey article by Breitung and Pesaran (2005). In addition to the more powerful panel unit root tests, we also use individual unit root tests. We do so in order to put ourselves in the position

procedure.

[20] One missing value for Mexico for 1986Q3 was taken as the average of the preceeding and the succeeding quarter.

of a researcher who solely relies on time-series analysis.

For the series in levels we include individual intercepts and trends (when appropriate), whereas we include only an intercept for the series in first differences (for the test results see table 3). We first started with all 17 countries included in the panel. Results for the order of integration of the *reer* were borderline then however. Looking at the country-specific individual unit root test results revealed that the *reer* of Mexico and Switzerland are (trend)stationary. We decided to exclude these countries from the subsequent analysis in order not to generate more heterogeneity in the panel than necessary. Repeating the panel unit root tests to the smaller panel of 15 countries revealed that the *reer* is now clearly found to be I(1) at the 5 percent level. We therefore think that the 'borderline' result was caused by the excluded two countries.

nfa and *gov* are also I(1) processes accoring to all test results. For *tb* and *open* only one of the 4 test results points towards stationarity and only at the 10 percent level. We therefore also treat these series as I(1). *tot* and *rird* on the other hand seem to be stationary. *ntt* is the only borderline result we obtain for the 15-countries panel. Whereas we cannot reject the null hypothesis of a unit root at the 5 percent level according to the Levin, Lin and Chu test and the Fisher-ADF test, we can reject the null according to both other tests. We decide also to treat this variable as non-stationary in levels in the subsequent analysis. Individual unit root tests (ADF and DF-GLS tests proposed by Elliott et al. (1996))[21] are not reported in the appendix but can be obtained from the author upon request.

Summarizing, we find *reer*, *nfa*, *tb*, *ntt*, *gov* and *open* to be integrated of order 1, whereas *tot* and *rird* appear to be stationary processes.

4 Estimation Approaches

As outlined above, we will do both, a panel analysis and fully country-specific analyses. Since most of the variables are tested to be I(1), (panel) cointegra-

[21] Elliot et al. (1996) and Ng and Perron (2001) show that this test is more powerful when an unknown trend and/or mean is present.

tion techniques are applied to identify possible long-run relationships between the *reer* and the potential determinants described in section 2. We will employ various techniques to estimate the cointegrating vectors. To ensure the comparability of the results from the fully country-specific estimations with the country-specific results derived from the panel, our analysis will however focus on the dynamic ordinary least squares (D-OLS) approach developed by Saikkonen (1991) and Stock and Watson (1993) and extended to panel analysis by Kao and Chiang (2000). D-OLS incorporates leads and lags of the first differences of the regressors to improve efficiency of the estimates by accounting for the endogeneity of the regressors. First differences of the regressors are included to absorb endogenous feedback effects from the dependent variable to the regressors. The D-OLS estimator is therefore consistent even if regressors are endogenous. In the context of standard time series analysis (without a cross-section dimension), a D-OLS(k_1,k_2) regression can be written as:

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + \sum_{i=1}^{n} \sum_{j=-k_1}^{k_2} \gamma_{i,j} \Delta X_{i,t-j} + \varepsilon_t$$

where k_1 and k_2 denote the numbers of leads and lags, which can be chosen according to various information criteria. We present only estimates from D-OLS(1,1) regressions as the results turned out to be very robust against the inclusion of further leads and lags. As the D-OLS approach automatically induces serial correlation among the residuals, we additionaly use the Newey-West method to obtain undistorted standard errors[22]. To assess the robustness of the results, we also used another single equation approach, namely the fully-modified ordinary least squares (FM-OLS) proposed by Phillips and Hansen (1990), and (in the case of the country specifications) the multivariate Johansen approach, which endogenizes all the variables.[23]

[22]For further information on D-OLS see Ricci et al. (2008) and Babetskii and Égert (2005)

[23]The clear advantage of the Johansen approach is that it explicitly takes into account possible endogeneity among the variables, which is very likely to be present. For instance, one might expect reverse causality between the REER and the productivity differential or the net foreign asset ratio. For more details see Page (2006). A problem with respect

In the panel analysis, panel cointegration tests are used to assess whether a certain set of variables follows a common stochastic trend. In the time series analysis we follow the Engle-Granger Two-Step Approach to assess whether a given set of variables is cointegrated.[24] We calculate critical values for the Engle-Granger cointegration tests from the response surface function presented in MacKinnon (1990) to check whether the residuals from the 'long-run relationship', $\upsilon_t = Y_t - \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t}$, are indeed stationary.[25] If not, then the null of no cointegration cannot be rejected.

In our analysis we do not only consider specifications, in which *tb* or *nfa* and *all* other variables are included, but also check whether we find evidence in favor of cointegration among different subsets of the variables. We do so, because – given different models and specifications examined in the literature –, it is à priori not clear, which specification is the most appropriate and which fundamentals should be included. Or as Égert (2004) puts it:

> *Across different papers, the whole gamut of fundamentals is used, and, as a corollary, the outcome is sensitive to which particular fundamentals are included in the estimated model. The use of different fundamentals may be a result of different theoretical frameworks or may simply reflect ad hoc choices.*

5 Fully Country-Specific Results

In table 4 we present a selection of the country-specific D-OLS results together with heteroscedasticity and autocorrelation consistent (HAC) standard errors. The selection is based on three qualifications: First, all series included in the specification have to be tested I(1) in the individual countries' unit root tests, second, the residual of the cointegrating vector has to

to the Johansen procedure is that any possible misspecification in one of the underlying simultaneous equations will translate into the others, thereby also invalidating these point estimates. Results obtained from the Johansen approach can be obtained from the author upon request.

[24] We follow this approach because the residuals obtained from a possible cointegrating vector obtained using D-OLS will surely deviate from those using the Johansen approach.

[25] The critical values are calculated according to $C(p) = \varphi_\infty + \varphi_1 T^{-1} + \varphi_2 T^{-2}$.

be stationary, and third, there has to be mean reversion in the error correction model (ECM) representation, which is further evidence in favor of cointegration and ensures that the regression can be interpreted as a real exchange rate equation. Overall, results are very mixed. First, for four countries (AUS, ESP, FRA, UK) we have not been able to find any specification, fulfilling all the above criteria. Second, we do not find a single specification (containing the same set of explanatory variables) for the remaining countries, possibly pointing towards the heterogeneity of the different BEER equations. The only variable being part of the long-run relationship(s) in all the remaining countries is *ntt*, which we interprete as evidence in favor of the Balassa-Samuelson effect, also because the sign and size of the estimates are sensible (a 1 percent increase leads ceteris paribus to a 0.65 percent to 2.67 percent increase of the *reer*). The trade balance and the net foreign assets to GDP ratio are included in several of the specifications for which the three criteria are fulfilled, but their estimated impact is only very small and so we doubt their economic significance on the basis of the country-specific results. The only other variables which turn out to be both statistically and economically significant in a number of specifications are *gov* and *tot*. The former is connected with a real depreciation of the real effective exchange rate in most cases. The estimated coefficient of *tot* is positive in most specifications thereby providing weak evidence in favor of the substitution effect dominating the income effect. Based on the estimated adjustment parameters of the cointegration residual in the ECM reprentation we furthermore calculate the implied half-life time of deviations from the estimated equilibrium exchange rate.[26] The half-life time within the presented models varies between less than 2 quarters and about 5 quarters for most of the specifications.[27] Summarizing the fully country-specific results, we conclude that it is somewhat tricky to find sensible and robust specifications for the regarded countries. This may either be due to the non-existence of sensible cointegrating vectors,

[26]The half-life time is calculated as $\frac{ln(0.5)}{ln(1+\alpha)}$, where α is the estimated coefficient of the lagged cointegration residuals.

[27]Only in GER and ITA adjustment to shocks is much slower (the implied half-life time is about 3 years for Germany and almost 6 years for Italy).

to the low power of unit root tests in small samples (68 observations) or to imprecise estimates. We now turn to the panel analysis.

6 Panel Results

To assess whether different sets of variables are cointegrated we conduct the widely used panel cointegration test by Pedroni (2001).[28] In total we test 12 different specifications, which are presented in table 5. All specifications include *ntt* as an explanatory variable. The first eight specifications additionaly include either *nfa* or *tb* and are augmented with *gov* and/or *open*. Anticipating the mixed results obtained for these 8 specifications, we also tested for cointegration in 4 smaller specifications without *nfa* or *tb* included.

Evidence in favor of cointegration is the strongest when only *ntt* is considered as a regressor. In this case, 5 of the reported 7 statistics point towards the presence of a cointegrating vector among the variables. If the specification additionaly includes *gov* we can only reject the null of no cointegration in 3 of 7 cases. For three other specifications only 1 of the statistics points towards cointegration, for the remaining 7 specifications we find no evidence for cointegration at all, although the former specifications are restricted cases of the latter.

As stated above, in our panel analysis we also employ the D-OLS estimator in order to generate comparable results.[29] To assess the robustness of the results, we additionally use the Panel FM-OLS estimator proposed by Pedroni. Results turn out to be very similar and can be obtained from the author upon request. In our estimations we allow for country-specific effects and/or common time effects. The former are included because we are likely to observe residual country-specific effects not explained by the other

[28] As this method is residual-based, the normalization of the cointegrating vector (or the choice of exogenous and endogenous variables) is somewhat arbitrary and it is not possible to check for the presence of more than 1 cointegrating relationship. It may be insightful to estimate the equilibrium relationship(s) also within a panel VECM as conducted by Carlsson et al. (2007) in their study on PPP. However, this is left for further research.

[29] For details about this estimator in the panel context see Kao and Chiang (2000) and Mark and Sul (2003).

regressors and second, as the real exchange rates are index numbers, they do not have a common anchor across countries.[30] The latter are included to mitigate the effects of possible cross-sectional dependency.[31]

We report Driscoll and Kray (1998) standard errors, which account for within-group correlation, heteroscedasticity and cross-sectional correlation.[32] Including time effects does not substantially change the point estimates of the other coefficients.

Dynamic OLS (1,1) results are presented in table 6 for the specifications, where at least one of the reported Pedroni test statistics is in favor of rejecting the null of no cointegration – however, given the results of the panel cointegration tests we focus on specifications 9 and 10. This choice is further motivated by the point estimates of the other variables included in the other specifications. In line with the country-specific estimates, the coefficients for these variables are again very small and have only a minimal impact on the predictions. As in the country-specific analysis we find strong evidence for the Balassa-Samuelson effect. If we include *gov* in the specification, the respective coefficient turns out to be negative, implying that an increase in government expenditures causes the real exchange rate to depreciate.

Interpreting the results and the subsequent analysis deserves some caution, because we have to reject the poolability null hypothesis across countries according to the Roy-Zellner test[33] (reported for specifications 9 and 10 at the bottom of table 6).[34] However, in line with Baltagi (2005) and Baltagi and Griffin (1997) we choose to continue our analysis in a pragmatic way by relying on the out-of-sample RMSE performance to decide whether pooling is recommendable or not.

[30] See Ricci et al. (2008).

[31] See Nunziata (2005).

[32] We used the Stata program 'xtscc' by Daniel Hoechle (2007) to provide robust standard errors.

[33] See Roy (1957), Zellner (1962) and Baltagi (2005).

[34] We only tested the slope coefficients of the original regressors (*ntt*, respectively *ntt*, *gov*) for homogeneity across countries, not the ones from the lags and leads of their first differences.

7 Conditional Forecasts

Based on the results of the panel cointegration tests, the plausability of the coefficient estimates, and the limited impact of other variables on the *reer*, we will continue our analysis with the very parsimonious specifications '*reer*, *ntt*' (panel specification 9) and the one additionaly including *gov* (panel specification 10). In the preceeding analysis we used a restricted sample until 2002Q4. The remainder of the sample (2003Q1 to 2006Q4) has been reserved to do conditional forecasts. In this section we conduct conditional forecasts to assess the relative performance of the competing models. The estimated coefficients are held fixed at their in-sample values for the whole ex post forecast evaluation horizon. The interpretation of the results deserves some caution, since forecasting errors may either be attributed to the instability of the estimated parameters in a specific model, or to true misalignments of the real effective exchange rate with respect to its estimated equilibrium values. However, the BEER approach is primarily concerned with explaining the *observed* real effective exchange rate and this intention should also remain valid 'out-of-sample'. We therefore regard a model as superior to another if it provides a better out-of-sample fit.[35] One criterion to assess the relative predictive performance of two competing models (within a specific sample) is to compare their root mean squared errors (RMSE), which are calculated as:

$$\text{RMSE} = \sqrt{\frac{\sum (F_t - A_t)^2}{n}}$$

where F_t is the forecasted value of the REER in period t and A_t its actual value. The lower the RMSE the better is the predictive performance of the model. To combine the RMSEs of two competing models (i,j) into a single number, Theil's U index of inequality is calculated, which is defined as the ratio of the two respective RMSEs:

[35] Considering the limited size of the reserved sample, we certainly cannot be sure, whether this result is robust or simply due to the presence of specific shocks.

$$\text{Theil's U} = \frac{RMSE_i}{RMSE_j} \tag{4}$$

In table 7 Theil's U is calculated for different pairs of models. We compare the RMSEs from the fully-country specific model delivering the best fit in the post-estimation period with the RMSEs which are obtained from panel specifications 9 and 10. As the results obtained from the two panel specifications are similar, we focus our analysis on the parsimonious specification 9. According to the relative RMSE, the homogenous panel specification 9 delivers a better forecasting performance for 8 out of 11 countries, the only exceptions being BEL, CHN and JPN. To test whether the forecasting performance is significantly better, we conduct Diebold Mariano tests, which test the null hypothesis of equal expected forecast accuracy against the alternative of different forecasting ability across models. As only conditional forecasts are conducted, the classical Diebold-Mariano statistic can be used and no correction for possible autocorrelation among the error terms has to be made since there are no overlapping forecasts. According to the test result, the panel delivers significantly better forecasts for 7 countries, the fully country-specific models are significantly better in just two cases (BEL and JPN), although we have given the latter an 'unfair' advantage by choosing the country-specific model with the best 'out-of-sample' fit.

Based on these results, we think that pooling the data provides more robust estimates of the impact of underlying fundamentals on the (observed) real exchange rate, although the poolability hypothesis has been rejected. Given the better performace of the pooled panel models in terms of their RMSE performance, we believe that the reduction in variance achieved by using the (restricted) pooled model outweighs the costs in terms of inducing bias by superimposing identical coefficients.[36]

The subsequent analysis of historic real exchange rate misalignments will therefore be based on the estimates obtained from panel specification 9.

[36] See Baltagi (2005) and the article by Toro-Vizcarronda and Wallace (1968) cited therein. For further details about this method of choosing between pooling across cross sections or not and an application in the finance-growth context see Schiawo and Vaona (2006).

8 Real Effective Exchange Rate Misalignments

To derive currency misalignments, we first re-estimate the chosen panel specification over the full sample. Results are similar compared to the ones obtained over the restricted sample. This underscores the stability of the parameter estimates derived from the panel.[37] Figure 8 shows the estimated equilibrium real effective exchange rates (only based on the long-run relationship, lags and leads of first differences are not included) and the historical real effective exchange rates for all countries. Figure 9 shows the implied percentage overvaluation of the real effective exchange rate compared to its estimated equilibrium value over time. Since the net foreign asset to GDP ratio is not included in our final specification, we cannot tell stories like "the sharp depreciation of the USD within the last 5 years is connected to the growing US external liabilities". Based on our results in the preceeding sections we would rather say that the direct influence of the US net foreign asset position on the real value of the USD is fairly limited. What we observe is that the US *reer* follows the general movements of the estimated equilibrium exchange rate. We find the US Dollar to be undervalued over a long period from 1987 to 1997[38] (reaching about 10 percent in early 1993) and to be overvalued from 2000 to 2003 (with a peak overvaluation of about 13 percent in 2001). Since then we observe a correction towards its estimated equilibrium value. At the end of the sample we find the USD to be very close to its predicted value. For Germany we observe an approximate mirror image of this development. Its equilibrium exchange rate is found to be overvalued between 1990 and 1997 and highly undervalued from 2000 to 2003. At the end of 2006 we see a moderate overvaluation of about 3 percent.[39] End of 2006 we find a number of currencies to be misaligned. The Canadian Dollar, the British Pound and the Australian Dollar are 8, 8, respectively 14 percent

[37] In contrast, re-estimating the fully country-specific models over the full sample sometimes leads to dramatic changes in the size of estimated parameters and even sign changes.

[38] This result is very close to the one by Bénassy-Quéré et al. (2008).

[39] These results are very similar to the ones from Bénassy-Quéré et al. (2008) for the 'synthetic' Euro. So the development of the Deutsche Mark seems to be a good proxy for the Euro, although intra-Eurozone trade has not been netted out and therefore trading weights have not been adjusted accordingly.

overvalued in real terms, whereas we see a strong undervaluation of about 22 percent of the Japanese Yen. In contrast to the widespread view that the the Chinese Renminbi is highly undervalued, we find its real value to be in line with its only identified fundamental.[40]

9 Conlusions

In this paper we have estimated equilibrium real exchange rates and currency misalignments for 15 countries. We derived fully country-specific estimates and country-specific estimates derived from the panel. The forecasting performance of the panel specification has been tested to be significantly better than the one from the pure country specifications, although the poolability hypothesis has been rejected. We therefore think that the assessment of Rapach and Wohar (2004) with regard to the trustworthiness of panel vs. pure time series estimates generalizes to real (effective) exchange rates. The only variable identified to have a statistically and economically significant influence on the real effective exchange rate is the relative productivity differential, lending strong empirical support for the Balassa-Samuelson hypothesis. End of 2006 we find two currencies to be significantly overvalued: the Australian and the Canadian Dollar. On the other side, we find the Japanese Yen to be more than 20 percent undervalued. A possible extension to this analysis would be to test whether the RMSE performance is higher for models derived from subpanels for which the null hypothesis of poolability cannot be rejected. For our panel of 15 countries another 32751 sub-panels consisting of at least two countries could be tested with the help of an iterative procedure.

[40]However, this may be a good example for the limitations of the BEER approach, as it does not (and cannot) take into account that a currency might be over- or undervalued over the full sample. As the BEER approach is residual-based approach of misalignment on average over- and undervaluations cancel each other out. In order to minimize the importance of this drawback, the sample should generally be as long as possible, since it makes persistent over- and undervaluations throughout the sample less likely.

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Table 1: Trade Weights for Panel

	AUS	BEL	CAN	CHN	FRA	GER	IRL	ITA	JPN	KOR	MEX	NLD	ESP	SWE	CHE	UK	US
AUS	0,000	0,022	0,029	0,090	0,044	0,089	0,013	0,047	0,180	0,053	0,011	0,023	0,017	0,018	0,016	0,079	0,269
BEL	0,008	0,000	0,014	0,028	0,164	0,206	0,019	0,088	0,047	0,012	0,008	0,077	0,048	0,023	0,022	0,117	0,121
CAN	0,006	0,008	0,000	0,032	0,020	0,033	0,005	0,016	0,051	0,015	0,031	0,009	0,007	0,005	0,005	0,026	0,732
CHN	0,017	0,015	0,031	0,000	0,041	0,087	0,006	0,035	0,258	0,085	0,016	0,020	0,016	0,012	0,010	0,037	0,313
FRA	0,007	0,064	0,016	0,033	0,000	0,218	0,021	0,120	0,053	0,015	0,009	0,050	0,094	0,020	0,034	0,104	0,142
GER	0,009	0,054	0,017	0,046	0,144	0,000	0,023	0,116	0,073	0,020	0,014	0,066	0,056	0,028	0,056	0,106	0,172
IRL	0,008	0,029	0,016	0,020	0,081	0,140	0,000	0,052	0,071	0,018	0,010	0,039	0,027	0,016	0,024	0,218	0,230
ITA	0,010	0,046	0,016	0,036	0,158	0,231	0,017	0,000	0,055	0,018	0,011	0,050	0,069	0,019	0,040	0,088	0,135
JPN	0,021	0,016	0,032	0,162	0,041	0,086	0,014	0,033	0,000	0,086	0,021	0,022	0,015	0,012	0,015	0,047	0,378
KOR	0,017	0,011	0,025	0,150	0,033	0,065	0,010	0,030	0,239	0,000	0,020	0,017	0,014	0,008	0,009	0,039	0,313
MEX	0,003	0,006	0,041	0,022	0,015	0,036	0,004	0,014	0,045	0,016	0,000	0,007	0,009	0,005	0,005	0,014	0,759
NLD	0,007	0,068	0,014	0,034	0,110	0,223	0,022	0,083	0,060	0,017	0,008	0,000	0,043	0,030	0,026	0,127	0,126
ESP	0,006	0,045	0,012	0,029	0,224	0,199	0,016	0,125	0,044	0,015	0,012	0,046	0,000	0,019	0,021	0,098	0,090
SWE	0,013	0,042	0,019	0,046	0,095	0,201	0,019	0,068	0,069	0,017	0,013	0,062	0,037	0,000	0,024	0,118	0,156
CHE	0,008	0,030	0,014	0,028	0,114	0,286	0,020	0,103	0,063	0,014	0,010	0,040	0,030	0,017	0,000	0,081	0,140
UK	0,013	0,051	0,022	0,033	0,116	0,178	0,061	0,074	0,066	0,020	0,009	0,063	0,046	0,028	0,027	0,000	0,194
US	0,014	0,017	0,196	0,088	0,049	0,090	0,020	0,036	0,168	0,050	0,154	0,020	0,013	0,012	0,014	0,060	0,000

Note: Trade weights based on Bayoumi et al. (2005). Sum of weights rescaled to 1 for countries included in the panel.

Table 2: Sum of Trade Weights of Partner Countries with Respect to a Specific Country

	Sum of Trade-Weights of Partner Countries Included in the Panel
AUS	70%
BEL	78%
CAN	89%
CHN	75%
FRA	78%
GER	70%
IRL	84%
ITA	74%
JPN	72%
KOR	74%
MEX	90%
NLD	77%
ESP	77%
SWE	69%
CHE	80%
UK	77%
US	76%

Table 3: Panel Unit Root Test Results

Series	LLC	t_IPS	Fisher-ADF	PP-Fisher
reer	-0.87	-1.27	34.324	26.16
$\Delta reer$	-21.30***	-20.77***	387.95***	481.63***
nfa	-0.04	-0.22	38.68	20.75
Δnfa	-2.48***	-12.62***	226.94***	223.57***
tb	1.09	-0.32	40.91*	39.08
Δtb	-30.87***	-32.84***	317.22***	362.61***
ntt	-2.60***	-0.87	48.07**	32.78
Δntt	-19.88***	-19.43***	338.47***	402.14***
gov	1.14	1.26	20.19	22.50
Δgov	-33.26***	-32.76***	365.12***	391.13***
tot	-7.56***	-11.65***	181.49***	183.49***
Δtot	-30.33***	-29.52***	392.64***	377.16***
rird	-2.24**	-3.74***	67.43***	52.59***
$\Delta rird$	-21.94***	-26.69***	433.28***	446.94***
open	-0.62	-1.26	42.21*	35.63
$\Delta open$	-21.22***	-23.06***	379.77***	475.51***

Note: ***,** and * denote significance at the 1, 5 respectively 10 percent level.

Table 4: Fully Country-Specific D-OLS Results

	NFA	TB	NTT	GOV	TOT	OPEN	Constant	Adj. R^2	AIC	SC	Adj. Speed ECM
BEL10		0.01*	0.83***		0.35		-0.83	0.75	-4.64	-4.21	-0.13
		(0.00)	(0.11)		(0.22)		(1.31)				0.08
CAN10		-0.01*	1.34***		0.82***		-5.30***	0.96	-4.45	-4.02	-0.24*
		(0.01)	(0.14)		(0.19)		(0.94)				0.14
CAN12		-0.01	1.48***	-0.34**	0.64		-5.69***	0.97	-4.61	-4.06	-0.33*
		(0.01)	(0.13)	(0.13)	(0.19)		(1.09)				0.19
CAN14		-0.00	1.01***	-0.25**	0.74***	-0.00**	-3.64***	0.97	-4.76	-4.08	-0.33*
		(0.00)	(0.21)	(0.12)	(0.20)	(0.00)	(0.88)				0.20
CAN21			1.05***	-0.28***	0.72***	-0.00***	-3.81***	0.97	-4.86	-4.30	-0.24**
			(0.17)	(0.09)	(0.19)	(0.00)	(0.77)				0.12
CHN2	-0.01***		1.85***	-0.67***			-5.07***	0.79	-2.43	-2.00	-0.37***
	(0.00)		(0.13)	(0.12)			(0.67)				0.12
CHN5	-0.01***		2.37***	-0.52***	0.87***		-11.27***	0.91	-3.26	-2.70	-0.37**
	(0.00)		(0.14)	(0.08)	(0.15)		(1.12)				0.15
CHN6	-0.00		1.63***	-0.55***		0.00	-3.84**	0.83	-2.63	-2.08	-0.47***
	(0.00)		(0.30)	(0.16)		(0.00)	(1.72)				0.17
CHN8		0.01	1.71***				-3.38**	0.54	-1.69	-1.40	-0.20**
		(0.01)	(0.35)				(1.63)				0.08
CHN9		-0.01	1.11***	-0.43***			-1.22	0.75	-2.26	-1.83	-0.25*
		(0.01)	(0.27)	(0.07)			(1.19)				0.15
CHN10		0.00	2.45***		1.39***		-13.12***	0.81	-2.53	-2.11	-0.24*
		(0.01)	(0.20)		(0.20)		(1.30)				0.14
CHN12		-0.01	1.90***	-0.24***	0.95***		-8.91***	0.84	-2.70	-2.14	-0.33*
		(0.00)	(0.28)	(0.06)	(0.19)		(1.78)				0.19
CHN14		-0.01	1.64***	-0.28**	0.82***	0.00	-7.18***	0.88	-2.91	-2.22	-0.33*
		(0.01)	(0.32)	(0.12)	(0.23)	(0.00)	(2.00)				0.20
CHN15			1.39***				-1.87*	0.51	-1.68	-1.52	-0.18***
			(0.23)				(1.07)				0.06
CHN16			1.42***	-0.36***			-2.54***	0.70	-2.12	-1.82	-0.28**
			(0.19)	(0.08)			(0.89)				0.14
CHN20			1.36***	-0.34***		-0.00	-2.21	0.76	-2.32	-1.89	-0.30*
			(0.33)	(0.11)		(0.00)	(1.76)				0.15
GER18			1.04***			-0.01***	0.35	0.85	-4.41	-4.11	-0.06
			(0.32)			(0.00)	(1.47)				0.08
GER20			1.09***	-0.13		-0.01***	-0.06	0.84	-4.31	-3.88	-0.05
			(0.30)	(0.29)		(0.00)	(1.51)				0.09
IRL5	-0.00***		1.77***	-0.19*	-0.17		-3.03	0.89	-4.80	-4.24	-0.30***
	(0.00)		(0.27)	(0.10)	(0.11)		(1.13)				0.11
ITA11		-0.02***	-1.00			-0.02***	9.95*	0.86	-3.87	-3.44	-0.03
		(0.01)	(1.17)			(0.00)	(5.58)				0.08
JPN6	-0.01***		1.58***	1.12***		-0.06***	0.60	0.92	-3.87	-3.31	-0.39***
	(0.00)		(0.57)	(0.15)		(0.00)	(2.81)				0.14
JPN7	-0.01***		1.64***	1.03***	0.10	-0.06***	-0.41	0.92	-3.92	-3.23	-0.38***
	(0.00)		(0.46)	(0.15)	(0.24)	(0.01)	(2.43)				0.13
JPN20			2.19***	0.28		-0.06***	-3.98	0.75	-2.81	-2.38	-0.22*
			(0.91)	(0.19)		(0.01)	(4.47)				0.11
KOR18			0.11			-0.01***	4.90***	0.76	-2.70	-2.41	-0.05
			(0.18)			(0.00)	(0.83)				0.08
NLD4	-0.00***		0.65***			-0.01***	2.17***	0.63	-4.49	-4.07	-0.20***
	(0.00)		(0.10)			(0.00)	(0.46)				0.06
SWE17			0.87***		1.38***		-5.73***	0.93	-4.01	-3.71	-0.06
			(0.17)		(0.26)		(0.83)				-0.45
US1	0.00		2.67***				-7.74***	0.70	-3.29	-3.00	-0.17***
	(0.00)		(0.61)				(2.76)				0.04
US8		-0.07***	0.25				3.18	0.83	-3.89	-3.59	-0.29***
		(0.01)	(0.63)				(2.83)				0.08
US9		-0.06***	0.90	0.19							-0.22**
		(0.01)	0.56	(0.14)							0.11
US15											-0.13**
											0.06
US16											-0.09
											0.07

Note: HAC standard errors in brackets. ***,** and * denote significance at the 1, 5 respectively 10 percent level.

Table 5: Pedroni Panel Cointegration Tests

Specification	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	REER	REER	REER	REER	REER	REER	REER	REER	REER	REER	REER	REER
	NFA	NFA	NFA	NFA								
					TB	TB	TB	TB				
	NTT	NTT	NTT	NTT	NTT	NTT	NTT	NTT	NTT	NTT	NTT	NTT
		GOV		GOV		GOV		GOV		GOV		GOV
			OPEN	OPEN			OPEN	OPEN			OPEN	OPEN
Panel Tests												
v-statistic	1.13	1.16	0.92	1.04	1.14	0.68	1.04	0.90	1.67**	1.05	1.12	0.86
rho-statistic	0.00	0.37	0.56	0.78	-0.79	0.03	0.15	0.65	-1.68**	-0.63	-0.47	0.01
ADF-statistic	-0.80	-0.59	-0.47	-0.42	-1.66	-1.05	-0.80	-0.56	-2.18**	-1.45*	-1.12	-0.95
PP-statistic	-1.35*	-1.12	-0.83	-0.02	-2.32	-0.92	-1.35*	-0.97	-2.40***	-1.65**	-1.31*	-0.87
Group Mean Tests												
rho-statistic	1.26	1.43	1.63	1.75	0.59	1.45	1.24	1.72	-0.08	0.61	0.73	1.14
PP-statistic	0.04	0.04	0.21	0.16	-0.79	-0.06	-0.14	0.08	-1.26	-0.69	-0.36	-0.19
ADF-statistic	-1.11	-0.96	-0.75	0.78	-2.34***	-0.75	-1.12	-1.17	-1.86**	-1.57*	-0.76	-0.62

Note: ***,** and * denote significance at the 1, 5 respectively 10 percent level.

Table 6: Panel Dynamic OLS Results and Poolability Tests

Pooled Dynamic OLS (1,1)	**1**	**5**	**7**	**9**	**10**	**11**
NFA	-0.00***					
	(0.00)					
TB		-0.01***	-0.00**			
		(0.00)	(0.00)			
NTT	1.15***	0.99***	0.75***	1.18***	1.31***	0.76***
	(0.11)	(0.11)	(0.08)	(0.10)	(0.09)	(0.08)
GOV					-0.32***	
					(0.07)	
OPEN			-0.00***			-0.00***
			(0.00)			(0.00)
Constant	-0.67	0.11	1.39***	-0.79	-1.93***	1.35***
	(0.49)	(0.49)	(0.40)	(0.48)	(0.44)	(0.38)
within R^2	0.36	0.40	0.47	0.34	0.40	0.46
Roy-Zellner Statistic				10.56***	15.51***	

Note: Driscoll and Kraay robust standard errors in brackets. ***,** and * denote significance at the 1, 5 respectively 10 percent level. The null hypothesis within the Roy-Zellner test is poolability across countries.

Table 7: Theil's U Country-Best vs. Panel Specifications

BEL	BEL10	Panel 9	Panel 10	**JPN**	JPN20	Panel 9	Panel 10
BEL10	1.00			JPN20	1.00		
Panel 9	1.57	1.00		Panel 9	1.14	1.00	
Panel 10	2.16	1.38	1.00	Panel 10	0.82	0.72	1.00
CAN	CAN12	Panel 9	Panel 10	**KOR**	KOR18	Panel 9	Panel 10
CAN12	1.00			KOR18	1.00		
Panel 9	0.64	1.00		Panel 9	0.47	1.00	
Panel 10	0.55	0.85	1.00	Panel 10	0.16	0.79	1.00
CHN	CHN8	Panel 9	Panel 10	**NLD**	NLD4	Panel 9	Panel 10
CHN8	1.00			NLD4	1.00		
Panel 9	1.30	1.00		Panel 9	0.54	1.00	
Panel 10	6.14	4.72	1.00	Panel 10	0.65	1.20	1.00
GER	GER20	Panel 9	Panel 10	**SWE**	SWE17	Panel 9	Panel 10
GER20	1.00			SWE17	1.00		
Panel 9	0.15	1.00		Panel 9	0.12	1.00	
Panel 10	0.12	0.80	1.00	Panel 10	0.16	1.30	1.00
IRL	IRL5	Panel 9	Panel 10	**US**	US16	Panel 9	Panel 10
IRL5	1.00			US16	1.00		
Panel 9	0.60	1.00		Panel 9	0.54	1.00	
Panel 10	0.40	0.67	1.00	Panel 10	0.58	1.08	1.00
ITA	ITA11	Panel 9	Panel 10				
ITA11	1.00						
Panel 9	0.41	1.00					
Panel 10	0.66	1.61	1.00				

Note: Only the fully country-specific models providing the best out-of-sample fit in the reserved part of the sample are considered. For all other country-specific models listed in table 4 the relative RMSE performance of panel specifications 9 and 10 would consequently be better.

Table 8: Diebold Mariano Test Results

Country	Intercept Country-Best vs. Panel 9	Intercept Country-Best vs. Panel 10
BEL	-0.02***	-0.05***
CAN	0.02**	0.03***
CHN	-0.00	-0.1***
GER	0.14***	0.15***
IRL	0.04***	0.07***
ITA	0.04***	0.02***
JPN	-0.05***	0.01
KOR	0.11**	0.13**
NLD	0.05***	0.04**
SWE	0.11***	0.11***
US	0.02**	0.02**

Note: ***,** and * denote rejection of the Diebold Mariano null hypothesis of equal forecasting performance at the 1, 5 respectively 10 percent level of significance.

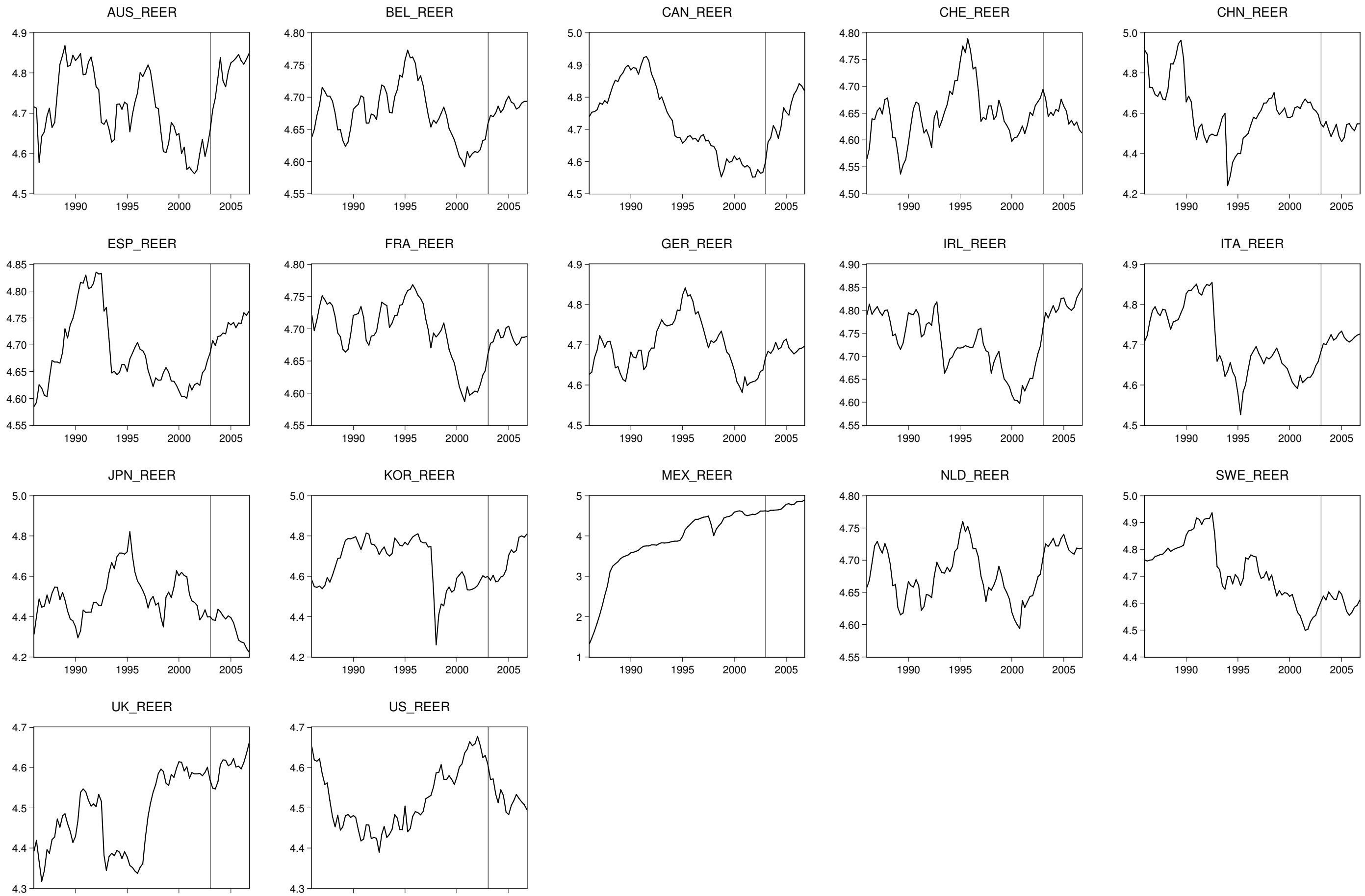

Figure 1: Real Effective Exchange Rate Indices (in logs)

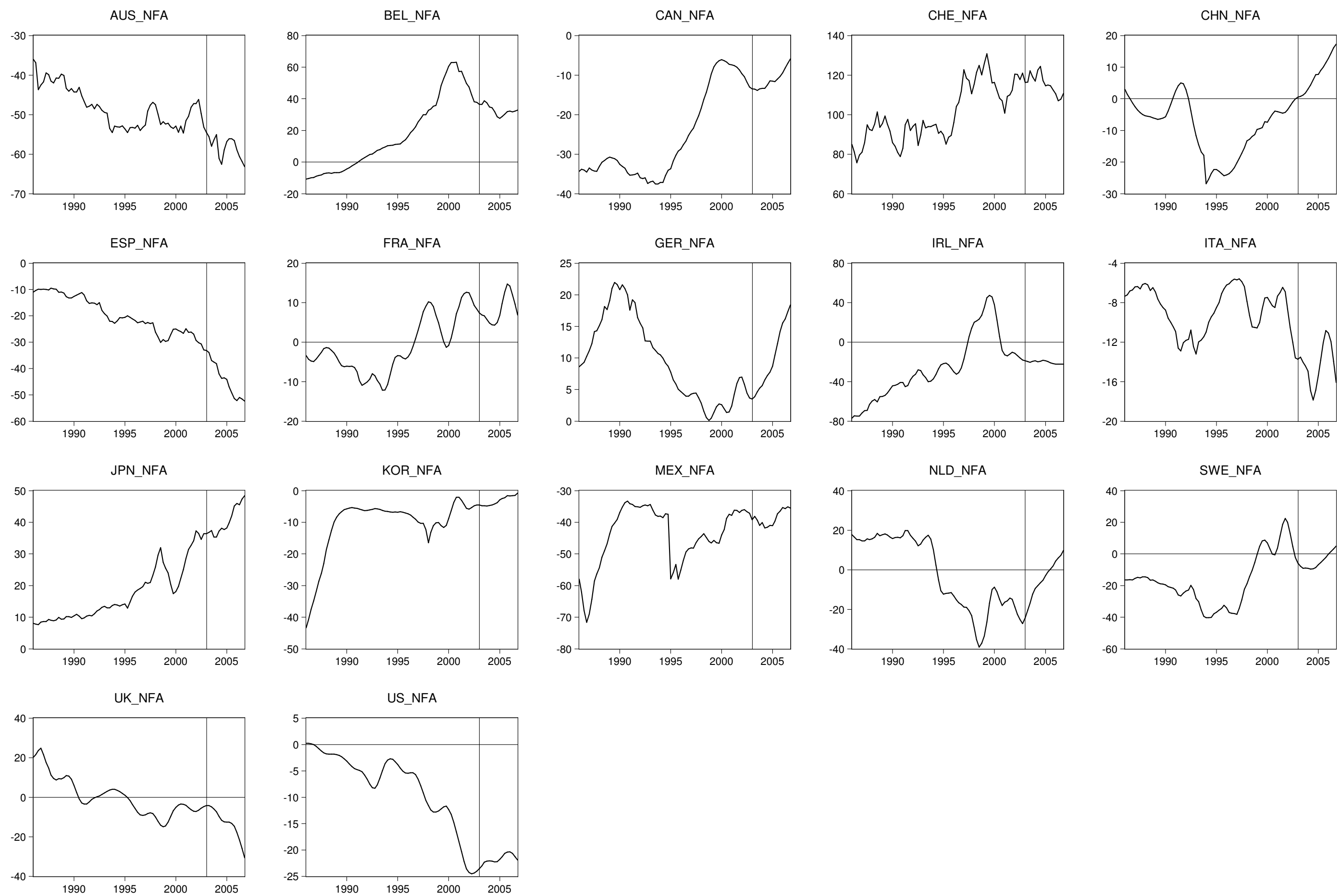

Figure 2: Net Foreign Assets to GDP Ratios

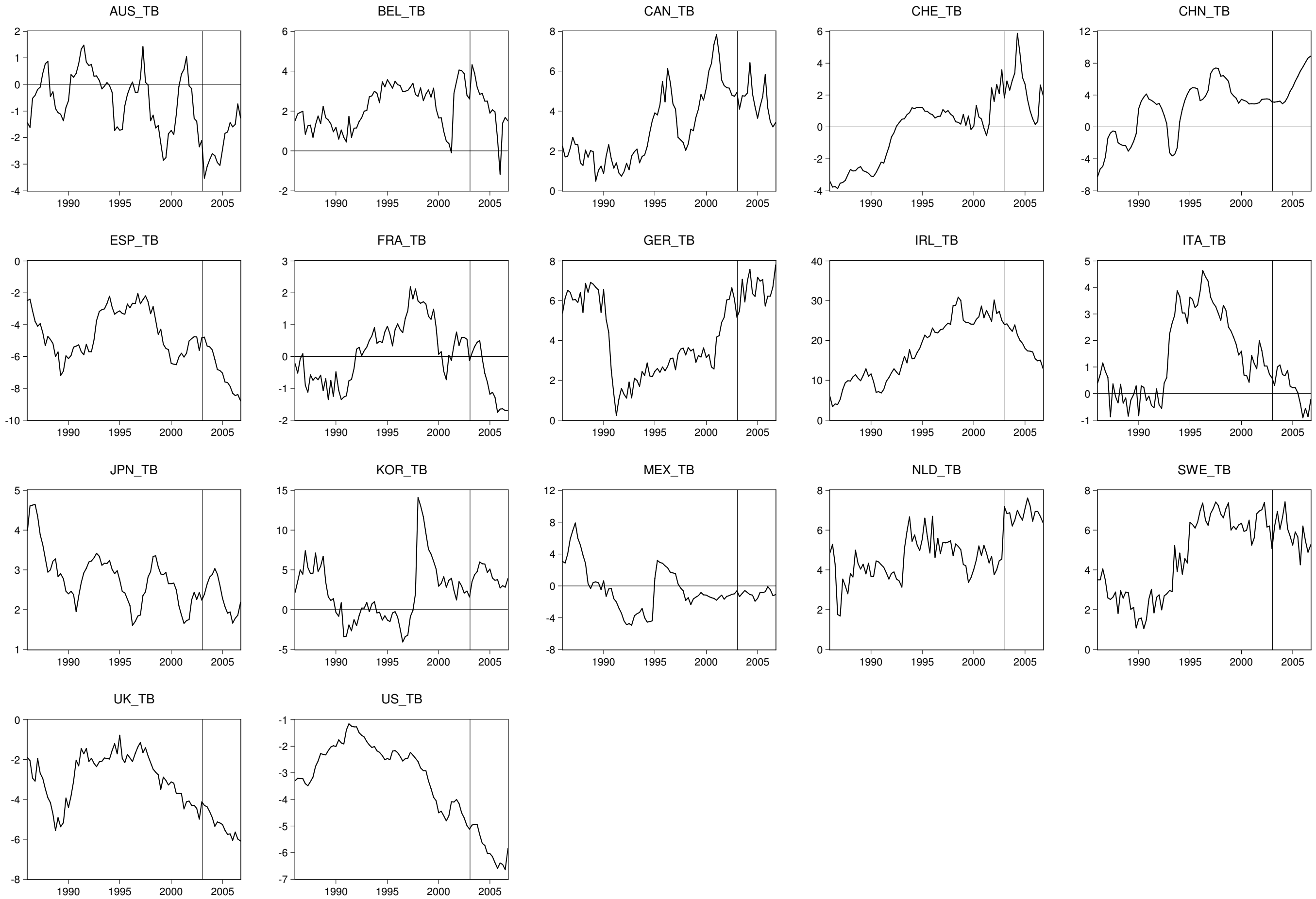

Figure 3: Trade Balance to GDP Ratios (in percent)

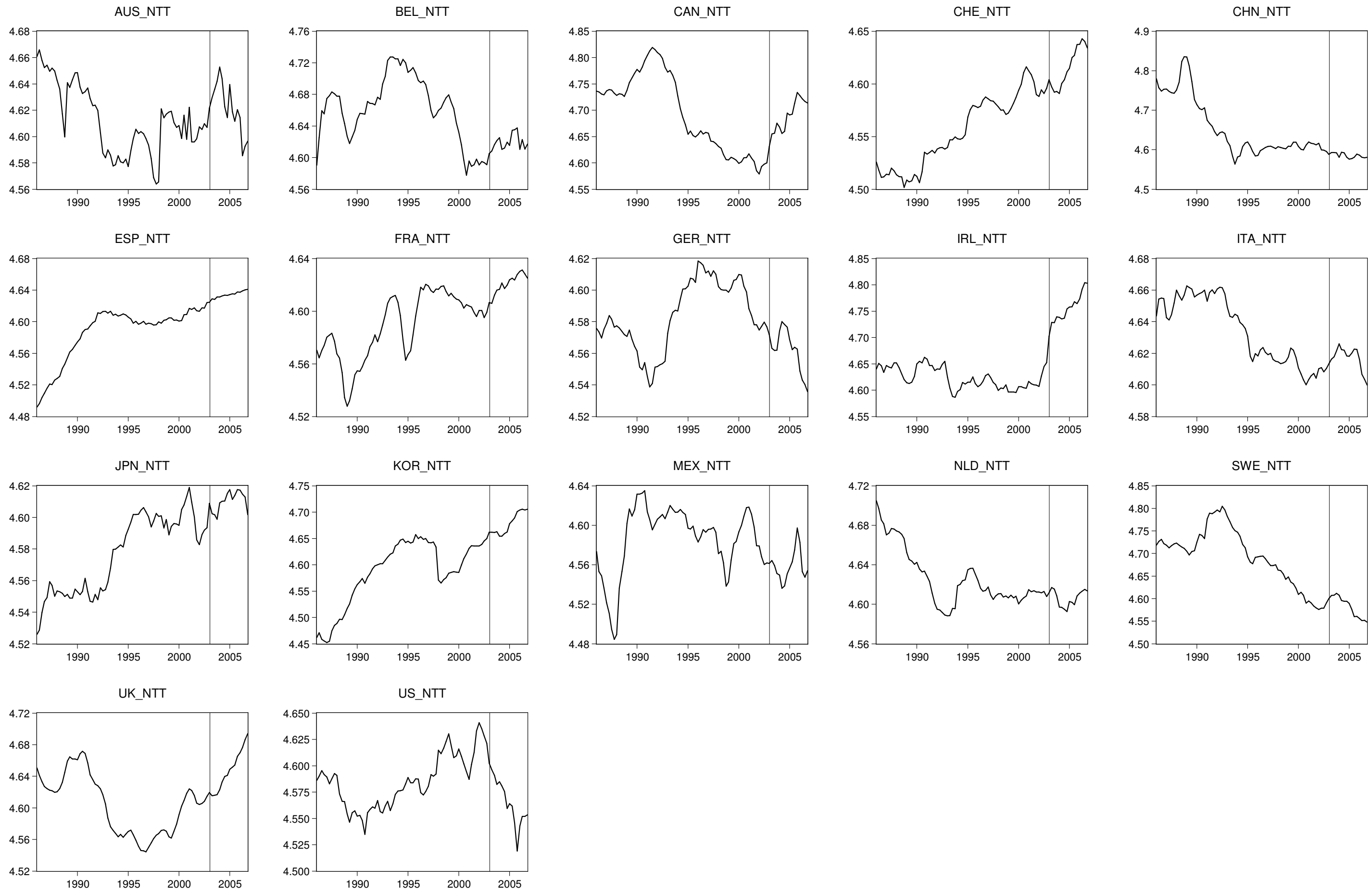

Figure 4: Trade-Weighted Rel. Price of Non-tradables to Tradables (in logs)

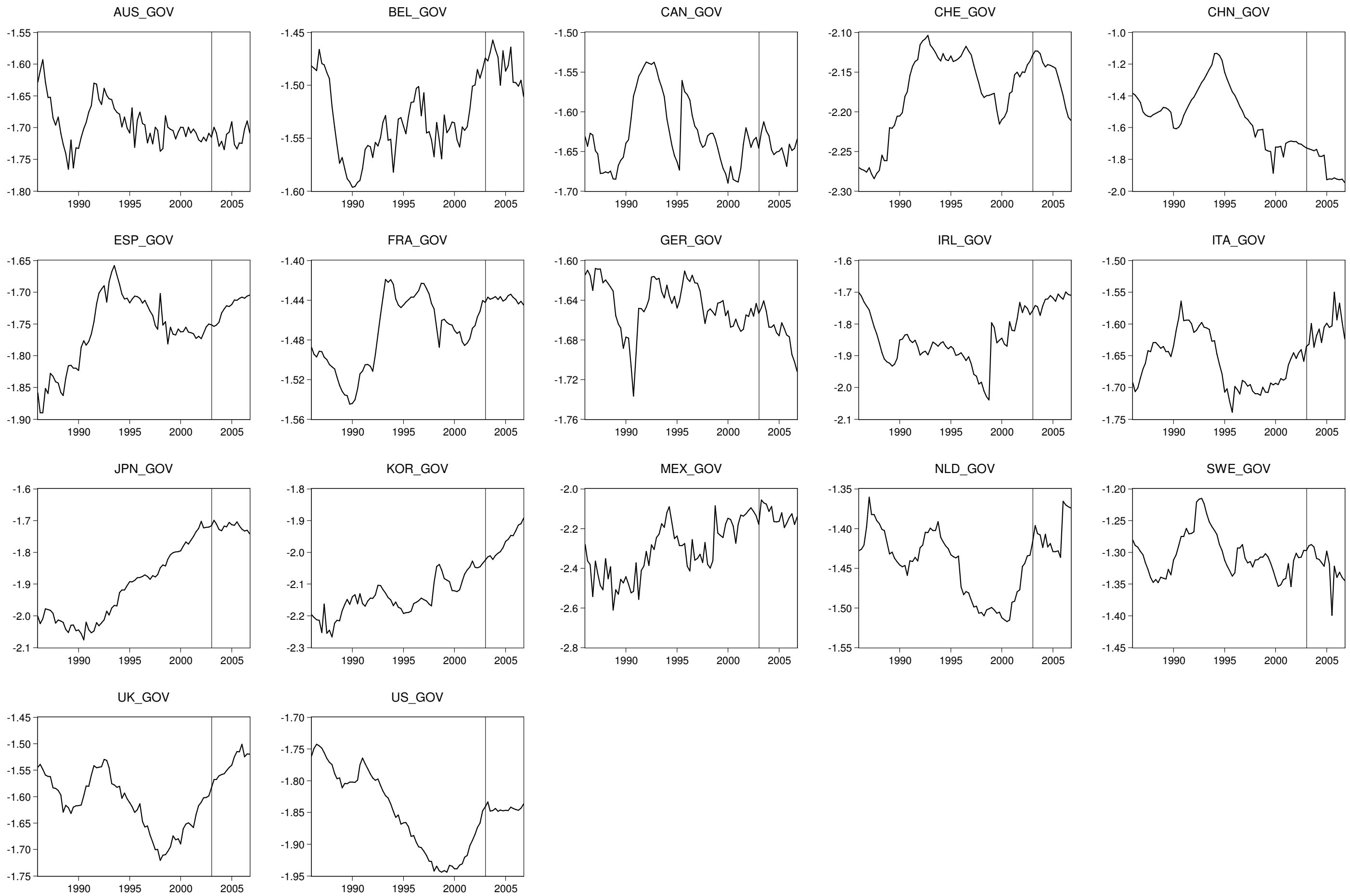

Figure 5: Trade-Weighted Rel. Government Expenditure to GDP Ratios (in logs)

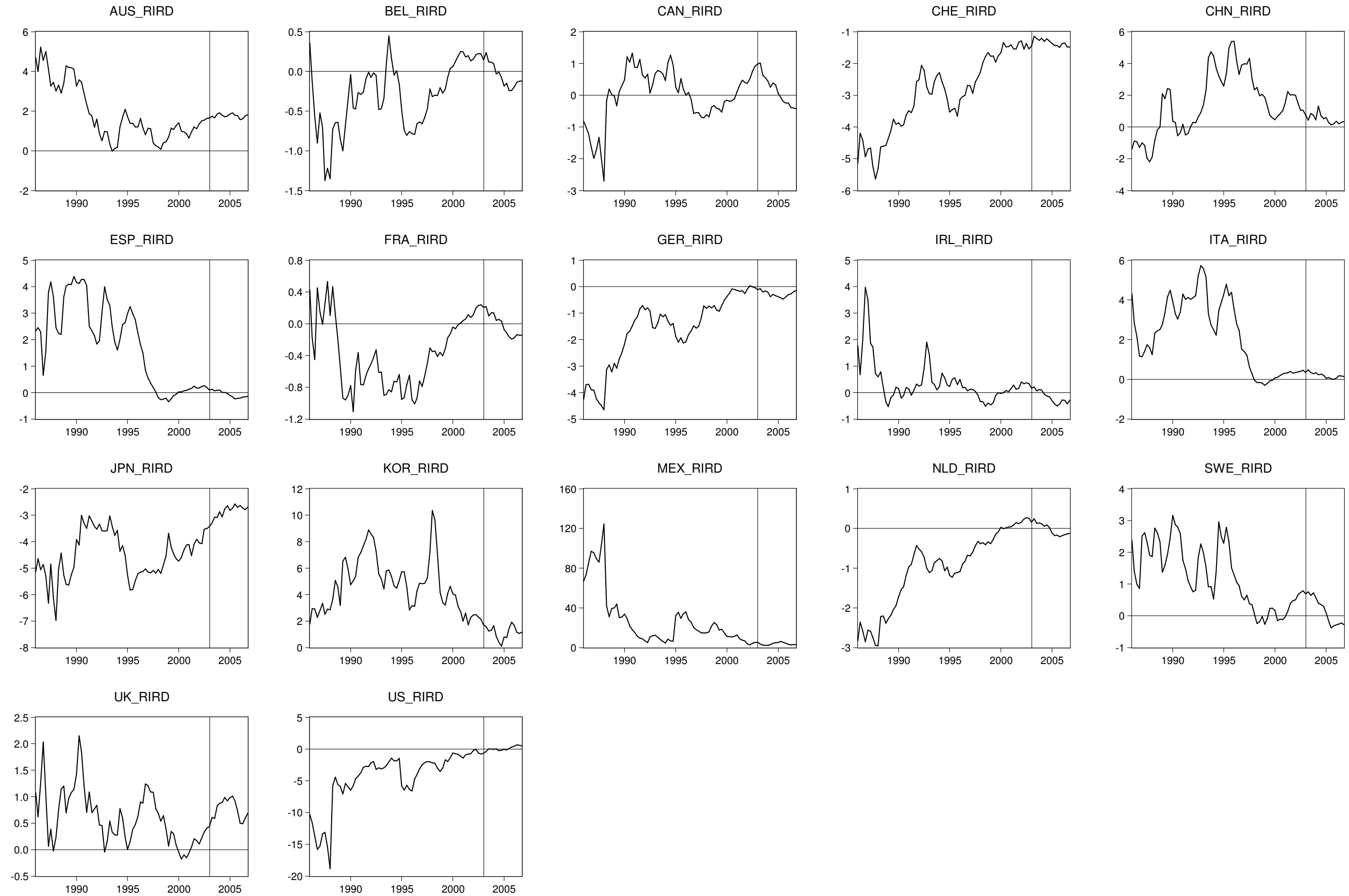

Figure 6: Real Interest Rate Differential

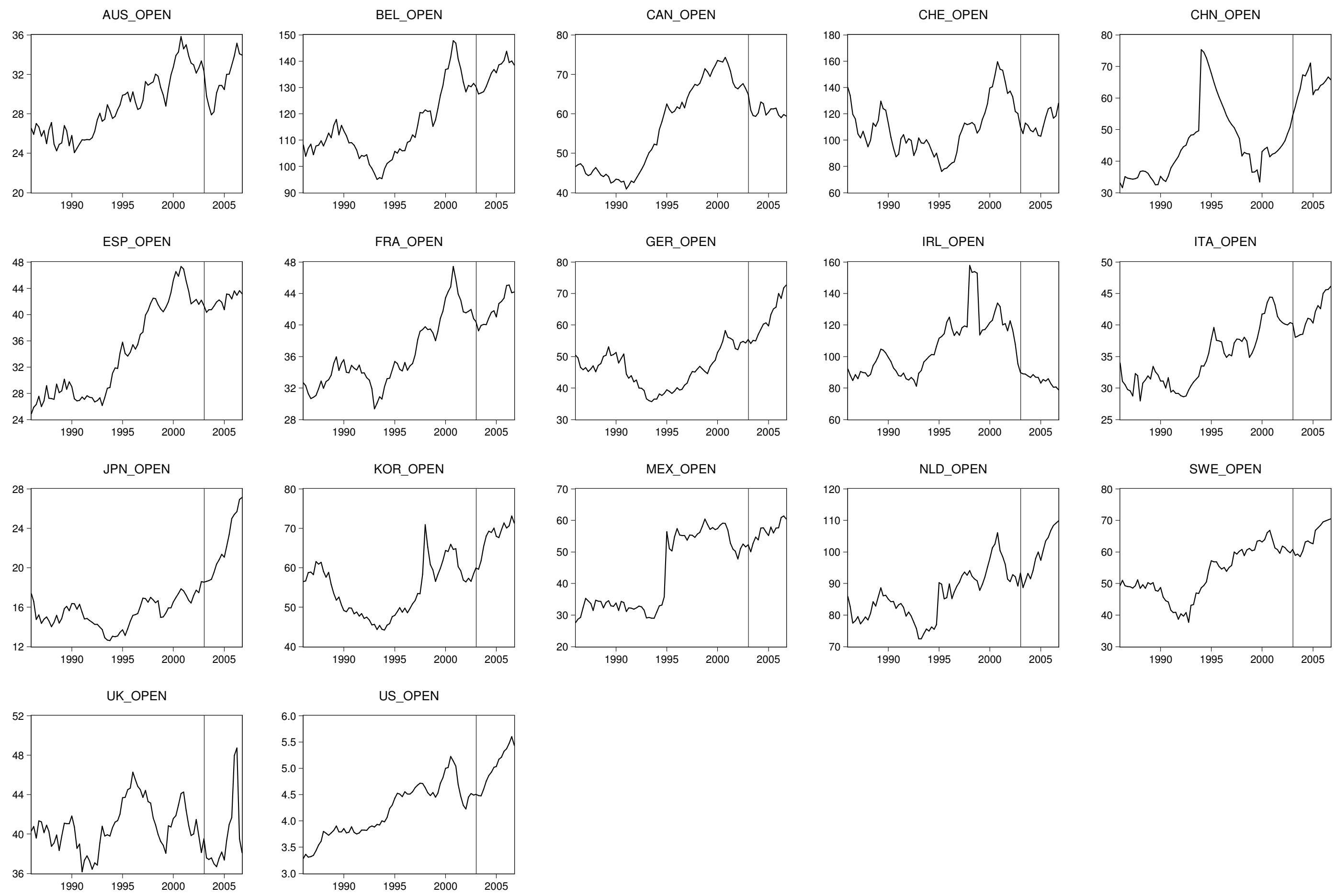

Figure 7: Openness (Sum of Exports and Imports divided by GDP)

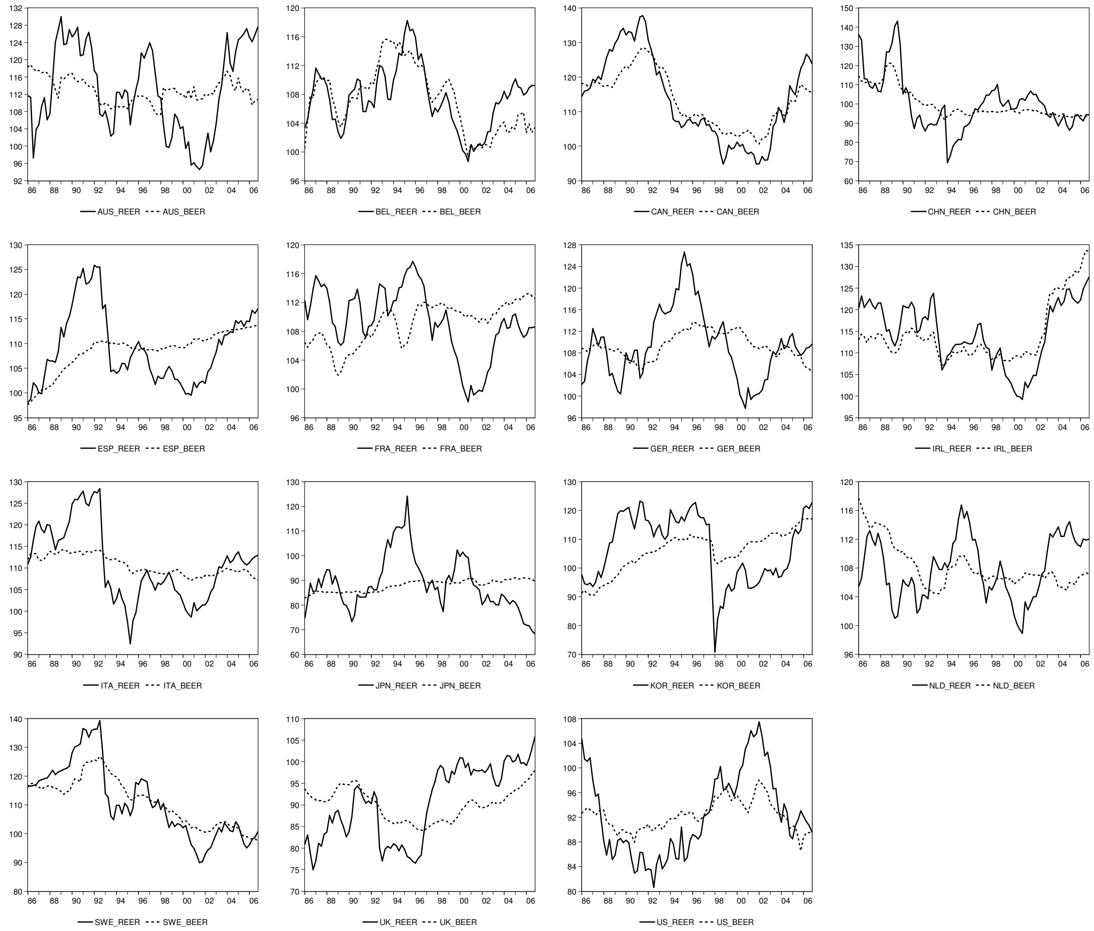

Figure 8: REER vs. BEER (in levels)

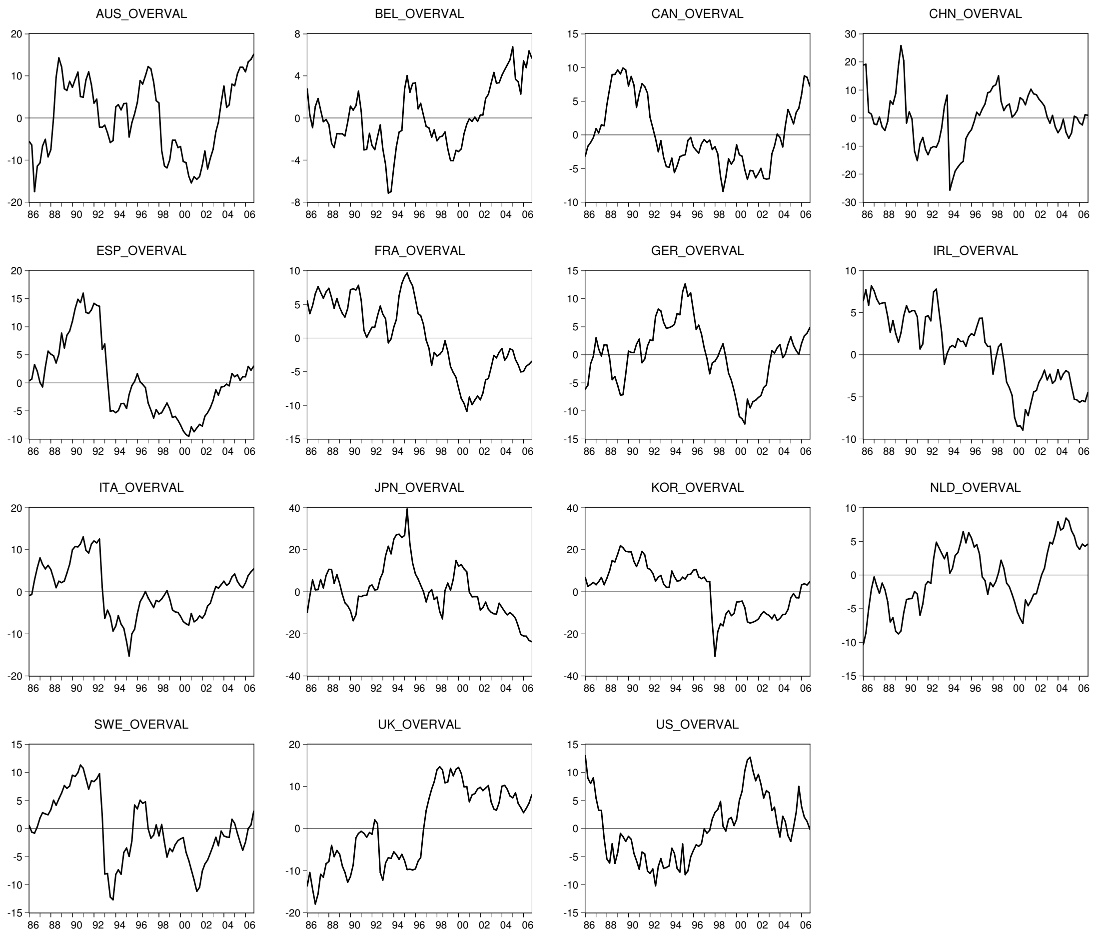

Figure 9: Overvaluation of REER vs. BEER in Percent