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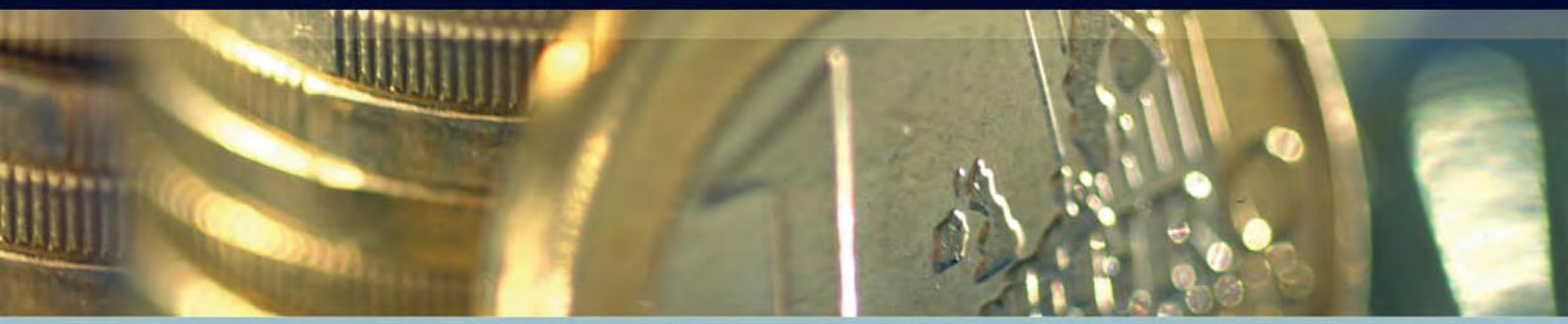

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Comparing alternative methodologies for real exchange rate assessment

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Abstract

This paper compares alternative methodologies for estimating real exchange rate misalignment for EU countries. It is shown that current account-based approaches (based on NFA stabilisation and current account norms) and relative-price based approaches (BEER and PPP-based) deliver broadly consistent assessments, however sometimes differences are non-negligible. Moreover, the behaviour of the two relative price-based approaches does not appear to be as fully aligned as expected. Current account-based misalignment appears to be driven to a larger extent by shocks affecting domestic absorption and national savings and quite often becomes manifest before price-based misalignment. All misalignment measures, and especially the BEER, are significantly related with medium-term developments in real exchange rates (overvaluation implying a forthcoming reduction in the REER), while only current-account based misalignment is a significant predictor of forthcoming current account developments.

Keywords: real effective exchange rates, equilibrium exchange rates, current account imbalances, PPP.

JEL classification: F31, F32.

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1. Introduction

Exchange rate assessment is becoming increasingly relevant for economic surveillance in the EU. The reduction of interest rate spreads associated with the introduction of the single currency was matched by widening current account imbalances within the euro area. The persistence of different wage and productivity dynamics among euro-area countries, coupled with the impossibility of correcting competitiveness differentials via the adjustment of nominal parities, resulted into divergent dynamics in real effective exchange rates. As for the EU countries not belonging to the euro area, abundant capital inflows after transition and during catching up were often coupled with conspicuous current account deficits, overheating, and price competitiveness losses. After the financial crises current account reversals were observed in numerous non euro-area countries. For some countries adopting fixed exchange rate regimes difficulties were encountered in keeping their pegs, for those letting their currency float, capital outflows were matched by marked fluctuations in nominal parities.

Including in light of the above mentioned developments, DG ECFIN of the European Commission has been putting in place and using a battery of analytical tools for the detection of cases of exchange rate misalignment. These analytical tools are broadly similar to those used by Consultative Group on Exchange Rate Issues (CGER) of the International Monetary Fund. Approaches based on information about current account balances are considered together with methodologies producing estimates directly from information on relative prices (both real effective exchange rate and gaps between nominal and PPP parities).

This paper reviews and illustrates the methodologies employed to assess exchange rate misalignment and discusses results for EU countries. In doing that, it aims at pursuing a threefold objective.

First, it aims at clarifying the meaning and limitations of different approaches for the estimation of equilibrium rate misalignment. The practice of estimating equilibrium exchange rates has a long-standing tradition in applied and policy-oriented analysis (see, e.g., MaCDonald, 2000; Driver and Westaway, 2004; Siregar and Rajan, 2006; Isard, 2007; for recent surveys on the topic). In spite of undeniable progress by the economic profession in devising more reliable and sophisticated estimation techniques, not only estimates remain subject to substantial uncertainty (e.g., Detken et al., 2002), but the basic concepts underlying the notion of equilibrium exchange rate itself are often subject to intense debate within the policy community, and misunderstandings are not infrequent.

Second, rather than describing the specific results for each country and periods considered, the apaper aims at identifying the key features and properties of misalignment estimates according to the different approaches. Are misalignment estimates obtained from different approaches in general of same order of magnitude? Are these misalignments persistent or are instead rapidly

corrected? What types of shocks seem to be driving misalignment estimates from different approaches? To what extent the presence of misalignment signals a forthcoming correction of real effective exchange rates? Does the methodology used to compute misalignment matter in this respect?

Finally, the paper analyses the relations among different misalignment measures. Should one expect different misalignment measures to normally point in the same directions? If yes, especially under what circumstances? Are different misalignment measures driven by the same underlying phenomena?

On the basis of results on the above questions, the paper aims at enucleating a series of principles and recommendations on how to come to an overall assessment and how to use the different measures.

The remainder of the paper is structured as follows. In the next section the methodologies for estimating exchange rate misalignment are presented. In section 3 and 4 the main features and properties of misalignment results are discussed. Section 5 analyses the links between the misalignment results obtained with different methods. Section 6 concludes.

2. Alternative approaches to assess exchange rate misalignment

2.1. Current-account based equilibrium exchange rates

With this approach, the misalignment is defined as the required change in the REER to close the gap between the "underlying" current account balance, i.e., a value of the current account purged from transitory and temporary factors, and an "equilibrium" current account, namely a current account target with desirable properties. This broad definition is common to approaches that became know in the literature as Fundamental Equilibrium Exchange Rate (FEER, see e.g.,Williamson, 1994) or the Natural Equilibrium Exchange Rates (NATREX, see, e.g. Stein, 1994).[1]

The logic of the approach is that of a consistency check. The question answered is as follows: "what is the change in the REER that, other things being equal, induces a durable change in the current account/GDP ratio towards a benchmark value with desirable features?".

[1] Broadly speaking, the FEER method requires both internal and external balance, where by internal balance it is meant economic output close to potential, while external balance holds when present and future current account balances are compatible with long-run sustainable capital flows. As long as the conditions necessary to meet internal and external balance change, the value of the FEER misalignment may also change. With the NATREX approach it is added the requirement that the real exchange rate in the long run is to be consistent with a stock of capital and a stock of foreign debt that remain stable at their steady-state levels (e.g., Siregar and Rajan, 2006; Isard, 2007).

Current account-based approaches require as a first step the estimation of a current account gap. The exchange rate misalignment is defined as follows (overvaluation is defined as a positive number):

$$\frac{(REER_{i,t} - REER_{i,t}^{eq})}{REER_{i,t}^{eq}} = \frac{uca_{i,t} - ca_{i,t}^{bench}}{\varepsilon_{i,t}} \quad (1)$$

where the expression at the numerator of the left-hand term of (1) is the current account gap, i.e., the difference between the underlying current account/GDP ratio (uca_{it}) of country *i* at time *t* and a benchmark for the current account / GDP ratio (ca_{it}^{bench}), while the denominator is the current account long-term semi-elasticity, namely:

$$\varepsilon_{i,t} = \frac{\Delta CA_{i,t} / Y_{i,t}}{\Delta REER_{i,t} / REER_{i,t-1}} \quad (2)$$

Hence, three basic ingredients are needed to dispose of current account misalignment estimates.

First, a measure of the *underlying current account* (see Appendix A.1.1 for details). In the present analysis this is obtained as the actual current account-to-GDP ratio adjusted for: (i) the domestic economic cycle; (ii) the economic cycle in trading partners; (iii) lagged effects of the REER on the current account.

While a positive cyclical development in the domestic economy (as measured by the output gap) raises imports, so that it contributes to an increase the underlying current account compared with the headline figure, the opposite holds with the output gap in trading partners. The current account could also be affected by the slow reaction of trade volumes to change in the REER. For instance, a recent appreciation of the REER implies a reduction of the trade balance and therefore of the current account which is not yet visible in available data but that are nevertheless to be taken into account.

The second necessary ingredient for estimating current account-based misalignment is a notion of *equilibrium current account* (see next sections and Appendix A.1.3 and A.1.4 for details). By equilibrium current account it is meant a benchmark current account value with desirable properties. Two notions of equilibrium current account are considered in the following analysis:

- the *net foreign asset (NFA) stabilisation approach*, which employs as a benchmark the current account that guarantees the stabilisation of the NFA/GDP ratio at the recent level;
- the *current account norms approach*, which is based on panel regressions which estimate the current account that would prevail over the medium-to-long term on the basis of economic fundamentals.

The final ingredient for the computation of current account-based misalignment is a *current account semi-elasticity* providing the link between the current account/GDP ratio and the percentage change in the real effective exchange rate (see Appendix A.1.2 for details). This semi-elasticity permits to translate the gap between the underlying current account and the equilibrium current account into a gap between the actual and the equilibrium real effective exchange rate. Current account semi-elasticities depend positively on: (i) the (absolute value of) elasticity of export and import volumes with respect to relative prices; (ii) the degree of country openness; (iii) the balance of trade in goods and services.

As illustrated in Appendix A.1.2, while the value of trade elasticities is assumed to be a structural parameter, constant over time and across countries, trade shares change in time and and space. Current account semi-elasticites are thus likely to differ across countries in light of differences in openness and trade balances. It is important to have clear the assumptions underlying current account semi-elasticities and their limitations:

- First, current account semi-elasticities are constructed under the assumption of complete pass-through of exchange rates into relative prices. Under this assumption, the exchange rate as an effective tool for adjusting the trade balance and hence the current account requires trade elasticities to be sufficiently large in absolute value ("Marhsall-Lerner conditions").
- Second, although current account semi-elasticities and misalignment estimates themselves are highly sensitive on trade elasticities, these parameters are subject to substantial uncertainty (see, e.g., Bussière et al., 2010). In light of recent evidence from disaggregated sector-level analyses which point to somewhat larger trade elasticities compared with those most often found in analyses using aggregate trade volume time series (e.g., Kee et al. 2008; Imbs and Mejan 2009) the elasticities used in the present analysis are chosen to be on the high side of the range of estimates (see, e.g., Goldstein and Kahn (1985) for a not recent but very comprehensive survey of trade elasticity estimates). See Appendix A.1.2.

2.1.1. NFA stabilisation approach

The current account that stabilises the stock of NFA on GDP is the current account that, at time *t*, stabilises the stock of NFA on GDP at the target *nfa** and is obtained as:

$$ca_{i,t}^{stab} = \frac{g_{i,t} + \pi_{i,t}}{(1+g_{i,t})(1+\pi_{i,t})} nfa^* \qquad (4)$$

where lower case variables denote ratios on GDP, g_t is GDP growth and π_t is inflation.

In the present application, a neutral criterion is chosen for determining the NFA target. The chosen target is the stabilisation of the value of the latest available NFA/GDP ratio. As for the data used for growth and inflation, in order to avoid that values depend excessively on short-term developments, potential growth and the average of the growth rate of the GDP deflator in between *t*-1 and *t*+1 are chosen.

The stabilisation of the current ratio of the NFA/GDP ratio is a minimum prudential requirement in case of large current account deficits and large stocks of net foreign liabilities. The approach has also the advantage of transparency and simplicity. However, it is important to be aware of its limitations.

- First, the concept is not symmetric. While it makes perfect sense requiring that the current account balance is above the one required to avoid the worsening of a largely negative ratio of the stock of NFA on GDP, a current account balance below the NFA-stabilising value is not necessarily harmful when the NFA/GDP ratio starts from a positive and large value.

- Second, stabilising the NFA/GDP ratio at the current level might be in some cases not sufficient to prevent the risk of disorderly current account adjustments. However, it is to note that if the value for the target NFA/GDP ratio *nfa** is different compared with the current NFA/GDP ratio, then a trade balance gap should be used rather than a current account gap and that the estimation of a trade balance gap involves the additional difficulty of estimating the return on the NFA stock, an estimate normally surrounded by substantial uncertainty.[2]

- Third, estimates of NFA-stabilising current accounts are highly sensitive to the value of potential growth used. Moreover, for countries undergoing periods of very high inflation or deflation, results may not be fully meaningful (extremely small or large NFA-stabilising current accounts).

2.1.2. Current account norms approach

The current account norm of a country is the current account consistent with fundamentals. In the present application, regressions on an unbalanced panel of 61 industrial and emerging economies over the 1970-2010 period are used to estimate the link between current account and a series of

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[2] Using a current account gap would lead to an underestimation (overestimation) of the trade balance adjustment required for countries with a relatively high (low) NFA share on GDP. This is understood by noting that the current account gap and the trade balance gap would coincide only if $nfa^* = nfa_t$ because $ca_{i,t}^{stab} - ca_{i,t} = \frac{g_{i,t} + \pi_{i,t}}{(1+g_{i,t})(1+\pi_{i,t})} nfa* - tb_{i,t} - i_{i,t} nfa_{i,t}$ and $tb_{i,t}^{stab} - tb_{i,t} = (\frac{g_{i,t} + \pi_{i,t}}{(1+g_{i,t})(1+\pi_{i,t})} - i_{i,t}) nfa* - tb_{i,t}$.

explanatory variables representing fundamental determinants (see Appendix A1.3 for the list of the sample countries). In order to correct for cyclical fluctuations, yearly data are transformed into 4-year non-overlapping averages. The estimated current account norm for each country and each of the 4-year sub periods are obtained as in-sample predictions from these regressions.

The explanatory variables used for the estimation of current account norms are aimed at capturing structural medium-to-long term determinants of the saving-investment balance, the trade balance, the net income balance. In analogy with Chinn and Prasad (2003) and Lee et al. (2008), the following explanatory variables are considered (see Annex A.1.3 for exact statistical definitions and data sources):

- **General government budget balance/GDP ratio.** The higher the government budget balance surplus, the higher national savings and therefore the current account balance.

- **Old-age dependency ratio.** Life-cycle consumption theory predicts that the higher the old dependency ratio, the lower the share of savings on GDP and the current account/GDP ratio.

- **Real GDP per capita at purchasing power parity at PPP.** Countries with relatively high (low) per-capita GDP are more likely to lend (borrow) to (from) other countries, and to run ceteris-paribus a higher current account surplus (deficit).

- **Real GDP per capita growth.** Countries characterised by relatively high (low) growth rates of GDP per capita are more likely to borrow (lend) from (to) other countries, and to run ceteris-paribus lower current account surpluses (deficits).

- **Net foreign asset/GDP ratio.** A high stock of net foreign assets implies ceteris-paribus higher net investment income and therefore higher current account surpluses on GDP. This effect is likely to prevail over an opposite effect on the trade balance, which can be lower while keeping the stock of NFA on GDP stable the higher is the initial NFA/GDP ratio.

- **Oil balance.** In light of the price rigidity of the demand for oil, a higher imbalance between oil consumption needs and production capacity translates into a structurally higher trade deficit and hence current account deficit.

Since most variables are broadly stationary, OLS estimation techniques are used without resorting to panel cointegration techniques. Formally, the regressions that are performed for the estimation of the current account determinants are as follows:

$$ca_{i\tau} = \alpha + \sum_{k=1}^{K} \beta_k X_{i\tau}^{k} + \varepsilon_{i\tau} \qquad (3)$$

where $ca_{i\tau}$ is the current account/GDP ratio in country *i* and time period τ, $X_{i\tau}^{k}$ is explanatory variable k (among those listed above), and $\varepsilon_{i\tau}$ is an error term. The regression explains about 40 per cent of the variance of current account / GDP ratios (see Table 1). Regression coefficients have the expected sign. The size of the coefficients is also on line with that of existing studies (Lee et al., 2008).

A series of remarks is in order.

- First, the specification does not include fixed effects. The reason is that in computing current account norms as predictions from the above regression, one wants to avoid using a measure of unexplained factors such as fixed effects. Such practice would amount to consider as structural all the country-specific difference between observed current account balances and those explained by fundamentals. Especially in the case of countries for which relatively short time series are available or that underwent repeated periods of current account stress, fixed effects may capture temporary rather than structural differences from the predicted value for the current account.

- Second, factors that are likely to produce only a temporary effect on current account balances are not included. In particular, the inclusion of dummies aimed at capturing periods of financial distress or current account crises would raise the issue of when to set these dummies equal to one an when to zero when estimating current account norms in real time.

- Third, the value of the explanatory variables used in the predictions is averaged over a series of recent years. There is a difference with respect to CGER estimates in this respect. While in the CGER approach the assessment of the norm is forward-looking, in that the explanatory variables are extrapolated over the medium term on the basis of the judgement of country desks, the present approach is rather backward looking (since based on values averaged on a series of recent years). Backward-looking estimates have a clear cost in that a desirable exchange rate assessment should be able to capture also forthcoming developments, but forward-looking estimations are subject to unavoidable projection errors. Irrespective of whether a backward or a forward-looking values are used, what actually matters is the extent to which the chosen values for the fundamentals serve the purpose of defining valid benchmarks for current accounts (e.g., excessively large fiscal deficits recorded in the recent past or forecast for coming years may both lead to compute excessively loose current account norms).

- Fourth, the estimated current account norms are to a certain extent sensitive to the specification of the regression equation and the sample used (see, e.g., Bussière et al., 2010).

2.2. Relative price-based approaches

When price-based approaches are used, the equilibrium real exchange rate is estimated directly from relative price data. In the first step, the relation between relative prices and a set of fundamentals is estimated via econometric regressions. In the second step, the equilibrium exchange rate is obtained as the prediction from this estimate using the current level of the fundamentals. Two different approaches are performed in the present analysis, one based on determinants of the time series of Real Effective Exchange Rate indexes and one on deviations from the Purchasing Power Parity exchange rates.

2.2.1. Behavioural Equilibrium Exchange Rate

Estimates of the BEER permit to assess whether the price competitiveness of a country evolves in line with fundamentals. Pioneer work on BEER estimates include Clark and MacDonald (1998, 2000), Alberola et al. (1999).[3]

A meaningful notion of price competitiveness needs to consider relative prices with respect to a potentially large group of trade partners, with weights taking into account competition both in the own market and in that of each trading partners, and in third markets. This scheme of "double export weighting" is the one used for the computation of the REER variables used by DG ECFIN of the European Commission, available on the AMECO database and used in the present analysis. Since the REER is an index number, and permits only comparisons over time, the price to pay for the use of a well-grounded measure of price competitiveness is the impossibility of performing cross-country comparisons with REER indexes and therefore also with estimates of "equilibrium" exchange rates so obtained. Only misalignment estimates, expressed as percentage deviation of the REER from equilibrium, are comparable across countries.

As for explanatory factors, the specification adopted in the present application is akin to that found in recent work (e.g., Lee et al., 2008; Benassy-Quere et al., 2008). The estimates are conducted on a panel of countries. Since the variables are non-stationary, a panel cointegration approach is used.

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[3] See also Hansen and Röger (2000) for a BEER application in time series to EU countries.

Specification

As opposed to current account-based approaches, with price-based approaches, the exchange rate in line with fundamentals is estimated directly on relative price data. It follows that the current account implications of the misalignment estimated with relative price-based methods are not as strong ex-ante as with current-account methods. The most basic way to estimate a BEER-type misalignment is to compare a point value of the REER to its long-term average or a filtered series. With such a short cut, there is no strong a-priori guarantee that identified periods of exchange misalignment also correspond to periods of large current account imbalances. However, in most recent BEER approaches the underlying statistical model is derived from the requirement that the REER is compatible with the current account being in line with a given benchmark. By recalling that the real exchange rate is defined as

$$REER = \frac{EP}{P^*} \tag{5}$$

- where P and P^*, respectively, stand for domestic and foreign prices and E is the nominal effective exchange rate, i.e., the price of the domestic currency for a geometric trade-weighted average of foreign commercial partners – expressing price levels in logs as:

$$p = \beta p^{NT} + (1-\beta)\, p^{T} \tag{6}$$

$$p^* = \beta^* p^{*NT} + (1-\beta^*)\, p^{*T} \tag{7}$$

- where the superscript *T, NT* refer to tradable and non-tradable goods respectively and the "beta" parameters represent the share of non-tradable goods (in consumption, if the REER is built using the CPI/HICP deflator) - , and assuming further that those shares are broadly similar across countries, then the logarithm of the REER can be expressed as follows:

$$reer = \underbrace{\left(e + p^{*T} - p^{T}\right)}_{(\text{terms of trade}, tot)} + \beta \underbrace{\left[\left(p^{NT} - p^{T}\right) - \left(p^{*NT} - p^{*T}\right)\right]}_{(\text{relative price T vs. NT}, rp)} . \tag{8}$$

The above formula shows that, under fairly general assumptions, the real exchange rate can be decomposed into two components: the terms of trade (i.e., the relative price of tradable goods with respect to foreign partners, the measure of prices that has direct relevance for the trade balance) and the relative price of tradables versus non-tradable goods, often dubbed the "internal exchange rate", which measures the extent to which price level differences are attributable to an inflated non-tradable sector.

Abstracting from net transfers and non-capital net factor income, the current account/GDP ratio (*ca*) is the sum of the trade balance/GDP ratio (*tb*) and the net capital income, summarised by the returns on the stock of net foreign assets as a share of GDP:

$$ca = tb(\underline{tot}) + i * nfa \qquad (9)$$

where the trade balance is an inverse function of the terms of trade.

The requirement for the current account balance to be in line with a given benchmark (a current account "norm" or a prudential level $\overline{ca}$), in light of equations (8) and (9) implies the following relation to be satisfied for the (log) REER:

$$reer = tb^{-1}(\overline{ca} - i * nfa, x) + (1-\beta)rp\,, \qquad (10)$$

Where $tb^{-1}()$ is the inverse of the function relating the trade balance to the terms of trade. The REER is expected to be an increasing function of the stock of net foreign assets (a larger stock of NFA raises net investment income, thus allowing a more appreciated REER to be compatible with the current account balance in line with benchmark) and of the relative price of tradables versus non-tradable goods. It is also expected to be affected by any other variable *x* that affects the trade balance in additions to the terms of trade.

In line with the above arguments, in the present BEER application the following determinants for the REER are considered (see Appendix A.2 for details on the construction of the variables and data sources):

- **The stock of the net foreign assets on GDP**. The expected sign is positive.
- **The ratio of the value added deflator in the tradable sector on that of the non-tradable sector compared with the same ratio for the trading partners**. This is a close approximation of the *rp* variable and the expected sign is positive.
- **The share of general government consumption on GDP**. Government consumption is tilted towards non-tradable goods and tradable goods of domestic origin (home bias). Hence, in addition to causing a real appreciation via an increase in the relative price of non-tradables (Froot and Rogoff, 1996) government consumption tends to improve the trade balance on for a given level of the terms of trade. Positive expected sign.

Alternative specifications are found in the literature.[4] The main reasons underlying the chosen specification are the following:

- Terms of trade variables are most often not included as explanatory factors because, in light of eq. (8), they would be redundant if the relative price variable is present as well. Nevertheless, terms of trade would not be fully separable from the relative price of tradables versus non-tradable goods as in equation (8) (and therefore not redundant) if the share of non-tradables in the economy varies considerably across countries. In principle, the use of terms of trade could be justified in this case. If the conjecture of different non tradable shares across countries is correct, in panel applications the coefficient of the terms of trade variable is ex-ante indeterminate. However, when the terms of trade variable is included the data generally reveal a strong positive regression coefficient for this variable together with coefficients for other explanatory variables losing significance of reverting their sign, a typical result of the high collinearity revealed by equation (8).
- In some applications (e.g., Lee et al., 2008; Ricci et al., 2008) a "commodity terms of trade" variable is used instead. This variable could be a relevant driver of the REER in developing commodity-exporting countries. In the present application the omission of such variable is likely to be a somewhat less relevant issue since the sample is made of advanced and emerging economies with relatively diversified trade structures.
- In a number of applications the relative price variable is summarised by the ratio of the CPI on the producer price index (PPI). Since the PPI only includes manufactures, this measure is aimed at capturing differences between the price of non-tradable and tradable goods. Our choice is rather to construct a relative price measure starting from sectoral value added deflators with a view to obtain a more satisfactory breakdown of the tradable vs non-tradable sectors.[5] This appears relevant especially for some of the EU economies were trade in services account for a relevant share of total trade flows.
- In other applications, rather than directly controlling for the relative price of goods, explanatory variables proxying the underlying reasons for changing relative prices of non tradables versus tradables are used. Most analysis use proxies of Balassa-Samuelson effects, generally measures of relative labour productivity (e.g., Canzoneri et al, 1999). Using

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[4] In early specifications also interest rate differentials, derived from an open interest parity conditions, are included among the explanatory variables in BEER equations, with less than fully satisfactory performances due to lack of cointegration in some cases (e.g., Benassy-Quere et al., 2008). See., e.g., MacDonald (1998) and Siregar and Rajan (2006) for a discussion on specifications linking the REER to interest rate differentials.

[5] This breakdown thus permits to follow the advice of De Gregorio, Giovannini and Wolf (1994) who tested tradability of sectoral aggregates and indicated these as the tradables sectors on the basis of a 10% sectoral export share

variables that successfully proxy Balassa-Samuelson effects have the major advantage of isolating drivers of relative prices consistent with "equilibrium appreciation" episodes, i.e., relating to structural transformations rather than possibly temporary demand-related factors. The difficulty with this approach is successfully measuring sectoral productivities for relatively large country samples. In our application, a measure of relative labour productivity constructed on the basis of sectoral real value added per capita data revealed a less than satisfactory performance (low explanatory power and fragility of the regression coefficient with respect to alternative specifications and sample definitions). Moreover, the behaviour of this variable in some cases appears to go against expected developments in relative productivities, most likely due to the inevitable difficulty of purging productivity measures from cyclical, demand-driven developments.[6]

It is worth stressing that BEER results are subject to usual robustness issues with respect to the chosen regression specification. Moreover, the sample definition could strongly affect the quality of the estimates and therefore results by affecting the extent to which a significant long-run relation among the variables exist in the panel, i.e., whether the requirement of panel cointegration is respected. Those issues become particularly relevant across heterogenous countries, and are further discusses in the next section.

Estimation

The estimation of BEER equations is performed on a panel of OECD and EU countries over the 1970-2008 period (see Annex A.2.1 for a description). The use of a panel approach permits to make use of additional degrees of freedom, thus achieving more significant and robust estimates (e.g., Bussière et al., 2010). Notice that the country sample is different compared with that used for the estimation of current account norms, with a total of 35 countries in the BEER exercise as opposed to 61 countries for estimating the norms.

Although the aim of the exercise is to obtain estimates for a large number of EU countries, and in this respect information pertaining to these economies is key, the inclusion of the EU New Member States (NMS) in the panel raises a series of issues. The relation between the REER and fundamentals for NMS, during the period for which data are available, is significantly different than that for the rest of the sample. If this is the case, there could a bias in the estimated regression coefficients. In particular, the relation between the REER and NFA in NMS is likely to be spurious and against that expected for the sample as a whole. Large capital inflows after transition led both to deteriorating NFA stocks in NMS and absorption booms resulting into appreciating REERs. A regression of the REER on the NFA stock for these countries would

[6] Discussions on these issues are found, e.g., in Chinn (1997), Schnatz et al. (2003), Ricci et al. (2008).

reveal a negative relation but the relation would be a spurious one, driven by a common, third factor (capital inflows). For the specific case of estimating BEER equations for the NMS, some existing work (Halpern and Wyplosz 1997) resorts to NMS-specific dummies and interactions. This is a shortcut that is incompatible with the rigorous implementation of panel regression techniques and that requires the assumption that REER behaviour in the NMS is characterised by relations with fundamentals which are structurally different than in the rest of the sample, while the differences could instead partly be the temporary reflection of post-transition adjustment and catching-up dynamics.

For the above reasons, the sample used for the estimation of the relation between the REER and fundamentals exclude the NMS and the estimated relation is used to make predictions (i.e., to estimate the "equilibrium" REER) also for these economies. An additional difficulty that arises with the NMS is related to the estimation of their fixed effects. When estimating BEER equations fixed effects are to be included, inter-alia for the simple reason that the REER is an index number so that different country intercepts are needed. However, the estimation of the fixed effects for NMS is likely to be hardly representative of structural country-specific factors likely to persist in the future (see, e.g., the discussion in Maeso-Fernandez et al., 2006). For the NMS only relatively short REER time series are available and past REER developments are strongly driven by idyosincratic, one-off, transition and catching-up-related convergence trajectories in relative prices. Aware of these limitations, and with a view to limit the extent to which misalignment estimates could be driven by country-specific trajectories, the fixed effect used to compute the equilibrium REER for the NMS is estimated on the overall NMS sample rather than on individual series.

Both the dependent (the log of the CPI/HICP-deflated REER) and the explanatory variables appear to be integrated of order 1 and cointegration tests are found supporting the existence of a cointegrating relationship (see Appendix A.2.1.) The co-integrating parameters are estimated using the Dynamic Ordinary Least Squares methodology proposed by Stock and Watson (1993). The methodology consists of adding first differences of the explanatory variables, and their leads and lags to the basic specification of the co-integrating relationship. Such a procedure reduces the bias in the estimate of the parameters of the co-integrating relationship which is present when the OLS estimator is used if the residuals are auto-correlated - as is often the case. Hence, the unbiased parameters of the co-integrating relationship are estimated by estimating with OLS the following equation:

$$reer_{i,t} = \sum_{j=1}^{3} \beta_j x_{i,t}^j + \sum_{j=1}^{3} \gamma_j \Delta x_{i,t}^j + \sum_{j=1}^{3} \delta_j \Delta x_{i,t-1}^j + \sum_{j=1}^{3} \lambda_j \Delta x_{i,t+1}^j + u_i + e_{i,t} \qquad (11)$$

Where subscripts *i,t*, refer, respectively, to countries and time periods, *reer* is the log of the CPI/HICP deflated REER, the explanatory variables *x* are described above, and where u_i are

country fixed effects. The coefficients of interest are the $\beta_j s$; they are the estimated co-integrating parameters and $\sum_{j=1}^{3} \beta_j x_{i,t}^j$ is the long-run relation between the REER and its determinants.

The estimated co-integrating parameters are shown in Table 2. All coefficients have the expected sign and are significant. Given that all variables are expressed in logarithms of index numbers (base year=2000), the coefficients estimated are interpreted as elasticities**.** Thus, the coefficient of government consumption suggests that a 1% increase in the government consumption/GDP ratio raises the REER by about 0.3%, while the impact of the NFA/GDP ratio and the relative price variable variables are about 0.08% and 0.2% respectively. It is to note that the magnitude of the relative price is smaller than expected from the theoretical relation in (10) (the share of non-tradables is normally higher than 20%). This is a feature that is found also in other analogous analyses (e.g., Choudhri and Kahn, 2005; Lee et al., 2008). Once the estimated co-integrating relationship is plugged into an ECM, the estimated half-life of the adjustment of the REER to its long-run relationship is about 3 years.

The final step is the computation of the "equilibrium REER", which is obtained as the in-sample prediction obtained from the sum of the estimated long-run relation and the fixed effects. For the countries included in the sample used to estimate the BEER relation this is given by:

$$reer_{i,t}^{eq} = \sum_{j=1}^{3} \hat{\beta}_j x_{i,t}^j + \hat{u}_i \qquad (12)$$

where the coefficients $\hat{\beta}_j$ are estimated from (11), while the fixed effects $\hat{u}_i$ are estimated regressing the estimated error correction terms ($reer_{i,t} - \sum_{j=1}^{3} \hat{\beta}_j x_{i,t}^j$) on country-specific constant terms.

For the NMS, the prediction is obtained as follows:

$$reer_{i,t}^{eq} = \sum_{j=1}^{3} \hat{\beta}_j x_{i,t}^j + \hat{u} \qquad (13)$$

where $\hat{\beta}_j$ are estimated from (11), and the common fixed effect $\hat{u}$ is estimated regressing the estimated error correction terms for the pooled data of NMS on a constant term.

Taking into account that all variables are measured in logarithms, the percentage misalignment is obtained as $(reer_{i,t} - reer_{i,t}^{eq}) * 100$.

2.3. Purchasing Power Parity

Measuring exchange rate misalignment by means of deviations of the nominal exchange rate from the PPP parity with respect to a base country has a long-standing tradition in economics (see, e.g., e.g., Froot and Rogoff, 1996; Cheung et al., 2007). While in the case of the REER the only meaningful analysis is in time series (since REER are index numbers), analyses based on PPP deviations are generally performed across countries (PPP data are comparable and all relative price measures are with respect to the same base country). The estimation of PPP equations along the cross-section dimension is indeed preferable on the grounds that the cross-section dimension better captures structural relations that take place over the long-run, like that between income per capita and cost of living, while with time-series regressions there is the risk that the estimated relation could also capture temporary factors.

While the price of tradable goods is expected to be equalised across countries (so that deviations from the PPP would per-se indicate currency misalignment), prices of non-tradables could be different across countries due to several reasons. Most of these reasons are likely to be captured by income per-capita.

- Balassa-Samuelson effects would predict that a higher relative productivity between tradable and non-tradable goods with respect to the base country translates into a higher relative price for non-tradables and then for the overall price level. Since productivity of tradables is higher in high-income countries, a positive relation is expected between income per capita and relative prices.[7]

- Income per capita is also related to a higher share of private services and public goods, largely non-tradable, which tend to raise the relative price of non-tradables and therefore the overall price level. Additionally, as productivity improvements are often slower among non-tradables, price dynamics are expected to be faster (price levels higher) the higher the share of non-tradables in the economy ("Baumol disease").

- Rising capital stocks would lead to increasing marginal productivity of labour, real wages and a rising relative price of non-tradables (which are generally relatively more labour intensive) and therefore equilibrium appreciation in line with the Kravis-Bhagwati hypothesis.[8]

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[7] See MacDonald and Ricci (2001) for a discussion of the role of the distribution sector for the impact of Balassa Samuelson effects on PPP gaps.

[8] See Kravis and Lipsey (1983) and Bhagwati (1984).

- Finally, per-capita income is positively related with the overall quality of goods, and therefore their price.

As for the BEER, in a first step, a measure of relative prices is regressed over fundamentals (i.e., income per capita), while in a second step the misalignment is computed as the difference between actual relative prices and those predicted. The main difference with the BEER approach outlined above is that with A PPP-based approach the measure of relative prices employed is not a REER constructed on the basis of a representative sample of competitors but a measure of the relative const of leaving compared with a base country. Hence, the relative price measure used is not necessarily a very representative gauge of price competitiveness. However, cross-country comparisons are possible because for all countries relative prices are constructed with reference to a same base country.

A meaningful comparison of PPP deviations across countries requires income per-capita to be computed at Purchasing Power Parities. A comparison with market exchange rates would not permit to take into account difference in the cost of living. Moreover, the income per-capita variable needs to be measured against the base country and should ideally be purged from short-term cyclical fluctuations. Finally, account needs to be taken of the fact that the cross-country relation between PPP deviations and relative income per capita could change over time, so that rather than using data for a single year, the estimates should better use pooled information for several years.

In the present application, the euro area is the base country used for PPP deviations and relative per capita income variables. The PPP deviation variable is obtained as the PPP exchange rate divided by the nominal bilateral exchange rate with respect to the base country (the euro area). The explanatory variable is the relative real income-per capita variable is in PPPs. In contrast to analogous existing analyses, cyclical fluctuations are controlled for by using potential rather than actual output to construct real per capita income variables. This helps capturing only income differences relating to structural rather than transitory developments.

The sample for estimating the relation between PPP deviations and income per capita includes advanced and middle-income economies. As opposed to the BEER implementation, there is no major issue with the inclusion of NMS data in the sample for the estimation of the relation between PPP gaps and per capita income (see Appendix A.2.2 for details on the sample). Note that including additional developing countries in the sample would not be recommendable, since it is shown in existing analyses that the relation is stronger in advanced and emerging economies and significantly weaker among developing economies (e.g., Cheung et al., 2007). In light of the presence of such structural break it is preferable to estimate the relation in a sample without developing countries.

To ease interpretation, only the cross-section dimension is considered in the estimation. However, to avoid that the estimate fully depends on a single or few data points, a panel between estimator is used over the period 1995-2010, a period for which information is available for all countries (balanced panel). The between estimator runs a regression across the time-average of the variables, so that only the cross-country dimension is used.

Table 3 reports the results. The variables are in logarithmic transformations, so that the coefficients are interpreted as elasticities. The coefficient of the relative income variable has the expected sign and magnitude: a 1 per cent increase in relative per-capita income is associated with an almost 0.8 percentage increase relative prices. The relation also turns out being highly statistically significant.

Also PPP-base estimates are subject to a series of limitations and caveats:

- It is worth recalling that PPP-based misalignment is not necessarily signalling relevant information for price competitiveness because price levels in the comparator country are not always highly representative of pressures from foreign competition.

- The relation between PPP-gaps and income per capita in generally strong when estimated in cross-sections or using the between-effects panel estimator, but it could be subject to structural breaks. The relation is likely to change as the time window and the selection of countries used for its estimation change.

- Income per-capita is generally strongly significant and can explain a large share of the cross-section variance of PPP gaps, while other explanatory variables used in cross-section regressions generally have a much poorer performance. This is the reason why PPP models often include income per capita as the only explanatory variable. The counterpart to this parsimonious solution is the risk of omitted variable bias and misleading in-sample predictions if significant regressors are excluded.

3. Summary of results

Misalignment results are computed and discussed for 24 EU countries (all current members with the exception of Cyprus, Luxemburg, and Malta) for a periods running from 1986 to 2009. The sample starts in 1986 to exclude the period of strong appreciation of the dollar before the Plaza agreement. Only hard data on real effective exchange rates, current accounts and most other variables are considered for the analysis of misalignment data, so that the sample ends in 2009.

In the following analysis, country groups will be considered separately depending on whether they belong to the euro area and whether they are NMS, i.e, whether they acceded the EU in 2004

or afterwards. Moreover, there will be a distinction according to the exchange rate regime, with three groups identified on the basis of the classification found in Bubula and Ötker-Robe (2002). Adopting a combination of de-facto and de-jure classification criteria, Bubula and Ötker-Robe (2002) distinguish between 13 different exchange rate regimes, ranging from the adoption of another currency as a legal tender (regime 1) to full independent floating (regime 13). We update the Bubula and Ötker-Robe (2002) classification to EU countries after 2001 and group the 13 different regimes into three broad groups: hard peg and monetary union (comprised of adoption of different currencies as legal tenders, monetary unions, currency boards), intermediate regimes (all regimes ranging from classification 4 to 7, i.e., from conventional peg to forward-looking crawling peg); flexible regimes (all regimes between 8 and 13, i.e, between forward-looking crawling band and independent floating).

As for time periods, we will present results for different sub-periods selected in such a way to coincide with the evolution of exchange rate regimes and of fundamentals affecting current accounts and real effective exchange rates: (i) 1986-1991: ERM years following Plaza up to the ERM crisis; (ii) 1992-1998: from the ERM crisis to the monetary union; (iii) 1999-2003: moderate imbalances; (iv) 2004-2007: large imbalances; (v) 2008-2009: the financial crisis.

Before turning to misalignment results, it is worthwhile having a clear picture of trends in real effective exchange rates. Figure 1 reports CPI/HICP deflated REERs (35 competitors, linked with series based on 24 competitors) for the countries under analysis. A simple inspection of the graphs reveals a series of relevant facts. First, the available *REER series for the NMS are short* (starting in 1995) *and characterised by steep upward trends*. These shape of these upward trajectories appear highly country-specific, which results in REER indexes (base year is 2000) that could differ markedly depending on whether the REER appreciation was stronger before (e.g., Latvia, Lithuania,…) or after the base year (e.g., Slovakia). These features of the NMS REER, plus the consideration that past appreciation trends have little information on REER developments looking forward, justify the choice of estimating a common fixed effects for NMS on their pooled data when implementing the BEER approach for these countries. Second, although REER series for non-NMS countries appear flatter and almost stationary in some cases, there are quite considerable cross-country differences, that appear consistent with common priors. While catching up countries like Ireland, Spain and Portugal (Greece appears to be an exception up to the early eighties) exhibit an appreciation trend, this is not the case in higher income per-capita countries like Belgium, Germany or France. Finally, wider fluctuations in REER series do not seem easily associated with the exchange rate regime (this is the case especially for NMS, e.g,, Poland with a floating regime has less strong appreciation than most NMS with fixed exchange regimes).

Synthetic measures of real exchange rate misalignment are presented by means of box plots. Box plots permit to condense not only synthetic measures of the position of the distribution but also -

and this matters for misalignment measures whose distribution is by construction roughly symmetric and centered around zero – of the dispersion. The box plots presented in Figures 2 to 7 report the median in the middle of the box, the 25 and 75 percentiles as the box extreme values and the latest adjacent values as those defining the length of the whisker, i.e., the length of the lines starting extending from both ends of the boxes. Adjacent values are those within 1.5 times the inter-quartile range (the difference between the 75 and the 25 percentiles, i.e., the length of the box) starting from the end of the box. Values not falling among those considered adjacent are outliers, and are not shown in the plots.

Figure 2 reports the entire distribution of misalignment measures for different time periods, according to the different approaches illustrated in the previous sections of the paper. A series of facts stand out. First, *the positions of the distributions of the different misalignment measures tend to move together*. While around the end of the past decade there was evidence of overvaluation for a large number of countries, irrespective of the approach taken, between 1992 and 1998, including in light of financial speculation against several ERM currencies in that period, undervaluation was prevailing. Second, the distributions of current account-based misalignment measures appear strongly aligned and co-move closely, *while the distribution of both relative price-based misalignment measures is less closely co-moving with misalignment distributions obtained with other approaches*. Third, *the dispersion of PPP-based misalignment measures is far bigger* compared with that of the other approaches and is subject to more marked changes over time. The evolution over time of PPP estimates are to a large extent driven by fluctuations in nominal parities with the euro. Since after 1998 for euro-area countries such fluctuations are ruled out, this partly explains the narrowing dispersion in PPP-based misalignment measures. An additional factor leading to a less dispersed distribution is real appreciation during catching up. As the currencies of catching up countries were originally largely undervalued in PPP terms, their appreciation led to a narrowing dispersion of misalignment estimates.

The same box plot is reported in Figure 3 but limiting the analysis to 11 countries belonging to the euro area (the original members adopting the euro in 1999, less Luxemburg, plus Greece). The graph shows quite clearly the growing dispersion of misalignment estimates with an *increasing number of over-appreciated countries after monetary unification*.

Figure 4 reports results for the three non-NMS countries outside the euro area (Denmark, Sweden, UK). These economies are characterised by a cost of living generally above that of the euro area after controlling for income per capita differences, which results into overvaluation measured with the PPP approach. The distributions of the other misalignment measures are centered below zero starting from the early nineties and exhibit a slight downward trend consistent with improving current account positions and stable or falling real exchange rates for these countries.

The box plot depicted in Figure 5 refers to the group of NMS (it starts from the third of the periods considered in that REER data are available from 1995 onwards for these countries). It is visible that the progressive appreciation led to overvalued currencies when measured using relative price data. *A tendency towards overvaluation in NMS is visible also on the basis of current account-based measures, but corrections seem to have taken place after the unfolding of the financial crisis*: the overall distribution is shifted downward and a number of countries appear to have moved into undervaluation territory. Interestingly, these corrections do not seem to have been paralleled by reduction in overvaluations or incipient undervaluations according the relative price-based measures, a piece of evidence that suggests that current account reversals in a number of NMS after the crisis were driven by capital flights and domestic recessions rather than by relative price developments.

Figures 6-8 report box plots distinguishing the exchange rate regime of countries starting from 1999. For countries with currency boards and in the monetary union is visible the growing appreciation and widening dispersion of misalignment results based on the BEER and the fact that the distribution of current account-based measures starts persistently being centered above zero after 2004. For countries adopting intermediate regimes (Denmark, Hungary, Latvia, and Greece before 2001) broadly similar trends are observed. *For countries with floating exchange rate regimes*, stands out the *correction of current account-based misalignment after the financial crisis*, which is paralleled by a widening distribution of BEER-based misalignment measures that signals a series of sizable undervaluation episodes associated with nominal depreciations.

4. Assessing the properties of alternative misalignment approaches

Are misalignments rapidly corrected or are they persistent? Are there relevant differences depending of the estimation approach followed? The analysis presented in Table 4 helps answering these questions. It shows panel regression results of misalignment measures on country-specific intercepts (fixed effects) and their own lagged value. For all misalignment measures adding additional lags yield insignificant coefficients with the exception of BEER estimates where the second lag is weakly significant and negative.

In all cases *misalignment appears to be quite persistent*, with a positive and highly significant regression coefficient. These simple autoregressive specifications permit to explain a relevant share of the variance of misalignment series. It turns out that *price based measures*, and notably the BEER, *seem more persistent* than current account-based misalignment measures. The evidence suggests that, other things being equal, current account-based indicators are likely to signal more frequently, and to larger extent, changes in the exchange rate misalignment status of countries.

Table 5 repeats the same analysis limiting the sample to cases in which the lagged misalignment is negative. The aim of the exercise is to check whether there is a difference in the persistence of misaligned exchange rates depending on whether the starting misalignment corresponds to undervaluation rather than overvaluation. Results show a broadly symmetric behaviour.

Table 6 addresses a different question, namely whether persistency is somehow related to the de jure or de facto constraints on nominal exchange rate adjustment. To this purpose, regressions are repeated for different samples, distinguished according to the exchange rate regime followed by countries. Results suggest that, while the persistency of price-based misalignment measures is quite stable across different exchange rate regimes, that of current account-based measures appears to be lower for countries adopting flexible regimes. Although a thorough interpretation of the result requires appropriate controls and checks, this evidence appears consistent with the broad view that nominal exchange rate flexibility favours the adjustment of current account imbalances.

The next question that we pose is: to what extent the presence of positive misalignment, i.e., the presence of overvalued currencies constitutes a signal that the corrections are expected going forward, so that a reduction in the real effective exchange rate will materialise? We address the issue symmetrically (hence, checking also whether undervaluation brings future appreciations) considering time horizons of 5 years (see Abiad et al. (2009) for an analogous exercise). Table 7 reports the results of regressions of percentage changes in the REER over a forward-looking horizon of 5 years against current misalignment measures. Country fixed effects are included. It turns out that, for current account-based measures, 1 percentage point of overvaluation are associated with about a 1/3 of a percentage point reduction in the REER in the subsequent 5 years. Regarding relative price based measures, the impact is stronger, with each percentage point of misalignment corresponding to more than half of a percentage point reduction in the REER in the coming 5 years. Those results appear broadly in line with those in Abiad et al. (2009) who also find, using a sample starting from 1997 and including a different set of countries, that both mid-point misalignement statistics across methodologies and the current account norm-based misalignment have significant predictive power on 5-year-ahead REER developments.[9]

Overall, the above analysis suggests that *misalignment measures*, notably priced-based ones, *could serve as predictors of medium-term developments in real effective exchange rates*.[10] Do

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[9] Abiad et al. (2009) also include fundamentals affecting current account norms and hence the equilibrium REER among the explanatory variables of 5-year-ahead REER developments and show that results are qualitatively similar to those obtained including only country effects and REER misalignment.

[10] It needs to be stressed that while run real exchange rates are to some extent predictabke on the basis of fundamentals over the medium term, they are hardly predictable over the short-run (Meese and Rogoff, 1984).

these measures also provide a signal useful to predict subsequent developments in current accounts? To address this question Table 8 repeats the analysis of carried out in Table 7 but using forthcoming medium-term current account developments rather than in the REER. While *current account-based misalignment* measures turn out being *significantly associated with subsequent current account developments* (each percentage point of misalignment being associated with between 0.08 and 0.2 per improvement in the current account/GDP ratio) no significant relation is found for relative price-based misalignment measures. In spite of the fact that current misalignment according to the BEER or the PPP approach is associated with REER depreciation going forward, there appears not to be a strong link with current accounts, possibly as a result of the fact that current large BEER or PPP misalignment is not always associated with simultaneous large current account imbalances.

Given that equilibrium exchange rates are by construction stickier than real exchange rate variables, the analysis above reveals that, on average, over the medium term, something between 1/3 and ½ of the misalignment is expected to vanish. Since what matters from the viewpoint of the surveillance and policy implications is the behaviour of largely misaligned real exchange rates, and since non-linear relations could play a relevant role in this respect, Table 9 reports which values are realised on average after 5 years starting from misalignment values above the upper quartile and below the lower quartile of the overall distribution across the working sample (24 EU countries, 1986-2009). It turns out that largely overvalued currencies are normally still overvalued after 5 years, but with a much reduced degree of overvaluation. This is especially true when misalignment is measured according to price-based approaches (with overvaluation dropping by about 85% with the BEER approach and 75% with the PPP approach). The case is not perfectly symmetric for the case of large undervaluations. After 5 years, undervaluation appears considerably reduced but to a much lower extent compared with the case of overvaluation. Especially for the NFA-stabilisation and the PPP approach, no major undervaluation reductions are registered following episodes of major undervaluation. This results is likely to bee linked to the asymmetric nature of the NFA stabilisation approach (no urgent reduction of surplus needed if the NFA/GDP ratio is rising) and to the fact that PPP gaps have no direct bearing on price competitiveness and current account developments (an undervalued PPP does not capture as the REER the urgency for competitors to recover margins and market shares).

5. Assessing the relations among different misalignment approaches

How do different misalignment measures relate each other? Are misalignment measures normally pointing in the same direction or are there cases where even the sign of misalignment differ depending on the methodology adopted? Are misalignment measures built on different methodologies driven by the same underlying phenomena or are there relevant differences in this respect? These are the issues we attempt to address in this section of the paper.

A simple inspection of the correlation matrix across misalignment measures (recall that misalignment figures are comparable both over time and across space, so that correlations can directly be computed on the panel as in Table 10) reveal that *while current account-based measures are quite correlated among themselves, relative price-based measures, and notably those obtained from the PPP approach, exhibit a weaker correlation with those obtained with the other approaches*. It is interesting to note that a "rough" proxy for a BEER estimate, consisting of the percentage difference between the REER and its country-specific long-term average, is quite closely correlated with BEER results. This finding suggests that, for countries disposing of long time series, this simpler surrogate of a BEER approach could behave quite similarly to a full-fledged BEER estimate. The computation of correlations excluding cases of misalignment values lower than 5% in absolute value yields qualitatively similar results (Table 10b). Table 11, which displays the correlation matrix for different country groups according to their exchange rate regime, suggests that a flexible exchange rate regime is associated with a stronger correlation between current account-based measures and BEER misalignment measures.

How frequent are cases in which different misalignment measures indicate a different misalignment sign? Across our working sample it turns out that:

- (i) only in about 22 per cent of cases misalignment measures are split, with two pointing to undervaluation, and the other two suggesting overvaluation,
- (ii) in about 45 per cent of the cases 3 measures indicate misalignment in the same direction;
- (iii) in about 33 per cent of the cases, all four measures point in the same direction.

When excluding the cases in which misalignment values are between -5% and +5% (values likely to be non-statistically significant in most of the cases, as suggested by a standard errors of predictions obtained from the BEER and PPP estimations), the frequency of configurations with 2 discordant measures is 15% , that for 3 discordant measures is 47%, the one for no discordant measures is 38%. As expected, the probability of obtaining discordant indications falls when excluding misalignment value likely to be non-significantly different from zero.

It appears worthwhile to dig deeper in the set of cases under (ii) to analyse which of the approaches is more likely to signal a direction of misalignment which is in discordance with that of the others. Table 12 provides this analysis. *The PPP approach is the one most often delivering misalignment directions in discordance with that arising from the other approaches*, followed by the BEER. The same result is confirmed when restricting the analysis to cases where misalignment is larger than 5% is absolute value. This higher probability of discordance for PPP estimates could be related to the fact that PPP is a concept that relates to relative cost of living rather than price competitiveness, so that its link with current account balances is comparatively weak.

The evidence so far suggests that, notably in light of well-known lags for price competitiveness to produce effects on trade flows and due to the fact that current account balances are driven by factors different than relative prices, the correlation between current account-based and relative price-based misalignment measures is not always strong. When taking an overall stance on exchange rate misalignment, it would be useful to dispose of ex-ante information to judge whether misalignment according to one approach often leads misalignment according to a different approach. For instance, it could be the case that a country results substantially misaligned according to the BEER without being so according to current account-based measures. Is a highly appreciated REER, revealed by the BEER likely to be conducive, with some lag to misalignment according to current account-based measures or is the REER lag structure embedded in the underlying current accounts used to compute misalignment measures with the NFA stabilisation and the current account norms approach sufficient? Alternatively, consider the opposite case, a country considered to be overvalued by current account-based methods but with price-based methods that do not point to large misalignment. Shall we expect rising BEER and PPP based misalignment going forward in light of overheating revealed by large current account imbalances underlying current account-based misalignment?

With the view to address the above issues Table 13 reports regression results where the four misalignment measures are regressed on the lag of each other and country fixed effects. Not surprisingly, current account-based measures appear to lead each other, and so do price-based measures. Less obviously, *lagged current account based measures have some "predictive" power on relative price measures* (significant on misalignment values obtained with the PPP approach), *while price-based misalignment values seem to have no influence whatsoever on subsequent current account-based misalignment values*. We interpret this finding as suggesting that underlying current accounts already incorporate information on recent REER developments, so that price based misalignment measures end up being a poor gauge of subsequent current account-based misalignment data. Conversely, current account imbalances driven by overheating dynamics result both in current account based misalignment and quite often in a delayed increase in price-based misalignment linked to rising price levels, cost of living and falling price competitiveness.

The final question we want to investigate is the following: are the main drivers of different misalignment measures similar or are they different? A full-fledged analysis of this issue is beyond the scope of this paper. As a prima-facie an attempt to address this issue Table 14 presents results of regressions where misalignment data are assumed to depend on their own lags, and a series of shocks likely to affect absorption and capital flows, and therefore the likelihood of lead to excessive current account imbalances and overheated price dynamics above what explained by fundamentals. With a view to capture only variations over time, fixed effects are included.

Fiscal policy shocks (the change in the primary cyclically adjusted balance), and two interest rate shocks, one on the interest on long-term German bonds (to an extent driven by German monetary policy) and one on the spread between domestic and German interest rates on the same bonds (aimed at capturing shocks in risk premia), directly affect absorption and therefore national savings, price dynamics and misalignment. Supply shocks (captured by the acceleration in potential growth) indirectly affect absorption via expectations: recent booms generate additional consumption and investment. Finally, a banking crisis dummy captures the impact on current accounts and exchange rates associated with capital flights (which help correcting possible accumulated imbalances) ensuing from baking sector distress.

Explanatory variables have generally the expected sign. However, while *current account-based misalignment measures* are strongly and *significantly affected by fiscal and monetary and risk premia shocks directly affecting absorption*, this is not the case for price-based measures. Overall, this evidence suggests that misalignment measures are not driven to the same extent by the most relevant factors affecting misalignment. Current account-based misalignment measures appear to be much more strongly linked to factors driving consumption and investment booms.

6. Conclusions

Assessing exchange rate misalignment has a long-standing tradition in policy-oriented research and is a common practice in policy institutions in charge of exchange rate surveillance. This paper reviews approaches to estimate misalignment used by DG ECFIN of the European Commission and discusses results. Two current account-based and two relative price-based misalignment approaches are illustrated. The approaches based on current account information build on two alternative notions of "equilibrium" current account, i.e., the NFA-stabilising current account and current account norms. Those based on information on domestic prices versus foreign prices are the BEER, which uses REER indexes series – a good gauge of price competitiveness but not suited to measure price levels as compared to foreign countries - and the PPP approach, which compares PPP gaps with respect to a base country in a cross section of countries, thereby providing a valuable information on price *levels* which is however not necessarily highly informative on competitiveness developments.

In discussing results for 24 EU countries over the 1986-2009 period, the paper focuses in particular on identifying main features of the alternative misalignment measures and analysing the links between them. While there is abundant literature discussing methodological refinements of alternative approaches, work aimed at comparing the properties of results obtained from different approaches seems somehow lacking.

The most significant results from the analysis can be summarised as follows:

- Measures of the position of the misalignment distributions are generally aligned across the alternative methods and tend to co-move in time, but both the position and the dispersion of misalignment estimates can differ quite considerably over time and across country groups. The PPP approach generally exhibits weaker alignment with the other approaches and larger dispersion of values.
- Misalignment measures, notably if obtained from relative price information, appear quite persistent in time. Nonetheless, the presence of misalignment signals corrections going forward: overvalued (undervalued) currencies are associated with significant REER reductions (increase) over the medium term, especially if measured on the basis of the BEER approach. Only current account-based misalignment measures are significantly linked with subsequent current account developments (overvaluations leading current account corrections).
- Current account-based misalignment measures are closely correlated among themselves. The correlation among these measures and price-based measures is weaker, notably among countries adopting hard pegs. Also the correlation between BEER and PPP-based results is not always strong. While current account-based misalignment appears to lead misalignment measured based on relative price-based measures (notably if obtained on the basis of the PPP approach), the opposite does not hold.
- Current account misalignment measures appear to be driven to a larger extent by shocks that normally feed into absorption booms compared with price-based misalignment measures.

The evidence above has some implications for the use and interpretation of misalignment results. First of all, the use of different misalignment approaches permits to shape a richer view in assessing exchange rates. There is no single notion of misalignment, and the different approaches reflect conceptual differences in the notion of misalignment. In this respect, current account-based and relative price-based misalignment measures are to be seen as complementary gauges to shape a medium-term exchange rate assessment (Bénassy-Quéré, Béreau, and Mignon, 2010). Second, it appears worthwhile complementing BEER measures with PPP-based misalignment information. PPP-based measures provide a useful countercheck in that they are built on information of price levels rather than index numbers, thereby helping to form an assessment on "equilibrium" price *levels*. Moreover, PPP results are not always highly correlated and concordant with BEER results, so that in some cases the information arising from PPP could make a difference in the overall misalignment assessment. Complementing BEER results with PPP results is even more relevant for those countries that, due to short and / or strongly trending REER time series (which is so far the case for the EU New Member States), BEER estimates could have limitations or be somehow misleading. Third, disposing of a full battery of alternative misalignment approaches helps digging into the underlying causes of misalignment and adds information on likely developments in real exchange rates and current accounts going forward.

Overall, the above considerations point in favour of a complementary use of alternative misalignment concepts but against the practice of mechanically averaging out misalignment estimates with a view to come up with a single quantitative indicator: the use of judgement, possibly based on additional focused analysis, appears a more desirable route to weight the information arising from different misalignment approaches.

A. Appendix

A.1. Current account-based approaches

A.1.1. Computing the underlying current account

The underlying current account is obtained by adjusting the actual current account for the impact of the cycle and that of lagged effects of the REER.

Cyclical effects are computed by means of output gaps, both for the domestic economy and for trading parterns. The impact on the current account is that on trade balance, which is calculated on the basis of elasticity values consistent with that of existing econometric estimates.

In line with existing studies, the impact of the REER on trade volumes is assumed to take three years, with 60% of the adjustment taking place contemporaneously, 25% during the second year and 15% during the third year.[11]

The underlying current account is constructed as the value of the current account consistent with domestic equilibrium (output equal to potential) and a full adjustment of trade volumes to developments in the REER that already took place. The underlying current account balance/GDP ratio (*uca*) for country *i* at time *t* is therefore obtained as follows:

$$uca_{i,t} = \frac{CA_{i,t}}{P_{i,t}Y_{i,t}} + \theta_M \frac{P^M{}_{i,t}M_{i,t}}{P_{i,t}Y_{i,t}} * \frac{Y_{i,t} - Y_{i,t}^*}{Y_{i,t}^*} - \theta_X \frac{P^M{}_{i,t}X_{i,t}}{P_{i,t}Y_{i,t}} * \frac{Y_{i,t}^F - Y^F{}_{i,t}^*}{Y^F{}_{i,t}^*}$$

$$+ \left(\frac{P_{i,t}^X X_{i,t}}{P_{i,t}Y_{i,t}} \eta_X - \frac{P_{i,t}^M M_{i,t}}{P_{i,t}Y_{i,t}} \eta_M \right) \left(reer_{i,t}^{prev} - 0.6 * reer_{i,t} - 0.25 * reer_{i,t-1} - 0.15 * reer_{i,t-2} \right)$$

$$+ \frac{P^M{}_{i,t}M_{i,t}}{P_{i,t}Y_{i,t}} * \left(reer_{i,t}^{prev} - reer_{i,t} \right), \qquad \text{(A.1.)}$$

where:

CA is the current account balance;

PY is nominal GDP, $P^M M$ and $P^X X$ are nominal imports and exports, *Y* and *Y** are, respectively, real actual and potential output (denote the same variables for trading partners Y^F and Y^F*);

reer is the *log* of the real effective exchange rate;

η_X and η_M are, respectively, the elasticities of exports and imports with respect to the *REER*;

θ_M and θ_X are the income elasticity of imports and exports;

$reer_t$ is an existing estimate of the value of the REER at time *t* (e.g., average value over the year) while $reer^{prev}$ denotes the most updated figure of the REER (e.g., prevailing at a certain quarter or month).

In general, $reer_t$ and $reer^{prev}$ would coincide, with equation (1) simplifying to:

$$uca_{i,t} = \frac{CA_{i,t}}{P_{i,t}Y_{i,t}} + \theta_M \frac{P^M{}_{i,t}M_{i,t}}{P_{i,t}Y_{i,t}} * \frac{Y_{i,t} - Y_{i,t}^*}{Y_{i,t}^*} - \theta_X \frac{P^M{}_{i,t}X_{i,t}}{P_{i,t}Y_{i,t}} * \frac{Y_{i,t}^F - Y^F{}_{i,t}^*}{Y^F{}_{i,t}^*}$$

$$+ \left(\frac{P_{i,t}^X X_{i,t}}{P_{i,t}Y_{i,t}} \eta_X - \frac{P_{i,t}^M M_{i,t}}{P_{i,t}Y_{i,t}} \eta_M \right) \left(0.4 * \Delta reer_{i,t} + 0.15 * \Delta reer_{i,t-1} \right) \qquad \text{(A.2.)}$$

where Δ is the difference operator.

A larger domestic (foreign) output gap temporarily worsens (improves) the current account due to increased imports (exports). The formula above allows taking into account those temporary effects. The income elasticity of both imports and exports are assumed to be equal to 1.5, in line with empirical estimates. The assumption underlying equations (2) and (3) is that the sensitivity of imports and exports to output stays roughly constant as the level of economic activity varies. The foreign output gap is computed by weighing the output gap of the 40 competitors used for the construction of the AMECO database REER with bilateral trade shares (output gap source: AMECO; OECD Economic Outlook; HP filter, lambda=100).

The adjustment for lagged REER effects consists of replacing the lagged values of the REER by the latest available value of the same variable. This amounts to estimating a counterfactual current account balance which assumes that the REER has remained stable at the most updated level and that therefore trade flows have fully adjusted to it. Note that the correction for the lagged effects only concerns the impact of the REER on trade volumes, while the impact on prices is simultaneous. This is understood from the fact that REER lags only act via import and export elasticities, while the REER at time *t* also fully transfers onto the trade balance via its impact on import prices (last term on the right hand side of equation (1)).

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[11] See Bayoumi and Faruqee (1998) who base their assumptions on the multi-region model as described in Masson, Symansky and Meredith (1990). Surveys of empirical trade equations report that more than 50 per cent of the impact of the REER on trade volumes takes place during the first year (e.g., Goldstein and Khan, 1985).

A.1.2. Computing the current account semi-elasticity

The final link to obtain the exchange rate misalignment is the current account semi-elasticity which is obtained as follows

$$\varepsilon_{i,t} = \frac{\Delta CA_{i,t} / Y_{i,t}}{\Delta REER_{i,t} / REER_{i,t-1}}) \cong \frac{P_{i,t}^{X} X_{i,t}}{P_{i,t} Y_{i,t}} \eta_X - \frac{P_{i,t}^{M} M_{i,t}}{P_{i,t} Y_{i,t}} (\eta_M - 1). \qquad \text{(A.3.)}$$

The values for the trade elasticities are set as follows: $\eta_X = -1.5$, $\eta_M = 1.25$.[12] Note that, due to the assumption of perfect pass-through of exchange rates on prices, while the impact of exchange rates on exports is only via quantities (the reduced price of domestic goods exported abroad is fully transferred to foreign consumers, with no direct impact on the export bill) the impact on imports is both on prices and on quantities (hence, the impact on the import bill is negative as long as the term $\eta_M - 1$, is positive, i.e., if the contraction in import quantities prevail over the increase in import prices). Note also that, starting from balanced trade, the Marshall-Lerner condition are simply expressed as a sum of the export and import volume elasticities above 1. Note, finally, that the term $+\left(\frac{P_{i,t}^{X} X_{i,t}}{P_{i,t} Y_{i,t}} \eta_X - \frac{P_{i,t}^{M} M_{i,t}}{P_{i,t} Y_{i,t}} \eta_M \right)$ in expressions (2) and (3) is the long-term semi-elasticity of trade *volumes* with respect to the REER.

The values of current account semi-elasticities vary over time as trade shares vary and across countries depending on the degree of openness and the trade balance. In order to avoid that figures depend excessively on temporary fluctuations in trade shares, 5-year backward-looking moving averages of current account elasticities are used for the computation of current account-based misalignment measures. Figure 9 reports the current account semi-elasticities value used to compute misalignment in 2009.

A.1.3. Computing NFA-stabilising current accounts

The data source for the NFA ratio on GDP is the DG ECFIN AMECO database, which collects data from national financial accounts, complemented by and IMF Balance of Payments Statistics

[12] These values are in line with those obtained from empirical estimations on aggregate data for most advanced economies in past decades (see, e.g., Goldstein and Kahn, 1985, for a comprehensive survey). In most of the studies export elasticities are found to be higher than those for imports. The chosen values are rather on the high side of the existing range of estimates for two main reasons (see IMF, 2007, ch. 3): (i) relatively recent developments in international trade that tend to raise the price responsiveness of trade flows are not yet fully captured in time series elasticity estimations. (ii) estimates based on aggregate trade flows may underestimate the true trade elasticities due to an "aggregation bias" (see, e.g., Imbs and Mejean IMF, 2009).

(which report data on the international investment position). Since financial accounts and balance of payments statistics are available with delays, the NFA/GDP ratio nfa_t is approximated by the latest available data. The data used for potential growth and inflation come from the AMECO database.

A.1.4. Computing current account norms

Regressions on an unbalanced panel of 61 industrial and emerging economies over the 1970-2010 period (2009 and 2010 current account data being forecasts) are used to estimate the link between current account and the above determinants. In order to correct for cyclical fluctuations, yearly data are transformed into 4-year non-overlapping averages (7 years for the 2004-2010 period). The following countries are included in the sample: Albania, Argentina, Australia, Austria, Belgium, Belarus, Brazil, Bulgaria, Canada, Chile, China, P.R.:Hong Kong, China,P.R.: Mainland, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Morocco, Mexico, Netherlands, Norway, New Zealand, Philippines, Poland, Portugal, Romania, Russia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, Ukraine, United Kingdom, United States, Uruguay.

Since most variables are broadly stationary, OLS estimation techniques are used without resorting to panel cointegration techniques.

The dependent variable is the current account/GDP ratio (source: AMECO, integrated by IMF, IFS data). The explanatory variables are defined as follows:

- General government budget balance/GDP ratio (difference with respect to trading partners). Source: AMECO complemented by IMF, World Economic Outlook database, Global Insight, World Bank, World Development Indicators.

- Old-age dependency ratio (fraction of population older than 65 years over the population between 15 and 64 years old, difference compared with trading partners). Source: AMECO, complemented by United Nations.

- Real GDP per capita at purchasing power parity at PPP (difference compared with trading partners). Source: Penn World Tables (data beyond 2007 projected forward using GDP per-capita growth rates from AMECO).

- Real GDP per capita growth (difference compared with trading partners). Source: AMECO complemented by World Bank, World Development Indicators.

- Net foreign asset/GDP ratio (value at the beginning of each 4-year sample sub-period). Source: AMECO, complemented by IMF Balance of Payments and Lane and Milesi and Ferretti (2007) data.

- Oil balance (percentage difference between oil barrels per year produced and consumed). Source: BP and US Energy Information Administration.

A.2. Price-based approaches

A.2.1. Behavioural Equilibrium Exchange Rate approach

The long-term relation is estimated on a sample consisting of an unbalanced panel of EU and non-EU OECD countries over the 1970-2007 period. While for most NO-NMS the relevant data are available for the whole period, for the NMS the sample starts in 1995.

The variables are measured as follows:

Real effective exchange rate (REER). Price concept used: HICP, CPI when not available. consumption deflator GDP deflator. Competitors: 35 competitors group, double export weights. The series are chain-linked with series based on the 24 competitors group for years prior to 1995 (data not available for NMS prior to that date). Source: AMECO.

Relative productivity of tradables over non-tradables. The productivity variable is constructed using the value added per person employed, source AMECO. The relative productivity in the competitor group is obtained via aggregations with the same double export weights as used for the construction of the REER (35 competitors group chain-linked with variables constructed on the basis of a 24 competitors group for years prior to 1995). The tradable sector is defined as the sum of agriculture and manufacturing, excluding construction and trade and transport services. Thus the variable is defined as $rp_{i,t} = \left[\frac{(VA/L)^{TR}{}_{i,t} / (VA/L)^{NTR}{}_{i,t}}{(VA/L)_{i,t}^{*TR} / (VA/L)_{i,t}^{*NTR}} \right]$ where (VA/L) refers to value added per person employed, the superscripts "TR" and "NTR" refer to tradables and non-tradables sectors, and the asterisk denotes the variables of foreign partner countries.

- Government consumption/GDP ratio. The data used is the "final consumption expenditure", source AMECO. If the variable is missing, equivalent data from World Bank, World Development Indicators are used.

- Net foreign assets/GDP ratio. The data used is "net financial assets; total economy", source AMECO complemented with International Investment Position data from IMF, Balance of Payments Statistics.

The variables exhibit panel unit roots and pass co-integration tests. Panel co-integration techniques can be used only if all variables are non-stationary. Moreover, a linear combination of the same variables must exist which is instead panel-stationary (the meaning of co-integration). Panel unit root and co-integration tests are therefore run on a balanced panel including EU15 countries (excluding Luxemburg) and 4 OECD countries (Canada, Japan, Norway and the US) from 1972 to 2008 (a balanced panel is needed for the panel unit root tests to run). For each variable, the Hadri (2000) test rejects at the 99 per cent level the null hypothesis of stationarity of the series in each panel. The Im, Pesaran and Shin (2003) test was run on all variables under the alternative of 1 or 2 lags and presence or exclusion of a trend. The test cannot reject at the 95 per cent the null hypothesis of non-stationarity in the majority of cases (exceptions are the REER with 1 lag, potential output and the CPI/PPI ratio). As for panel co-integration tests of the CPI-deflated REER specification, one of the two group-mean tests proposed in Westerlund (2007) rejects the null of no co-integration at the 90 per cent level when the underlying Error Correction Mechanism (ECM) for each panel includes between 1 and 3 lags of the differentiated explanatory variables and a constant. Using the GDP-deflated REER as the dependent variable, leads to no co-integration in the cases of relative productivity and potential output per capita. Therefore, the CPI-deflated REER appears to be preferable over the GDP-deflated REER as a dependent regression variable.

A.2.2. Purchasing Power Parity approach

The sample used is the same as that used for the BEER plus Turkey and the New EU Member States.

The source of the data is the DG ECFIN AMECO database. The PPP deviation variable is obtained as the PPP exchange rate divided by the nominal bilateral exchange rate with respect to the base country (the euro area). The relative real income-per capita variable is in PPPs to permit, and cyclical fluctuations are controlled for by means of output gaps (source: AMECO, is missing OECD Economic Outlook, if missing HP filter computations). The euro area average income per capita is computed using data from the initial euro area Members, plus Greece, minus Luxemburg. Hence, the dependent variable is interpreted as potential income per capita compared with the euro area at current PPPs.

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Figure 1. Real effective exchange rates, CPI/HICP deflated, 35 competitors (linked 24 competitors), 24 EU countries,

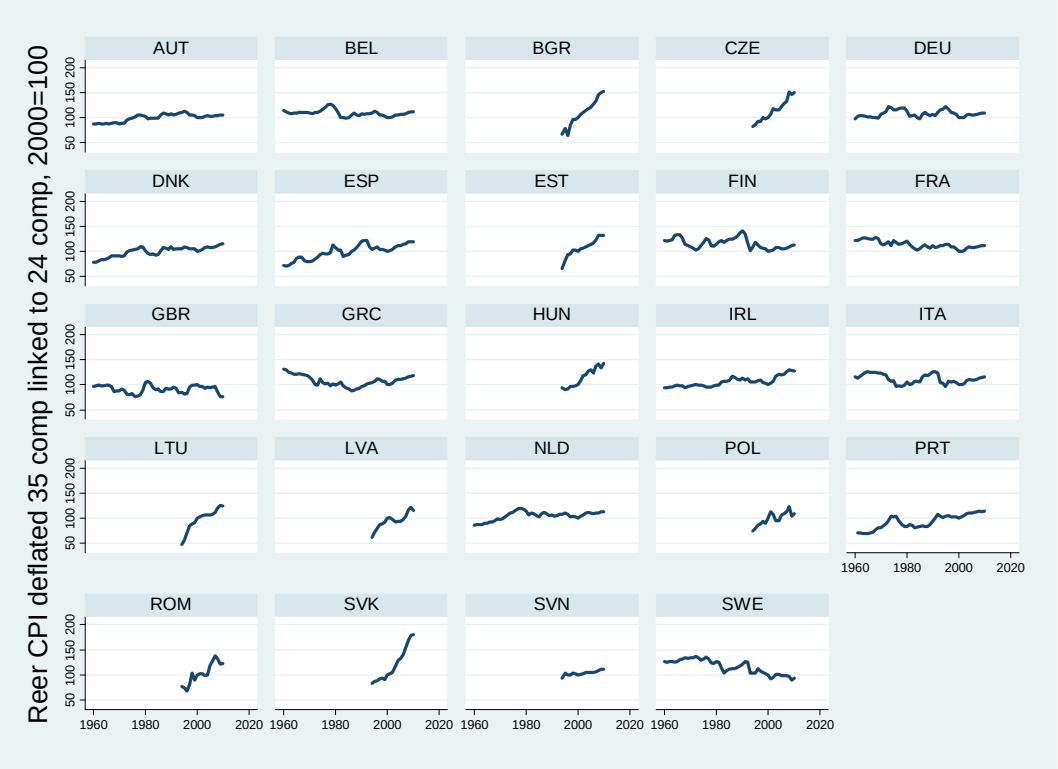

Figure 2. Exchange rate misalignment box plot,
24 EU countries, various approaches, various sub-periods

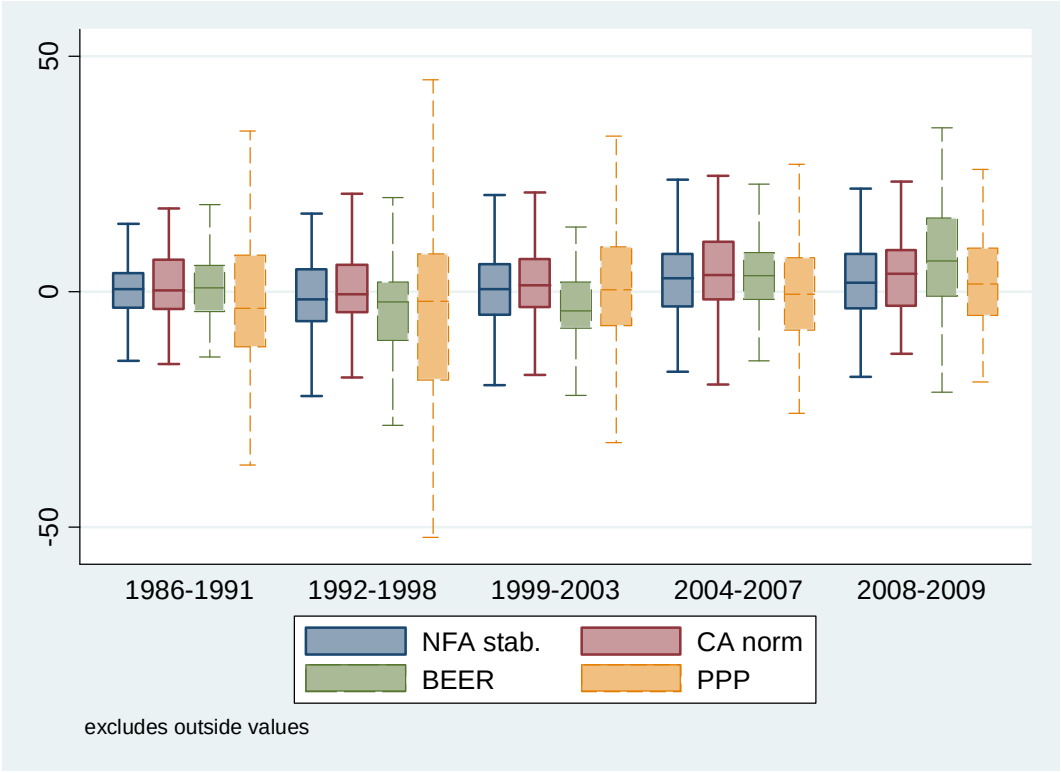

Figure 3. Exchange rate misalignment box plot,
11 euro-area countries, various approaches, various sub-periods

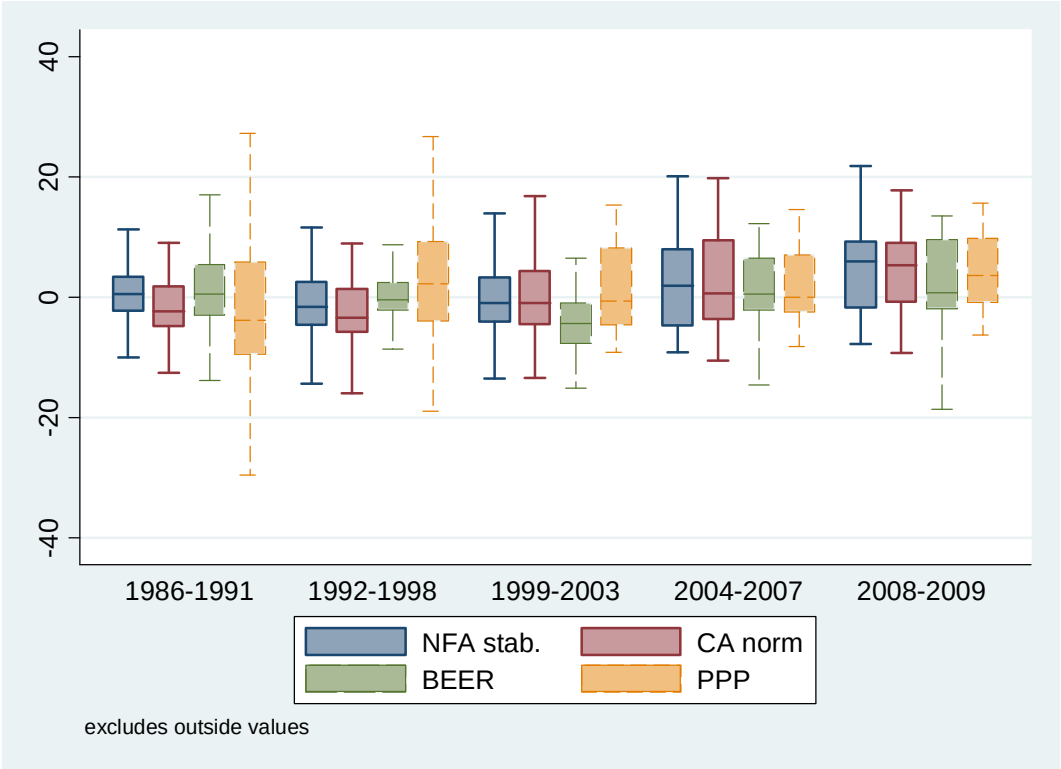

Figure 4. Exchange rate misalignment box plot,
3 EU non euro-area, non-NMS countries, various approaches, various sub-periods

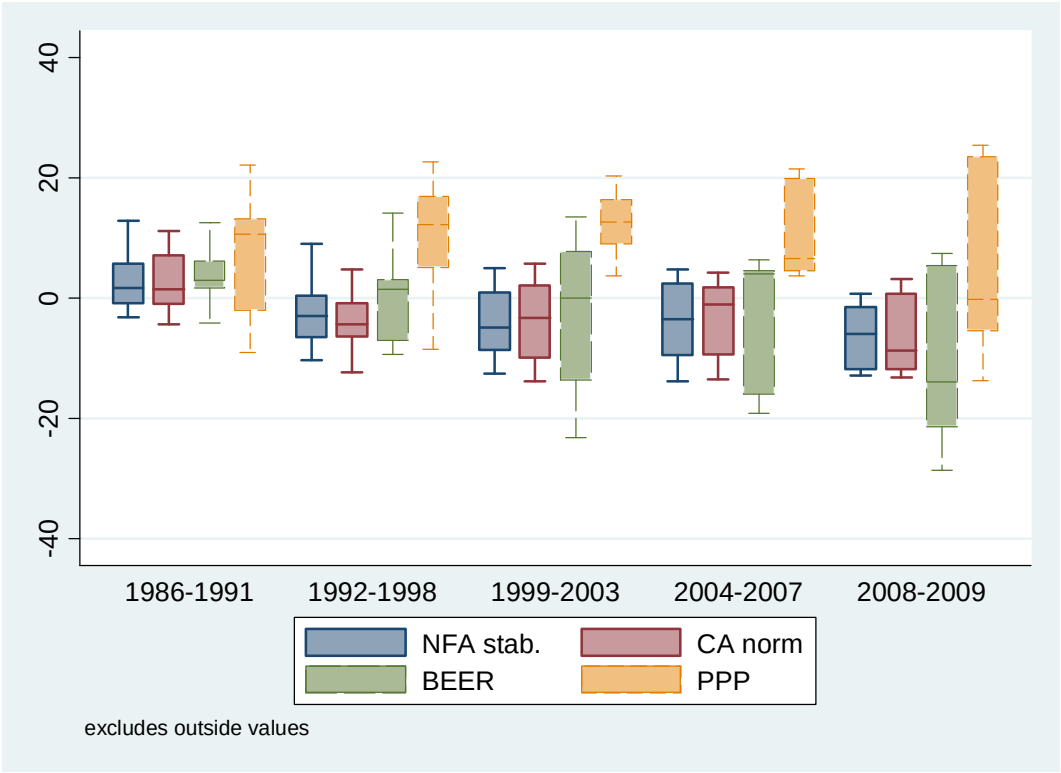

Figure 5. Exchange rate misalignment box plot,
12 EU NMS countries, various approaches, various sub-periods

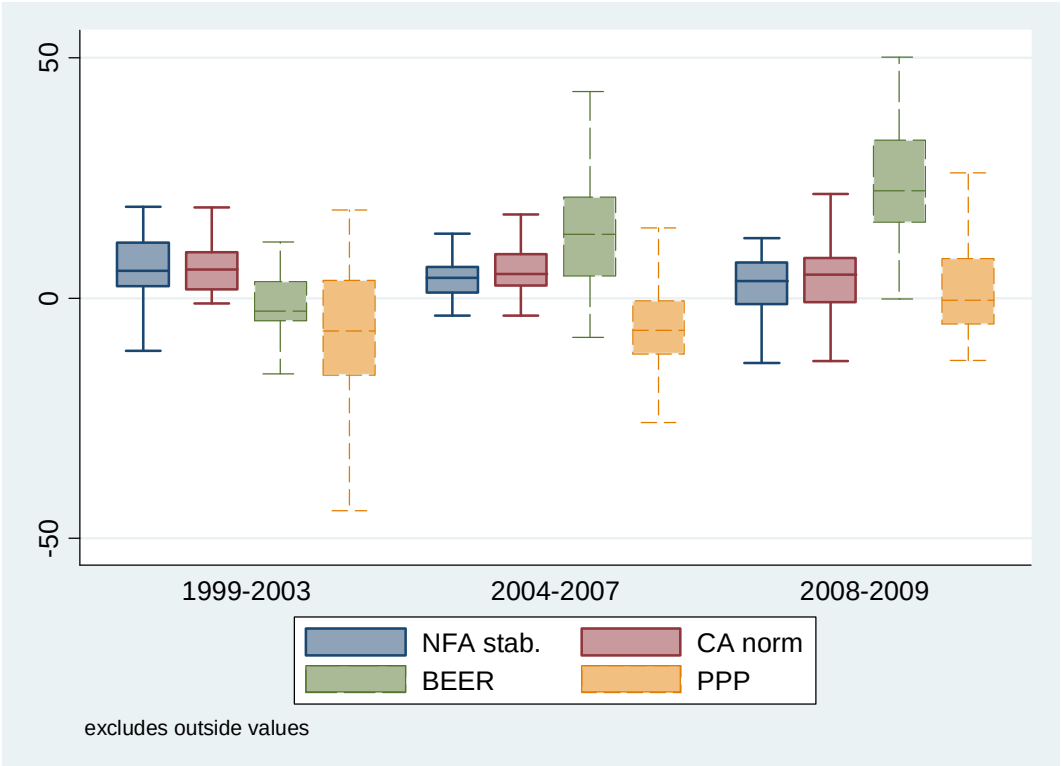

Figure 6. Exchange rate misalignment box plot,
EU countries with hard pegs and in monetary union, various approaches, various sub-periods

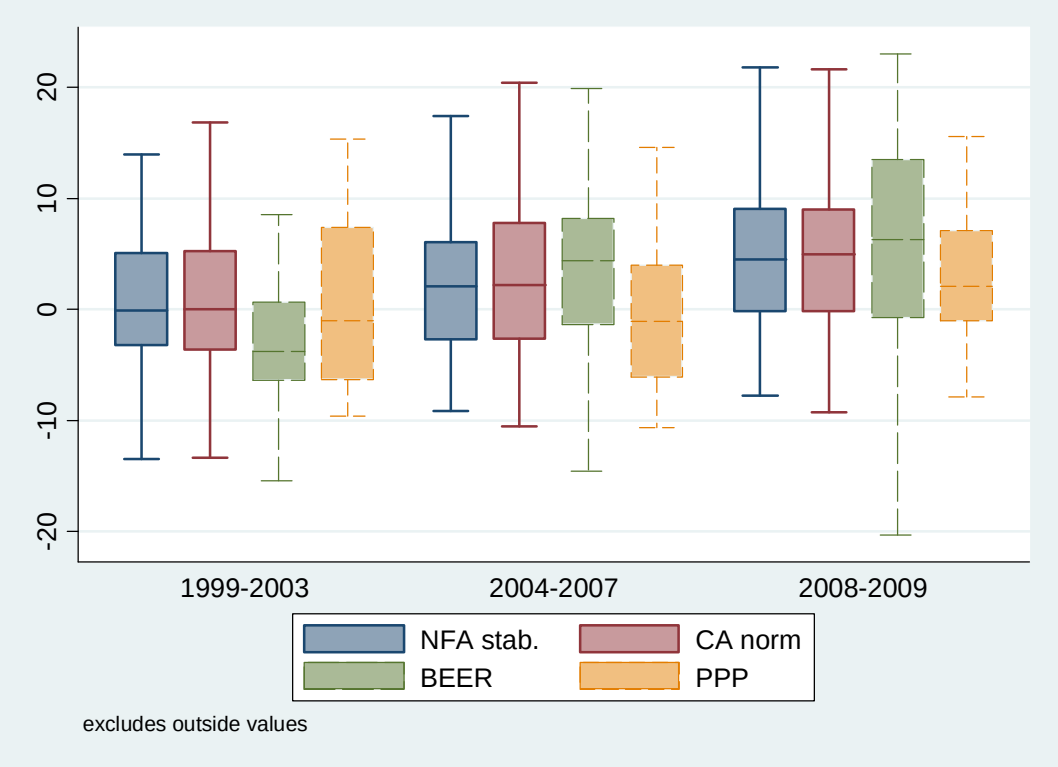

Figure 7. Exchange rate misalignment box plot,
EU countries with intermediate exchange rate regimes, various approaches, various sub-periods

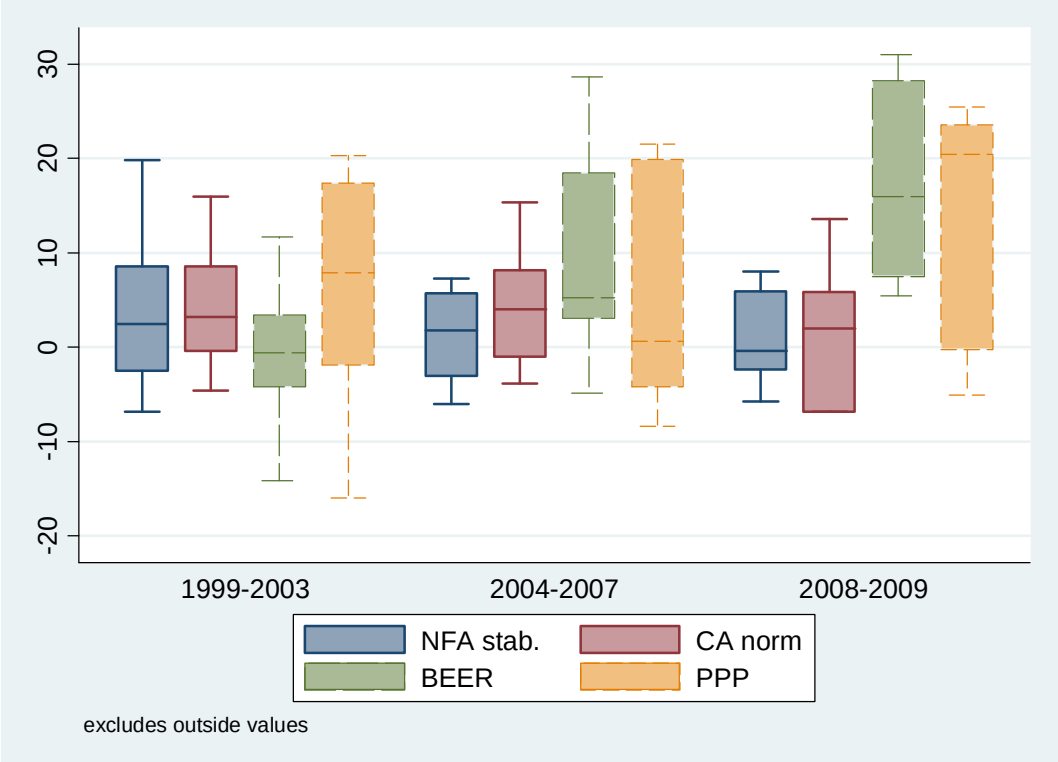

Figure 8. Exchange rate misalignment box plot,
EU countries with flexible exchange rate regimes, various approaches, various sub-periods

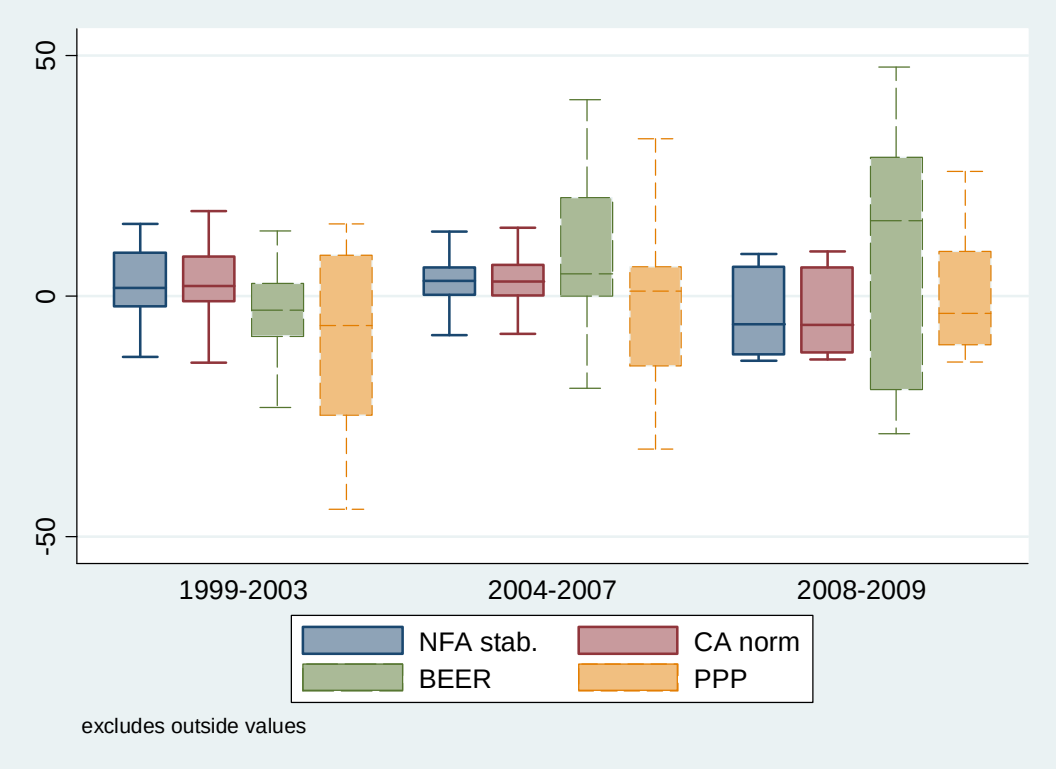

Figure 9. Current account semi-elasticities

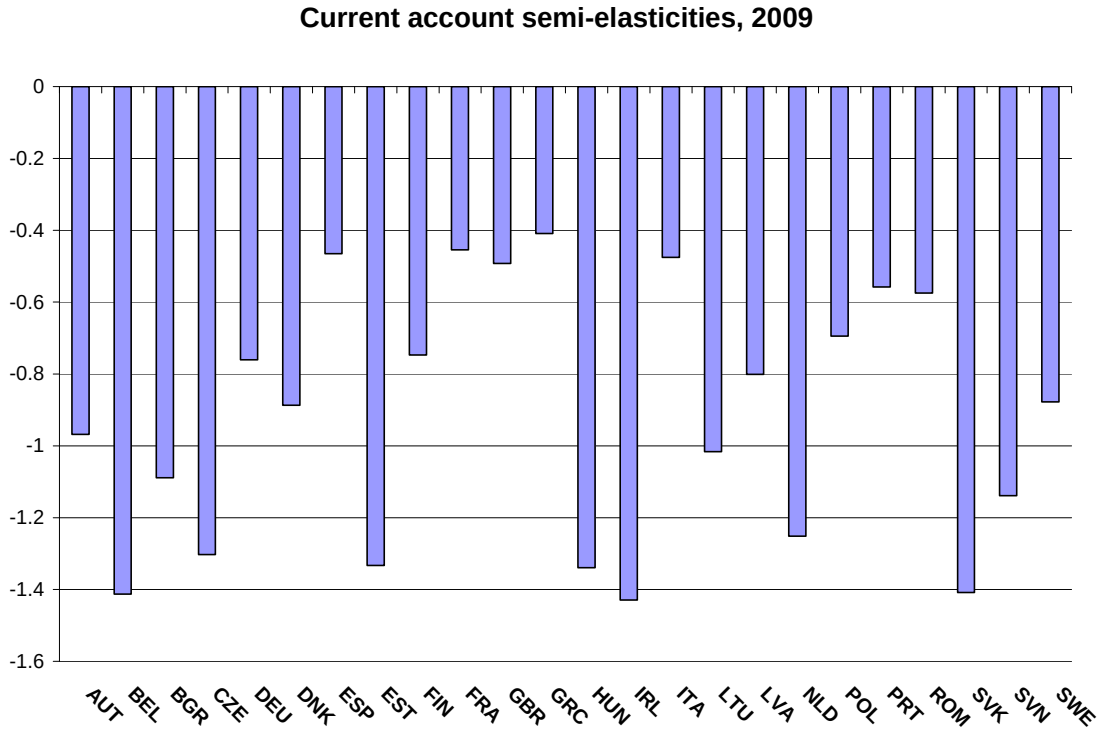

Table 1: Determinants of current account norms (60 countries, 4-year averages over the 1970-2010 period)

Dependent variable: current account/GDP	
Explanatory variables	
Government budget balance/GDP	0.27***
	(3.91)
Old-age dependency ratio	-0.13***
	(-2.77)
Real GDP per capita in PPP term relative to US	2.23**
	(2.06)
Growth rate in GDP per capita	-0.18*
	(-1.83)
Initial NFA/GDP	0.05***
	(6.91)
Oil balance	0.004***
	(3.76)
Constant	2.01**
	(2.46)
N. observations	336
R squared	0.40

Notes: Estimation: OLS with standards errors robust with respect to heteroschedasticity and residual correlation within panels. The absolute value of t tests is reported in parentheses. *,**,*** denote, respectively, statistical significance at 90, 95, 99 per cent. For the last period of estimation the average is over the available observations of the 2004-2010 period: data for 2009 and 2010 are based on the AMECO Autumn 2009 Forecast.

Table 2: Estimated co-integrating parameters (based on consumption-deflated REER) – (14 EU non-NMS countries + 8 non-EU OECD countries, 1970-2008)

Dependent variable:	Log (consumption-deflated REER)
Government consumption/GDP	0.30 *** [0.00]
NFA/GDP	0.08 *** [0.00]
Relative prices of NT/T	0.20*** [0.00]
N. observations	804

Notes: Estimation: OLS with p-values based on Newey-West standards errors. ***, **, * indicates significance at the 1%, 5% and 10% level respectively.

Table 3: Estimated relation between PPP deviations and relative potential income per capita, current PPPs (26 EU countries + 9 non-EU OECD countries, 1995-2010)

Dependent variable:	Log (PPP exchange rate / nominal exchange rate with euro)
Potential real income per capita in PPP / Potential real income per capita in PPP of the euro area	0.78*** (16.57)
Constant	0.03 (1.27)
N. observations	560
N. cross-sectional units	35
R. squared between	0.89

Notes: Estimation: Panel between estimator. T-statistics reported in parentheses. ***, **, * indicates significance at the 1%, 5% and 10% level respectively.

Table 4: Autoregressive behaviour of misalignment measures obtained via different approaches (24 EU countries, 1986-2009)

Dependent variable	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation (lag)	0.544***			
	[5.763]			
Misalignment current account norm (lag)		0.545***		
		[4.705]		
Misalignment BEER (lag)			0.830***	
			[19.38]	
Misalignment PPP (lag)				0.685***
				[19.61]
Constant	0.592***	0.388**	1.092***	0.258
	[4.337]	[2.415]	[88.89]	[1.351]
Observations	462	466	476	513
Number of countries	24	24	24	24
R-squared	0.445	0.372	0.738	0.756

Country fixed effects included. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 5: Autoregressive behaviour of misalignment measures obtained via different approaches (24 EU countries, 1986-2009, only negative lagged misalignment values)

Dependent variable	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation (lag)	0.694***			
	[13.35]			
Misalignment current account norm (lag)		0.593***		
		[11.09]		
Misalignment BEER (lag)			0.745***	
			[13.32]	
Misalignment PPP (lag)				0.667***
				[18.13]
Constant	-0.2	-1.207***	0.104	-1.989***
	[0.71]	[4.19]	[0.25]	[2.93]
Observations	198	211	240	273
Number of countries	20	20	24	20
R-squared	0.42	0.26	0.46	0.73

Country fixed effects included. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 6: Autoregressive behaviour of misalignment measures obtained via different approaches, distinguishing by exchange rate regime (24 EU countries, 1986-2009)

	Hard pegs and monetary union				Intermediate exchange rate regimes				Flexible exchange rate regime			
Dependent variable:	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation (lag)	0.578***				0.632***				0.355***			
	[8.638]				[4.427]				[5.829]			
Misalignment current account norm (lag)		0.599***				0.580***				0.298***		
		[5.738]				[3.318]				[5.841]		
Misalignment BEER (lag)			0.758***				0.750***				0.844***	
			[12.97]				[22.38]				[10.78]	
Misalignment PPP (lag)				0.557***				0.560***				0.696***
				[62.79]				[16.88]				[8.662]
Constant	1.375***	1.292***	1.505***	0.657***	-0.194	-0.265	0.931***	1.513***	0.502***	0.489***	0.609***	-1.485
	[10.52]	[4.679]	[48.50]	[31.04]	[-0.910]	[-1.710]	[24.81]	[48.63]	[5.339]	[6.577]	[6.414]	[-1.369]
Observations	162	162	164	168	130	131	135	146	104	107	111	127
Number of countries	16	16	16	16	17	18	19	19	11	11	12	14
R-squared	0.68	0.50	0.74	0.90	0.37	0.31	0.69	0.61	0.10	0.08	0.71	0.56

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

[1]=Misalignment NFA stabilisation
[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 7: Misalignment and subsequent REER developments (24 EU countries, 1986-2009)

Dependent variable: % change in REER in coming 5 years	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation	-0.350***			
	[-5.752]			
Misalignment current account norm		-0.359***		
		[-4.381]		
Misalignment BEER			-0.539***	
			[-5.318]	
Misalignment PPP				-0.572***
				[-5.706]
Constant	4.596***	4.576***	3.456***	4.449***
	[111.9]	[114.7]	[13.58]	[30.21]
Observations	424	426	436	446
Number of countries	24	24	24	24
R-squared	0.103	0.086	0.259	0.306

Country fixed effects included. Robust t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 8: Misalignment and subsequent current account developments (24 EU countries, 1986-2009)

Dependent variable: change in current account/GDP ratio in coming 5 years	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation	0.078			
	[2.68]***			
Misalignment current account norm		0.162		
		[4.30]***		
Misalignment BEER			-0.008	
			[0.28]	
Misalignment PPP				0.0314
				[0.929]
Constant	-0.153***	-0.176***	-0.159**	-0.315
	[-7.214]	[-8.388]	[-2.076]	[-1.599]
Observations	424	426	436	472
Number of countries	24	24	24	24
R-squared	0.02	0.08		0.02

Country fixed effects included. Robust t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 9: Developments following large misalignment episodes (24 EU countries, 1986-2009)

	[1]		[2]		[3]		[4]	
	t	t_{+5}	t	t_{+5}	t	t_{+5}	t	t_{+5}
Average value of misalignment below 25 percentile and average value after 5 year	-17.49	-10.90	-8.32	-3.14	-14.77	-3.14	-30.88	-15.90
Average value of misalignment above 75 percentile and average value after 5 year	11.57	2.21	14.23	5.68	15.14	1.73	24.50	6.21

Misalignment definition:

[1] Misalignment NFA stabilisation

[2] Misalignment current account norm

[3] Misalignment BEER

[4] Misalignment PPP

Table 10: Correlation among different misalignment measures (24 EU countries, 1986-2009)

	NFA stabilisation	Current account norm	BEER	PPP	Percentage difference of REER compared with country average
NFA stabilisation	1				
Current account norm	0.9070*	1			
BEER	0.3664*	0.3671*	1		
PPP	-0.0297	-0.0304	0.1194*	1	
Percentage difference of REER compared with country average	0.4806*	0.4382*	0.8832*	0.2598*	1

Table 10bis: Correlation among different misalignment measures excluding the values near between-5% and +5% (24 EU countries, 1986-2009)

	NFA stabilisation	Current account norm	BEER	PPP	Percentage difference of REER compared with country average
NFA stabilisation	1				
Current account norm	0.9111*	1			
BEER	0.2669*	0.3198*	1		
PPP	-0.1086	-0. 0697	0. 2220*	1	
Percentage difference of REER compared with country average	0. 3927*	0. 4334*	0. 8654*	0. 3588*	1

Table 11: Correlation among different misalignment measures distinguishing for the exchange rate regime of countries (24 EU countries, 1986-2009)

		NFA stabilisation	Current account norm	BEER	PPP
Currency board and monetary union					
	NFA stabilisation	1			
	Current account norm	0.9139*	1		
	BEER	0.3045*	0.3496*	1	
	PPP	0.0701	-0.052	-0.0875	1
Intermediate exchange rate regimes					
	NFA stabilisation	1			
	Current account norm	0.9426*	1		
	BEER	0.0509	0.1281	1	
	PPP	-0.1560	-0.071	0.2287*	1
Flexible exchange rate regime					
	NFA stabilisation	1			
	Current account norm	0.9277*	1		
	BEER	0.6323*	0.6110*	1	
	PPP	-0.2050*	-0.192	0.0911	1

Table 12: Percentage of cases in which a given misalignment measure is the only one to point in a different direction (24 EU countries, 1986-2009)

	NFA stabilisation	CA norm	BEER	PPP	Total
3 measures indicate overvaluation	3.2	2.3	17.6	34.7	57.9
3 measures indicate undervaluation	4.2	3.2	7.9	26.9	42.1
Total	7.4	5.6	25.5	61.6	100.0

Table 12bis: Percentage of cases in which a given misalignment measure is the only one to point in a different direction excluding the values near between-5% and +5% (24 EU countries, 1986-2009)

	NFA stabilisation	CA norm	BEER	PPP	Total
3 measures indicate overvaluation	0.0	6.9	12.1	22.4	41.4
3 measures indicate undervaluation	6.9	1.7	3.4	46.6	58.6
Total	6.9	8.6	15.5	69.0	100.0

Table 13: Do different misalignment measures lead each other? (24 EU countries, 1986-2009)

Dependent variable:	[1]	[2]	[3]	[4]
Misalignment NFA stabilisation (lag)		0.399***	0.168	0.280***
		[3.017]	[1.158]	[3.152]
Misalignment current account norm	0.536***		0.193	0.312***
	[4.996]		[1.151]	[3.062]
Misalignment BEER	-0.0231	-0.0644		0.390***
	[-0.217]	[-0.859]		[6.650]
Misalignment PPP	0.111	0.0296	0.715***	
	[0.802]	[0.274]	[7.036]	

Country fixed effects included. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression coefficient is obtained from a different fixed effect regression of the dependent variable against a single explanatory variable.
Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Table 14: Investigating the determinants of different misalignment measures (24 EU countries, 1986-2009)

Dependent variable: see footnote	[1]	[2]	[3]	[4]
Lagged dependent variable	0.73***	0.737***	0.794***	0.825***
	[17.01]	[17.56]	[11.44]	[29.53]
Fiscal shock (average y-o-y change in the cyclically adjusted primary balance/GDP ratio between t-1 and t-3)	-0.637**	-0.743**	-0.224	-0.368
	[2.57]	[2.77]	[0.72]	[1.16]
German interest rate shock (change in German real interest rates on 10 year government bonds between t-1 and t-3)	-0.303**	-0.353**	-0.047	-0.129
	[2.30]	[2.23]	[0.25]	[0.71]
Interest rate spread shock (change in the spread over German real interest rates on 10 year government bonds between t-1 and t-3)	-0.233**	-0.335***	-0.061	-0.151
	[2.44]	[4.04]	[0.42]	[1.19]
Supply shock (change in growth rate of potential growth between t-1 and t-3)	0.144	0.226***	0.041	0.086
	[1.72]	[3.35]	[0.44]	[1.48]
Bank crisis (a banking crisis occurred in one of 3 latest years)	-3.08***	-4.988***	-7.923***	-7.177***
	[2.85]	[4.74]	[3.57]	[7.46]
Constant	0.103	-0.034	0.891***	0.679***
	[1.09]	[0.36]	[4.84]	[6.73]
Observations	368	368	368	368
Number of countries	23	23	23	23
R-squared (within)	0.55	0.57	0.65	0.72

Country fixed effects included. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable:

[1]=Misalignment NFA stabilisation

[2]=Misalignment current account norm

[3]=Misalignment BEER

[4]=Misalignment PPP

Data sources:.
Fiscal shocks, interest rate shocks, supply shocks,: elaboration on data from AMECO database. Banking crisis shock: Laeven and Valencia (2008).