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## Explaining and forecasting euro area exports: which competitiveness indicator performs best?

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EUROPEAN CENTRAL BANK

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**WORKING PAPER SERIES**

**NO 833 / NOVEMBER 2007**

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# EXPLAINING AND FORECASTING EURO AREA EXPORTS

## WHICH COMPETITIVENESS INDICATOR PERFORMS BEST? <sup>1</sup>

by Michele Ca' Zorzi  
and Bernd Schnatz <sup>2</sup>



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## Abstract

*From a conceptual point of view there is little consensus of what should be the “ideal indicator” of international cost and price competitiveness as each of the standard measures typically employed has its own merits and drawbacks. This calls for addressing the question from an empirical angle, searching for the indicator that best explains and helps forecast export developments. This paper constitutes a first attempt to systematically compare the properties of the alternative cost and price competitiveness measures of the euro area. Although they diverge sometimes, we find little evidence that there is one indicator consistently outperforming the other in terms of explaining and forecasting euro area exports. This suggests that the measures based on consumer and producer prices, which offer some advantages in terms of quality and timeliness, are good approximations of euro area price and cost competitiveness.*

JEL: F17, F31, F41

Keywords: real exchange rate, trade, exports, price competitiveness, euro area, forecast.

## Non-technical summary

This paper is a first attempt to systematically compare the properties of alternative cost and price competitiveness measures of the euro area. To this end we examine five measures of real effective exchange rates plus one based on relative export prices. From a conceptual point of view there is little consensus of what should be the “ideal competitiveness indicator”, as each standard measure has its own merits and drawbacks. This calls for addressing the question from an empirical angle, in particular by looking for the indicator that best explains and helps forecast export developments.

We find that for all six measures of competitiveness considered, the estimated export equations yield results which are sensible and consistent with previous studies. An improvement of cost and price competitiveness by 1% appears to be associated with a rise in extra-euro area export volumes by 0.3-0.4% for most measures, except relative export prices, where a stronger reaction of about 0.6% is found. This is consistent with the existence of pricing-to-market strategies. We also find that a rise in foreign demand by 1% generally implies a rise in export volumes in the range between 0.75-0.8% and hence significantly lower than unity. This implies that, in the period under review, the euro area tended to lose export market shares in the global economy. Only when using relative export prices as competitiveness indicator, the elasticity of euro area exports to foreign demand is not found to be significantly different from unity.

Assessing the relative performance of these indicators, the “in-sample” properties of the estimated export equations are found to be rather similar across indicators and thus do not allow to reach firm conclusions on which measure is “best”. The real effective exchange rate based on consumer prices has a marginally lower standard error. An encompassing test suggests, however, that the producer price based indicator appears marginally better.

Turning to forecasting performance, we find that the measure based on relative export prices provides the most accurate forecasts in case of recursive estimation. It provides, however, marginally worse forecasts if we assume that the final model structure was already known in the past. Overall, we come to the conclusion that no particular indicator appears consistently superior according to all the criteria that we have chosen.

This suggests that measures based on consumer and producer prices, which offer considerable advantages in terms of timeliness and historical availability, could be considered good approximations of euro area price and cost competitiveness conditions.

## 1. Introduction

*“Competitiveness is commonly understood as the ability of a country to compete in international markets. This ability is usually assessed on the basis of various measures of cost and price competitiveness and complemented by accounting for non-price factors...”* stated ECB President Trichet at the Testimony at the Economic and Monetary Affairs Committee of the European Parliament on 10 October 2006. The objective of this paper is to assess empirically whether among the cost and price competitiveness indicators at our disposal, it is possible to single out one which outperforms the other in explaining and predicting extra-euro area export volumes. To this end we examine five measures of real effective exchange rates (REER) plus one based on relative export prices (RXP) reviewing their usefulness as plausible measures of competitiveness for the euro area. After concluding that, from a methodological standpoint, none of them can *a priori* be defined as “superior” or “inferior”, we assess their relative empirical performance.

In particular, two key questions are addressed here. Our first aim is evaluating the responsiveness of export flows to price competitiveness changes by estimating, as precisely as possible, a number of key elasticities. Our second aim is examining their relative performance in explaining and forecasting export flows.

Our paper builds on the work by Anderton et al. (2004), who similarly estimated extra-euro area export elasticities in terms of measures of demand and relative prices.<sup>2</sup> It also relies on the framework developed by Marsh and Tokarick (1996) and Clostermann (1998) for assessing the quality of alternative competitiveness indicators on the basis of their in-sample performance. In their study, Marsh and Tokarick (1996) assess three measures of cost and price competitiveness in terms of their ability to explain trade flows across the G-7 countries. They come to the overall conclusion that none emerges as superior to the other in its ability of explaining exports. By contrast, Clostermann (1998) finds that indicators based on broad cost and price indices perform best in explaining external trade in Germany. In particular, this author concludes that the measure based on total expenditure deflators (similar to the GDP deflator used in this paper) not only contains all the relevant information of other real exchange rate indicators but also has additional explanatory power.

This paper differs from these two previous studies as it is – to our knowledge – the first which systematically examines the relative merits of the real effective exchange rates of the euro in explaining and forecasting extra-euro area exports. Moreover, methodologically, we go beyond the in-sample comparison of the different measures by assessing the out-of-sample forecasting performance of export equations based on different cost and price competitiveness indicators.

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<sup>2</sup> This approach does not look at disaggregated data, although this might provide additional insights. For such an analysis, see ECB (2005).



For all six measures of competitiveness employed here, the estimation of export equations yields results which are sensible and consistent with previous studies. An improvement of cost and price competitiveness by 1% appears to be associated with a rise in extra-euro area export volumes by 0.3-0.4% for most measures, except relative export prices, where a stronger reaction of about 0.6% is found. This is consistent with the existence of pricing-to-market strategies, which dampen the variability in the measure based on relative export prices.

Turning to their relative performance as price competitiveness measures, we find support for the conclusion by Marsh and Tokarick (1996) that no single indicator can be said to be superior to the other in all circumstances. In more detail, our findings are the following: *in-sample* the export equation employing the real effective exchange rate based on developments in consumer prices has the lowest standard error; whereas, by testing more formally their relative merits with a general-to-specific modelling approach, we come to the conclusion that the export equation using the real effective exchange rate based on producer prices marginally outperforms the other indicators; *out-of-sample* instead, irrespective of the assumptions made for the evolution of the explanatory variables over the forecast horizon, the competitiveness measure based on relative export prices provides the most accurate forecast of export volumes, if we gradually modify the model estimates in line with incoming information. Assuming instead that the last estimated model structure was already known in the past, indicators based on producer prices and unit labour costs perform slightly better. The differences across these models are, however, generally marginal and do not permit to plainly favour one indicator above the other. An implicit conclusion one may draw from this analysis is that measures based on consumer prices or producer prices, which offer some advantages in terms of quality, comparability and timeliness, do not appear to be inferior approximations of euro area cost and price competitiveness relative to other measures.<sup>3</sup>

The remainder of the paper is structured as follows: The next section provides a brief conceptual discussion of the merits and drawbacks of different measures of price competitiveness based on consumer prices (CPI), producer prices (PPI), unit labour costs in the manufacturing sector (ULCM) and in the total economy (ULCT) and presents some stylised facts about the relationship between the various indicators of cost and price competitiveness and the euro area export performance. Section 3 presents estimates of euro area export equations across the different indicators and a first assessment of indicator quality. Subsequently, in Section 4 the relative performance of the cost and price competitiveness indicators is compared in a forecasting

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<sup>3</sup> The paper investigates an empirical regularity between measures of competitiveness and the export performance of the euro area without delving into more normative discussions of the concept of cost and price competitiveness from a welfare point of view. In this context, for instance, Chinn (2006) suggests that, while it is true that a weaker domestic currency in real terms makes it easier to sell domestic goods abroad, at the same time, it “is also equivalent to a worse trade-off in terms of number of the domestic units required to obtain a single foreign unit”. Accordingly, a loss in price competitiveness associated with a rise in purchasing power has ambiguous wealth effects.

exercise using four different methods to evaluate the merits of each indicator. Finally, Section 5 contains our main conclusions.

## 2. Exports, cost and price competitiveness and foreign demand: stylised facts

### 2.1. Suitable cost and price competitiveness measures: A conceptual discussion

There is little consensus about what should constitute an “ideal indicator” for measuring a country’s international cost and price competitiveness (see also the discussion in ECB (2003)). A real exchange rate measure based on *export prices* is intuitively the most natural candidate for explaining developments in external trade of a country – as it refers directly to the price of exports charged in foreign markets (see Chinn 2006). More formally, this can be represented as:  $q^T = (s - p^T + p^{T*})$ , where  $s$  is the log exchange rate (using the foreign currency as numeraire) and  $p^T$  and  $p^{T*}$  are the home and foreign tradable prices respectively. Other things being equal, the higher is  $q^T$  the more a country is able to sell its tradable products abroad. However, this indicator has a number of potential shortcomings: Firstly, export price determination is subject to pricing-to-market behaviour, i.e. export prices are endogenous to changes in the exchange rate. However, the variation in profit margins can compensate for exchange rate fluctuations only in the short to medium term; if relative costs and prices shift persistently, pricing-to-market strategies are not a sustainable option in the long term. Secondly, as discussed by Marsh and Tokarick (1996), export prices, when measured in terms of export unit values, are not transaction prices but average values per physical unit. A change in composition in exports across countries may therefore have an impact on this index without implying a change in competitiveness conditions. Thirdly, publication lags and strong revisions might also be an issue impeding a timely assessment based on this indicator. Finally, it is generally more difficult to find comparable export price measures among different countries than for other indicators of cost and price competitiveness.

As a result, cost and price competitiveness is often examined on the basis of indicators, which use broader cost and price measures and, thus, reflect more a country’s “underlying competitiveness”, defined as the relative cost position in the tradable sector, in turn often proxied by the manufacturing sector. Chinn (2006), for instance, considers a mark-up model of pricing in the tradable goods sector:  $p^T = \log \left[ \left( 1 + \mu \right) \left( \frac{W}{A} \right) \right]$  where  $\mu$  is percentage mark-up,  $W$  is the nominal wage rate,  $A$  is labour productivity. In this framework, price competitiveness can then be decomposed in terms of relative *unit labour costs*:  $q^T = (s - (w - a) + (w^* - a^*))$ . Compared to

using export prices, this measure has the convenient property of focusing on the cost side of the traded goods sector. It would therefore also account for lower profit margins in case of pricing-to-market behaviour. Although this indicator has become rather popular in the debate on price competitiveness, it is subject to a number of conceptual and statistical drawbacks. Conceptually, it can be argued that a focus on the manufacturing sector, which accounts for only about 20% of the total economy in large countries such as the euro area, is too narrow. Using instead a broader indicator such as *unit labour costs in the total economy* has the drawback that it includes the cost of many non-tradable goods, which are only indirectly affecting the price competitiveness of the export sector. At the same time, as emphasised by Marsh and Tokarick (1996) changes in the price of non-traded goods will also change the relative incentives to shift production toward the export sector. Accordingly, developments in the non-traded sector are also important for a more broadly defined concept of competitiveness. A caveat that applies to all indicators based on unit labour costs is that these reflect only a fraction of the total cost of a firm, ignoring for instance, distribution costs, taxes etc. Moreover, the evolution of these indicators may be affected by factor substitution, which does not necessarily imply a more efficient production. Finally, Lane (2004) has argued that in sectors subject to strong activity of multinationals, output growth may be affected by activities to optimise the tax burden of multinationals which leads to a bias in the statistics. For Ireland, for instance, Lane (2004) concludes that “... the broadly-based GDP deflator is less affected by this problem than are the ULC-based series.” Likewise, Clostermann and Friedmann (1998) also reported sizeable measurement problems of the ULCM-based indicator for Germany, suggesting that the ULCM-based indicator showed a rather peculiar trend, which seemed to be unrelated to developments in Germany’s actual competitiveness position and export performance.

Turning to broader measures of price competitiveness, *producer prices* are commonly considered to be suitable approximation of traded goods prices as the underlying basket includes a broad range of industrial products and goods that are subject to international competition. Compared to relative export prices, this indicator encompasses goods that could be traded across borders if the relative price would turn more favourable, while export prices include only those products which are effectively traded. This is in line with Neary (2006) who argues that one should pay equal attention to all sectors exposed to foreign competition, also domestically and not only in export markets, if one is concerned about economy-wide implications of changes in competitiveness. At the same time, however, producer prices have the main drawback that they do not include service prices, which in turn have become increasingly important in international trade.

A measure including service prices, which is sometimes employed in such analyses and proved to be rather successful in explaining German external trade (Clostermann, 1998), is a real exchange rate indicator based on *GDP deflators*. However, the latter is subject to distortions owing to taxes and subsidies and it shares with PPI-based indicators the drawback that the underlying price measures are not fully comparable across countries.

Competitiveness indicators based on developments in *consumer prices* avoid this problem as the definition of the consumer price index is reasonably homogenous across countries. Conceptually, however, it does not seem to be a good representation of price competitiveness in the tradable sector. It does not take prices of capital and intermediate goods into account and it is subject to distortions owing to taxes and subsidies. CPI-based indicators also include a significant share of non-traded consumption goods. The inclusion of non-traded goods in the price index underlying the competitiveness indicator is particularly distorting if productivity developments differ across sectors. Assuming that the share of non-tradables is the same in the domestic and the foreign economy,  $q$  can be rearranged as follows:  $q = q^T - \alpha(\hat{p}^N - \hat{p}^T)$  where  $\hat{p}^N$  and  $\hat{p}^T$  denote the relative price of home and foreign goods in the non-tradable (N) and tradable (T) sector (Chinn, 2006). Under the assumption that wages are equalised across sector, the Balassa-Samuelson (BS) literature has shown that:  $E(\hat{p}^N - \hat{p}^T) = E(\hat{a}^T - \hat{a}^N)$ , where in turn  $\hat{a}^T - \hat{a}^N$  represents the difference between relative (total factor) productivity in the tradable and non-tradable sector in the two countries (see for example Ca'Zorzi et al. (2005)). In countries where the BS effect is an important feature of the economy and productivity in tradable sector increases rapidly, cost pressures are likely to arise in the non-tradable sector. Under these circumstances the CPI-based real exchange rate could be a rather poor approximation of price competitiveness conditions in the exporting sector. In analysing trade among highly developed countries or regions like the euro area in which the Balassa-Samuelson is plausibly rather small, this approximation might be instead more reasonable. In particular, for the case of the United States, Engel (1999) has shown that the variation in the relative price of non-tradables  $\hat{p}^N - \hat{p}^T$  is rather unimportant.

In a nutshell, this discussion shows that it will be difficult to reach consensus on a conceptual basis on what constitutes the “ideal indicator” for measuring a country’s international cost and price competitiveness. Accordingly, the assessment becomes an empirical matter based on the relative performance of a wide range of measures of cost and price competitiveness in explaining export developments.

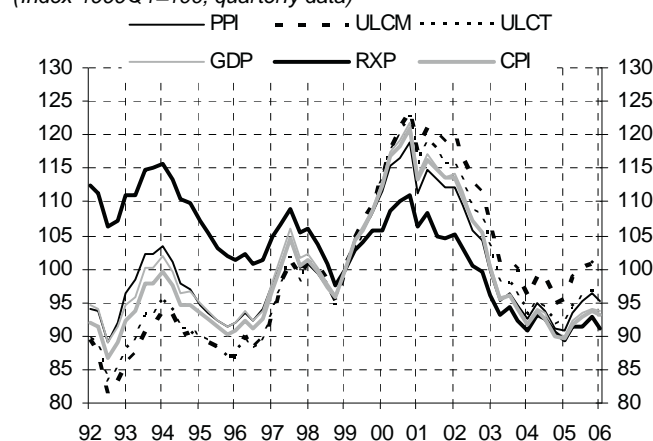
## **2.2 Data description and stylised facts**

In spite of their conceptual differences, developments in the different indicators for the euro area show generally a similar pattern (see Chart 1). In what follows the alternative measures of euro area cost and price competitiveness based on consumer prices (CPI), producer prices (PPI), unit labour costs in the manufacturing sector (ULCM) or in the total economy (ULCT), GDP deflator (GDP) or export prices (RXP) are measured consistently against twelve important trading partners of the euro area applying the same methodology (see Appendix A.1 for a detailed description of the data). Overall, while most indicators show a high degree of co-movement, a somewhat different picture emerges by examining the indicator based on relative export prices, as the latter seems characterised by a downward trend since 1992. This suggests that the euro area export prices had a tendency to rise faster than those of the euro area partner countries, thus, implying a gradual loss in export price competitiveness of the euro area. However, it may also

reflect a statistical artefact: Owing to the unavailability of a consistent set of data on export deflators of goods and services for the euro area countries, euro area export prices are defined as unit value indices (UVI) and competitors' export prices are based on export deflators of goods and services. UVI, however, do not control for the changes in the composition and quality of products. Assuming that the composition of euro area exports gradually has moved towards higher quality and more expensive goods, these UVI, *ceteris paribus*, tend to grow faster than price deflators, which might introduce a downward bias into the competitiveness indicator based on relative export prices. All other indicators of cost and price competitiveness do not suggest such a secular decline.

**Chart 1. Different measures of euro areas' cost and price competitiveness.**

(Index 1999Q1=100; quarterly data)



Source: ECB.

Note: Last observation refers to 2006Q1. An upward/downward movement indicates a real depreciation/appreciation of the euro.

Correlations across indicators in levels and in first differences confirm this broad assessment (see Table 1). The upper-right triangular matrix shows the correlations in levels while the lower-left triangular matrix shows the correlations in log differences. It shows that correlations are generally close to or above 0.9 for all indicators – even for relative export prices if one looks at developments in differences. At the same time, the standard deviation of the indicator based on relative export prices – both in levels and in differences – is lower compared to the other indicators, which is indicative for pricing-to-market behaviour, i.e. an exchange rate appreciation is partially offset by a reduction of profit margins and an adjustment of export prices to maintain market shares.



**Table1: Correlation across indicators**

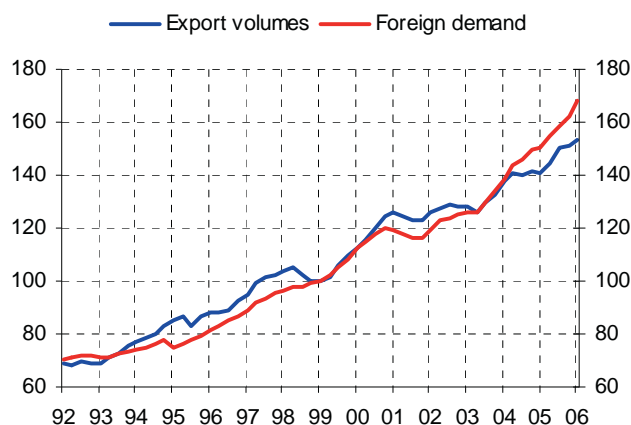
	CPI	PPI	ULCM	ULCT	GDP	RXP
CPI	-	0.99	0.92	0.97	1.00	0.33
PPI	0.99	-	0.88	0.94	0.99	0.42
ULCM	0.95	0.93	-	0.99	0.89	-0.04
ULCT	0.97	0.95	0.97	-	0.95	0.11
GDP	1.00	0.99	0.96	0.97	-	0.40
RXP	0.93	0.94	0.89	0.90	0.93	-
St-dev.	8.9	7.7	11.3	10.3	8.6	7.2
St-dev (diff.)	2.7	2.7	2.9	2.9	2.8	2.1

Note: The lower-left triangular matrix shows the correlations in differences while the upper-right triangular matrix shows the correlations in levels.

Chart 2 shows that extra-euro area export volumes seem to have grown over most of the past 15 years in line with foreign demand, as defined by the weighted average of imports of extra euro area trading partners. Between 1995 and 1999 and after 2004, however, this chart suggests some decoupling between the two series, which could be partly ascribed to the real appreciation of the euro and the associated decline in price competitiveness of euro area exports.

**Chart 2. Extra-euro area exports and foreign demand.**

(Index 1999Q1=100; quarterly data)



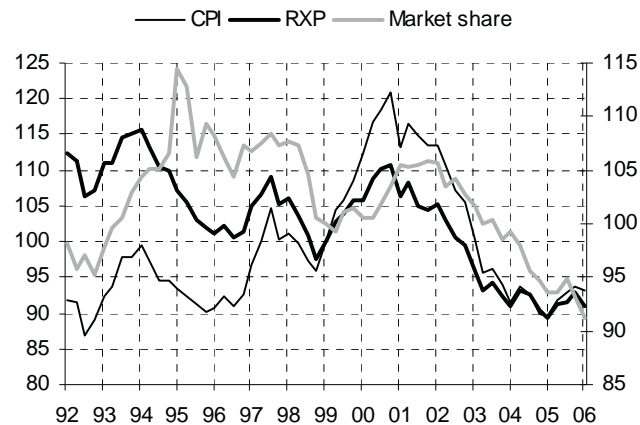
Source: ECB.

Note: Last observation refers to 2006Q1.

Indeed, the export market share of the euro area, i.e. the ratio between export volumes and foreign demand appears to corroborate some co-movement with cost and price competitiveness indicators. In particular, the real appreciation of the legacy currencies of the euro between mid-1997 and 1999 coincided with a sharp loss in euro area market shares, while the euro area regained market shares when the euro experienced a sharp decline after its launch in 1999, which significantly improved the cost and price competitiveness of euro area exports. It seems that the subsequent recovery of the euro which unfolded after 2002, and the corresponding rapid decline in price competitiveness, was associated with a marked decline in the euro area export market shares. A detailed assessment of the developments in market shares is provided in ECB (2005).

**Chart 3. Extra-euro area market share and competitiveness indicators**

(Index 1999Q1=100; quarterly data)



Source: ECB.

Note: Last observation refers to 2006Q1.

Given these stylised facts, in the next section we carry out a more elaborate econometric estimation of euro area export equations, by modelling both the short-term components (expressed in differences) as well as the long term components (expressed in levels).

### 3. Empirical methodology and estimation results

The standard formulation for the export equation is commonly based on the partial-equilibrium imperfect-substitutes model of international trade presented in Goldstein and Khan (1985) and takes the form of:  $x = \eta + \lambda f + \mu q$ , where  $x$  represents the (log) of real exports,  $q$  is (the log of) the real effective exchange rate as a measure of cost and price competitiveness and  $f$  is the (log) of foreign demand. In what follows, the real effective exchange rate is measured on the basis of the six different indicators presented in the previous section. A rise in foreign demand and a rise in cost and price competitiveness – the latter reflecting a depreciation of the domestic currency in real terms – should be associated with an increase in real exports. Thus,  $\lambda$  and  $\mu$  are expected to be positive.

Unit root tests suggest that the variables to be estimated are non-stationary in levels (see Appendix A2 for details), which calls for an estimation in a cointegration framework. Following Clostermann (1998), Murata et al. (2000) as well as Marsh and Tokarick (1996), the analysis is conducted within a single equation error correction framework advocated by Stock (1987) in the following form:<sup>4</sup>

<sup>4</sup> Johansen cointegration tests indicate one cointegration vector for each model, except for the model including relative export prices, where the Trace test indicates two cointegration relationships. However, these tests should be interpreted with caution given the small number of observations (N=55 if one lag is included in the dynamics).

$$\Delta x_t = \alpha [x_{t-1} - (\beta_1 + \beta_2 f_{t-1} + \beta_3 q_{t-1})] + \sum_{i=1}^n \gamma_{1,n} \Delta x_{t-i} + \sum_{i=0}^n (\gamma_{2,n} \Delta f_{t-i} + \gamma_{3,n} \Delta q_{t-i}) + \gamma_4 D95q2 - \gamma_5 D95q3 + \varepsilon_t \quad (1)$$

In equation (1), the long-term relationship is represented in brackets where the  $\beta$ 's constitute the long-run coefficients. Both,  $\beta_2$  and  $\beta_3$  are expected to be positive and  $\beta_2$  equal to unity as a country should have a stable export market share in the long-run. Frequently, the restriction of  $\beta_2 = 1$  is imposed to satisfy this theoretical constraint and a time trend is added to account for changes in market shares within the sample period (see, e.g. Barrell et al. (2006)). In this context, Murata et al. (2000) suggest that neither of these approaches – allowing  $\beta_2$  to differ from one or imposing such restriction and including a time trend – dominates the other in terms of explanatory power. Krugman (1989) however argues that imperfect competition and increasing returns to scale help explain the empirical regularity why slow (fast) growing countries seem to face a low (high) income elasticity of demand for their exports. In export equations such as this, the income elasticity would appear to be systematically related also to the country's long term rate of growth. The conclusion one may draw from his analysis is that the restriction of unity should not be imposed without carrying out the appropriate standard tests.

The  $\gamma$ 's in equation (1) are the short-term dynamics coefficients, where  $\Delta$  is the first-difference operator. Moreover,  $\alpha$  is the error correction coefficient and determines the speed of mean reversion. A significantly negative  $\alpha$  would be evidence for a stable long-term relationship between export volumes and its determinants. In addition to the variables presented above, we included two separate dummy variables for the second and third quarter of 1995 to capture high volatility in that particular year, unrelated to both foreign demand and cost and price competitiveness conditions. Finally,  $\varepsilon_t$  is the white-noise error term. To obtain a parsimonious specification, a general-to-specific method was employed. To begin with, the model was estimated with four lags in the dynamics ( $n = 4$ ), which were stepwise excluded when they were insignificant using the method proposed by Hendry (1993). This procedure resulted for each case in a very parsimonious specification which included in the short-run dynamics only the first difference of foreign demand (without lag) and the first difference in export volumes (with one lag).

Table 2 suggests that for each model using a different cost and price competitiveness measure, a stable long-run relationship exists.<sup>5</sup> In fact, with the exception of the equation based on relative export prices, the estimates that we obtain are all fairly similar. A rise in foreign demand by 1% generally implies a rise in export volumes in the range between 0.75 – 0.8% and – according to a

<sup>5</sup> Based on the standard t-distribution, the error correction coefficients are statistically significant. The critical values provided by Banerjee et al. (1998) is less supportive to the prevalence of cointegration. As additional evidence, Johansen cointegration tests indicate one cointegration vector for each model, except for the model including relative export prices, where the Trace test indicates two cointegration relationships. However, these tests should be interpreted with caution given the small number of observations (N=55 if one lag is included in the dynamics).



Wald-test – significantly lower than unity. The rejection of unity would imply that there is a fixed propensity to lose export market shares as foreign demand increases. In practice, this coefficient reflects the gradual loss in market shares of the euro area in the period under review that goes beyond what could be expected because of the price competitiveness channel. In line with the empirical regularity noted by Krugman (1989), a coefficient smaller than unity might pick up some model misspecification, possibly related to changes in supply conditions and the quality of products. As pointed out by Anderton et al. (2004), this could be related in particular to large-scale net FDI outflows from the euro area in the second half of the 1990s. The latter could imply that euro area multinationals have substituted their domestic exports with increased production abroad. Only in the model using relative export prices as the competitiveness indicator, the coefficient is at 0.93 and not significantly different from unity.

Turning to the competitiveness channel, an improvement of cost and price competitiveness by 1% appears to be associated with a rise in export volumes by 0.3-0.4% for most measures except relative export prices, where a stronger reaction of about 0.6% is found. The long-run reaction of export volumes to changes in relative export prices is slightly higher than in Anderton et al. (2004), who find an elasticity of 0.5.<sup>6</sup> Similarly, ECB (2005: p. 21) presents a summary of elasticities found in the ECB area-wide model and the multi-country model (total exports), which vary from 0.35 (for the Netherlands) to 0.58 in the case of euro area aggregate and Spain. For the other indicators of cost and price competitiveness, the elasticities are much lower than in Clostermann (1998) who finds in the case of German exports elasticities above 0.65 for most indicators. Murata et al. (2000) also find quite some variation in the price elasticity of exports across OECD countries. In a dynamic panel regression across 14 OECD countries, they suggest as a long-run elasticity of export volumes to changes in relative export prices close to unity, while Carlin et al. (2001) find a long-run elasticity of export volumes to changes in a ULC-based competitiveness indicator of around 0.20-0.30, close to the results in Table 2.

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<sup>6</sup> The magnitude of the response of exports to changes in the real exchange rate may also be subject to the perception of whether the change in the exchange rate is perceived temporary or permanent. This may be less relevant for relative export prices which take pricing-to-market behaviour more explicitly into account. It is, however, beyond the scope of this paper to assess the elasticity subject to market expectations.

**Table 2: Estimation results**

	CPI	GDP	PPI	ULCT	ULCM	RXP
ECT ( $\alpha$ )	-0.16	-0.16	-0.15	-0.16	-0.16	-0.13
<i>t</i> -value	-2.88	-2.86	-2.85	-2.82	-2.82	-2.57
<b>Long-term elasticities</b>						
Foreign demand ( $\beta_2$ )	0.80	0.80	0.80	0.77	0.75	0.93
<i>t</i> -value	12.33	12.40	11.85	10.58	9.85	9.60
Competitiveness ( $\beta_3$ )	0.32	0.33	0.39	0.29	0.29	0.61
<i>t</i> -value	2.08	2.04	2.02	1.97	2.00	1.54
Constant ( $\beta_1$ )	-0.52	-0.59	-0.84	-0.24	-0.15	-2.49
<i>t</i> -value	-0.78	-0.83	-1.01	-0.41	-0.28	-1.15
<b>Short-term elasticities</b>						
Real export; first difference, lagged ( $\gamma_{1,1}$ )	0.29	0.29	0.28	0.30	0.31	0.26
<i>t</i> -value	2.61	2.57	2.50	2.70	2.70	2.24
Foreign demand, first difference ( $\gamma_{2,0}$ )	0.51	0.52	0.52	0.51	0.51	0.53
<i>t</i> -value	3.68	3.70	3.71	3.66	3.63	3.66
Adj Rsq	0.47	0.47	0.47	0.47	0.46	0.46
Loglikelihood	159.8	159.7	159.9	159.5	159.5	159.3
Standard error	0.0143	0.0143	0.0143	0.0144	0.0144	0.0145
Durbin Watson	2.02	2.02	2.02	2.03	2.03	2.00
$\beta_2 = 1$ (Wald-test)	0.00	0.00	0.00	0.00	0.00	0.49

While the elasticities are quite different depending on the cost and price competitiveness measure used, the estimation results do not appear leading to firm conclusions about which measure is “best”. Both the adjusted coefficient of determination and the standard errors of the cost and price competitiveness measures are mostly very similar across alternative indicators. Only the measure based on relative export prices shows a t-value which is somewhat lower than for the other variables. In order to test more formally whether a real exchange rate indicator outperforms the others, Clostermann (1998) suggests using a multivariate encompassing test, where all real effective exchange rate series are included simultaneously into the estimation.

$$\Delta x_t = \alpha[x_{t-1} - (\beta_1 + \beta_2 f_{t-1} + \sum_{i=CI} \beta_i q_{t-1})] + \gamma_{1,1} \Delta x_{t-1} + \gamma_{2,0} \Delta f_t + \gamma_4 D95q2 - \gamma_5 D95q3 + \varepsilon_t$$

We impose the dynamic structure found in the general-to-specific procedure in (1) and employ again the general-to-specific framework to exclude stepwise further insignificant variables.<sup>7</sup> This

<sup>7</sup> The stepwise regression analysis which is based on the backward selection procedure (forward selection would give the same results). Backward selection starts with a model including all the price and cost competitiveness measures. The variable that has the highest p-value is excluded (“stepped out”). Each subsequent step excludes the variable that has the highest p-value in the presence of the predictors already in the equation. Variables are excluded (“stepped out”) one-at-a-time as long as their p-values are higher than 0.2. The stepwise regression, used in this paper, is similar except that variables that have been removed from the model are checked again at each step in case they become significant as other predictors are excluded. The software package RATS has been used to perform this test. We force a constant term to be in the regression although it is found to be insignificant.

procedure steps out all real effective exchange rate measures except the PPI-based indicator (see Table 3). The latter thus could be considered, at the margins, the most suitable indicator from this perspective.

**Table 3: Multivariate encompassing test**

REER variable stepped out	p-value
1. CPI	0.88
2. ULCM	0.80
3. GDP	0.57
4. RXP	0.24
5. ULCT	0.33

## 4. Forecasting performance: a horse race

### 4.1. Forecast methodologies and evaluation

In contrast to the existing economic literature which focuses on the performance of cost and price competitiveness indicators in estimated equations, in this section we compare the relative performance of these indicators in a forecasting framework. Altogether four different approaches are employed to evaluate the relative merits of each indicator. These are illustrated in Table 4.

**Table 4: Forecasting approaches**

		Model structure	
		Recursive estimates	Final estimates
Assumptions on the explanatory variables	Perfect foresight	A	C
	Forecast explanatory variables	B	D

Under the first two approaches, here labelled A and B, we assume that when a forecast is made, we only have past information about the true structure of the model. Thus we estimate the model recursively from the first quarter of 1992 to time  $t$  and forecast up to  $h$  quarters into the future, rolling  $t$  forward until reaching  $t+n$ . The maximum  $h$  step ahead forecast at  $t+n$  corresponds to the last quarter data available on export volumes. As regards the explanatory variables, we follow two strategies. While with approach A we assume having perfect foresight about their evolution, with approach B we introduce some simple modelling assumptions. More specifically, we assume that (i) foreign demand follows an AR(2) process with a time trend (ii) while the real exchange rate follows a driftless random walk. While the second assumption is a standard in

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Excluding the constant does not change the main results. For a reference, see Hendry (1993) as well as Hurvich and Tsai (1990).

forecasts involving the exchange rate, the first has been the result of a search grid involving autoregressive and moving average terms (up to 4) and using the standard information criteria. Approach A ensures that our findings are not dependent on the forecast assumptions made for the explanatory variables. Approach B, however, represents the more realistic situation in out of sample forecasting.

By using recursive estimates of the model structure, both approaches share, however, a common drawback. In both cases the forecast comparison can be based only on a relatively small number of  $n$  predictions. This is because we need a minimum number of observations  $t$  to estimate the model while having at the same time sufficient degrees of freedom and coefficient stability. Recursive parameter estimates (see Appendix A.3) indicate that the coefficients are estimated more tightly (as suggested by the error bands) and tend to become rather stable only after 2000q1. This larger error bands before are likely to be related to limited degrees of freedom available for the estimation. As we set the maximum step ahead at  $h = 8$  (i.e. 2 years) and the latest data point is 2006q1, we have at most four years of data for carrying out sensible recursive estimations. This implies that, with this approach, our forecast comparison is limited to 16 observations.

With the third and fourth approaches, here labelled C and D respectively, we attempt to mitigate the problem of limited observations by carrying out a dynamic simulation exercise. In this case, we assume to know the “true” structure of the model as found by estimating the model for the full sample period. This structure can then be employed for forecasting earlier periods in a rolling fashion, which implies that the problem of degrees of freedom and parameter stability subsides. For each forecast horizon, this increases the number of available forecasts, in our case to forty. This approach offers the advantage that we exploit the better knowledge we have now about the structural relationship among euro area variables than at the beginning of the decade. One more time this approach is implemented twice, the first time assuming perfect foresight for the explanatory variables (approach C) and the second by introducing the same simple assumptions for the explanatory variables discussed earlier (approach D). To compare the forecasts for export volumes across cost and price competitiveness indicators, forecast errors are computed for each model as the difference between the actual value at time  $t + h$  and the forecast value:

$$e_{t+h} = x_{t+h} - x_{t+h,t}$$

Subsequently, the forecasts are corroborated on the basis of the RMSE for each model over each forecast horizon:

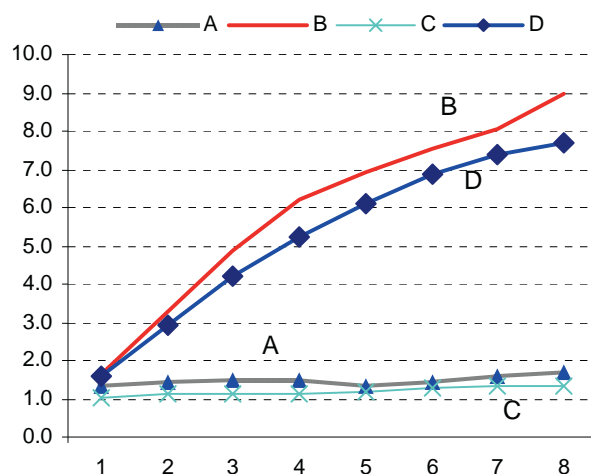
$$RMSE_h = \sqrt{\frac{1}{T} \sum_{t=1}^T e_{t+h,t}^2}$$

## 4.2. Results

It is interesting first of all to review the impact of the different approaches on the forecasting performance of our models. This is illustrated for example in Chart 4 with the equations which employ the producer price based real effective exchange rate as a competitiveness indicator. For other cost and price competitiveness indicators, the patterns are very similar.

**Chart 4. RMSE forecast patterns across forecasting approaches**

( $h$ = forecast horizon, indicator based on PPI)



Source: Authors' calculations.

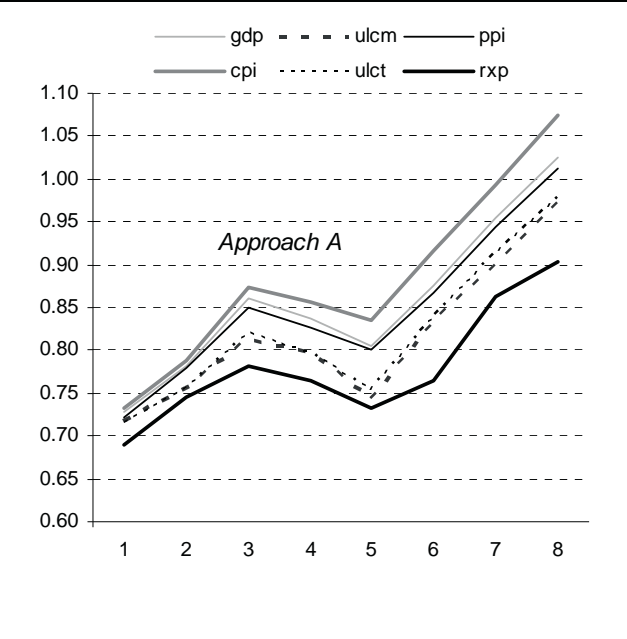
This chart shows that the models assuming perfect foresight for the explanatory variables are characterised by a rather modest increase in forecasting uncertainty as the horizon increases from 1 to 8 quarters (approaches A and C). By contrast models that have some simple autoregressive rules for foreign demand and the real exchange rate (approaches B and D), a corresponding step increase in the RMSE is recorded, which reflects the errors introduced by forecasting the explanatory variables as well.

The chart also shows that over the entire horizon the forecast based on the latest model structure (approaches C and D) are subject to slightly smaller errors than the one based on the rolling model structure (approaches A and B respectively). This indicates that the quality of the estimates has shown some improvement over time.

Turning to comparing forecasting accuracy across alternative indicators, Chart 5 shows that the forecast quality across models is rather similar along the forecast horizon (see Appendix A.4. for the detailed results in Tables). On the vertical axis this chart shows the RMSE for each model relative to the value corresponding to a simple random walk specification.

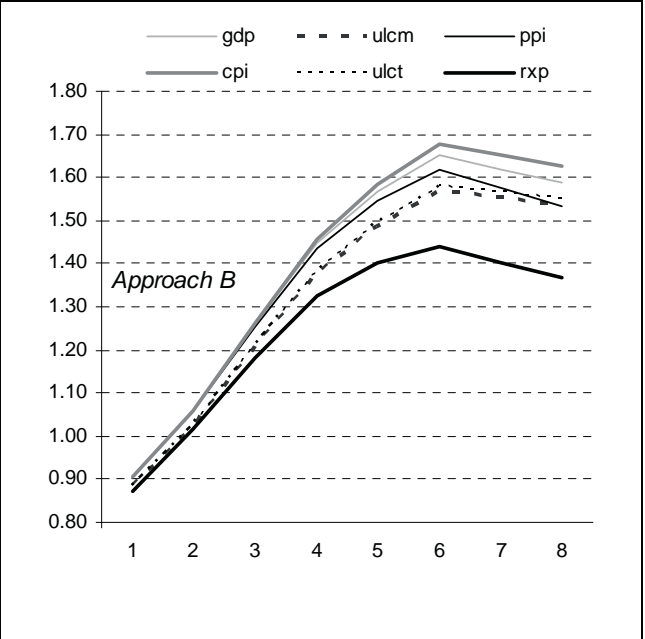
**Chart 5a: Recursive estimates and perfect foresight**

*Model-RMSE relative to random walk RMSE*



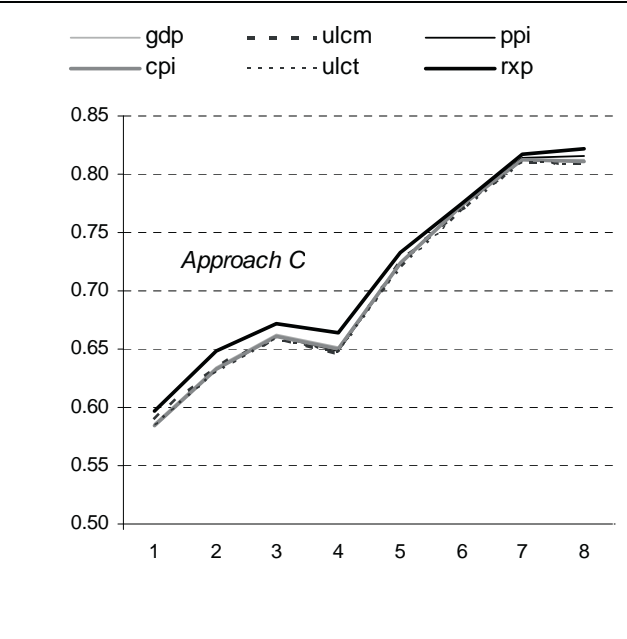
**Chart 5b: Recursive estimates and forecast for explanatory variables**

*Model-RMSE relative to random walk RMSE*



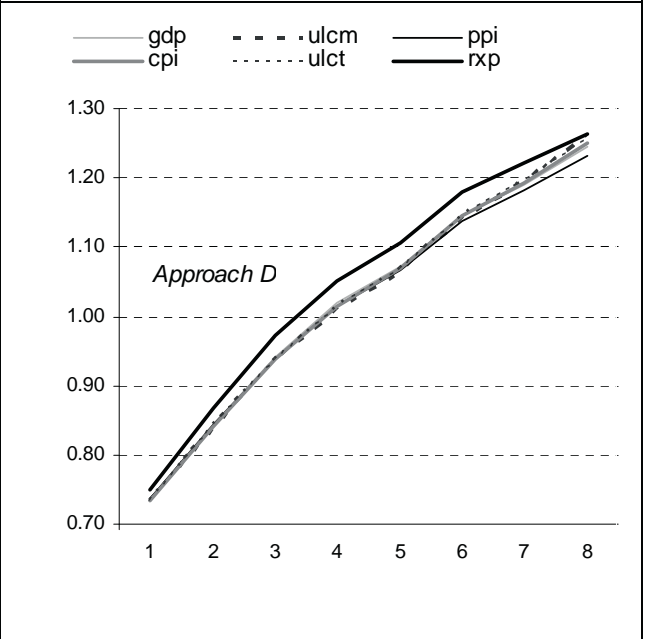
**Chart 5c: Final estimates and perfect foresight**

*Model-RMSE relative to random walk RMSE*



**Chart 5d: Final estimates and forecast for explanatory variables**

*Model-RMSE relative to random walk RMSE*



*Source: Authors' calculations.*

In both approaches which employ recursive estimates (A and B) the measure based on relative export prices outperforms the other indicators, particularly at longer horizons. In the case of perfect foresight of the explanatory variables, the export equations perform well vis-à-vis the random walk hypothesis (approach A). When we introduce for illustrative purposes some simple autoregressive assumptions for the evolution of fundamentals, relative export prices still

outperform the other indicators but the random walk forecast for exports turns out to be superior for horizons longer than two quarters (approach B).

Using, instead of recursive, the final estimates based on the full sample period (approaches C and D), there is a sizeable improvement of the forecasting accuracy relative to the random walk model and the performance is even more similar across models. This suggests that the precision of the estimated export equations has improved noticeably in recent years. When we assume perfect foresight all export equation models turn out to be superior to the random walk at all horizons irrespective of the price competitiveness measure used (approach C). When for illustrative purposes we model the evolution of the explanatory variables, all models appear superior to the random walk hypothesis for horizons of up to one year (approach D). Contrary to the cases with a recursive estimation procedure, this time it is the competitiveness indicator based on relative export prices which performs marginally worse than the others. Overall, however, the forecast performances of the indicators are very close to each other, so that effectively, each model can equally be used to forecast extra-euro area exports.

## 5. Conclusions

A systematic examination of the link between euro area exports and different measures of cost and price competitiveness suggests that there is little consensus of what should be the “ideal indicator” for measuring international cost and price competitiveness. In this paper we have addressed this question from an empirical angle by estimating alternative export equations based on different real effective exchange rates for the euro area. The elasticities that we have found for the corresponding export equations appear all in all rather sensible and broadly in line with previous findings. In particular, we have shown that an improvement in the cost and price competitiveness conditions by 1% appears to be associated with a rise in export volumes by 0.3-0.4% for most measures. The main exception to this is the measure based on relative export prices, where a stronger reaction of about 0.6% is found. This difference in the magnitude of these elasticities is consistent with the existence of pricing-to-market strategies, which dampens the variability in the measure based on relative export prices.

In this paper we have also compared the relative performance of these alternative measures in explaining *in-* and *out-*of sample export developments. As it turns out, in our in-sample exercise the export equation based on the CPI real effective exchange rate has the lowest standard error; whereas the export equation based on the PPI real effective exchange rate appears marginally better if a parsimonious specification is obtained via a general-to-specific modelling approach.

The out-of-sample exercise suggests instead that, irrespective of the assumptions made about the explanatory variables, the competitiveness measure based on relative export prices provides the most accurate forecasts of export volumes if the structure is recursive. If we assume instead that the latest structure of the model was already known in the past, there is again little difference

across indicators with the model based on relative export prices, though, performing marginally worse than the others.

Overall we have come to the conclusion that, although sometimes they diverge, no particular indicator has so far shown to be consistently superior to the other according to all the criteria that we have chosen. This implies that the measures based on consumer and producer prices, which offer considerable advantages in terms of timeliness, historical availability and revision needs, could be considered good approximations of euro area price and cost competitiveness conditions. Various extensions of the analysis may be possible as data availability improves. For instance, more consistent data on export prices, longer sample periods as time progresses or as more backward data is generated could improve the accuracy of estimated export equations. In addition, future research could improve the specification in export equations, for example by introducing non-linear mean reversion in the specification of the exchange rate.



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## Appendix A1. Data sources

The data used in this analysis covers a sample period between 1992Q1 to 2006Q1. The corresponding sources are as follows:

**Nominal exchange rates** (period average): Euro exchange rates against the currencies of 12 partner countries. Prior to 1999, a weighted average of euro legacy currencies has been employed. Partner countries included: Australia, Canada, Denmark, Hong Kong, Japan, Norway, Singapore, South Korea, Sweden, Switzerland, United Kingdom, and USA.

**Real Effective Exchange Rate:** REER-12 index, based on five deflators, i.e. consumer prices, producer prices, unit labour costs (total economy), unit labour cost (manufacturing), GDP deflator, average of observations through period. For relative export prices, the same methodology is applied to achieve the highest possible comparability across alternative indicators. The real effective exchange rates are computed by applying the following geometric mean:

$$\prod_{i=1}^N \left( \frac{d_i}{d_{euro}} e_{i,euro} \right)^{w_{ii}}$$

where  $d_i$  and  $d_{euro}$  are the cost and price deflators for partner country  $i$  and the euro area respectively,  $N$  stands for the number of competitor countries in the reference group against which the external value of the euro is measured,  $e_{i,euro}$  is an index of the exchange rate of the currency of partner country  $i$  vis-à-vis the euro and  $w_i$  is the overall trade weight assigned to the currency of the trading partner  $i$ . Further details on the methodology underlying the weighting scheme can be found in the ECB Monthly Bulletin, September 2004, Box 10 and in Buldorini et al. (2002).

**Export Price Index:** Extra-euro area 12 trade, Unit Value Index, seasonally adjusted.

**Export Competitor Price:** Aggregated with the same weights employed for the EER indexes. Export prices (goods and services, SA) are based on Quarterly National Accounts (OECD) whenever available. For Hong-Kong, Singapore, external trade statistics was used (only goods) from the IFS (line 70).

**Foreign Demand:** Euro area foreign demand is a weighted average of imports of extra euro area trading partners. It is computed as follows:  $EAFD = \prod_{i=1}^n M_i^{\alpha_i}$  where  $M_i$  is the index of total import volumes of country/region  $i$ ; and  $\alpha_i = X_{EA,i} / X_{EA}$  is the share of country/region  $i$  in the euro area total exports (extra trade only) where  $X_{EA,i}$  represents the export value of the euro area to country  $i$  and  $X_{EA}$  is euro area total export values. The weights are calculated on the basis of a time-varying scheme based on three-years moving averages.

**Extra-euro area real exports:** Extra Euro 12 trade, Export volume index, goods, seasonally adjusted.

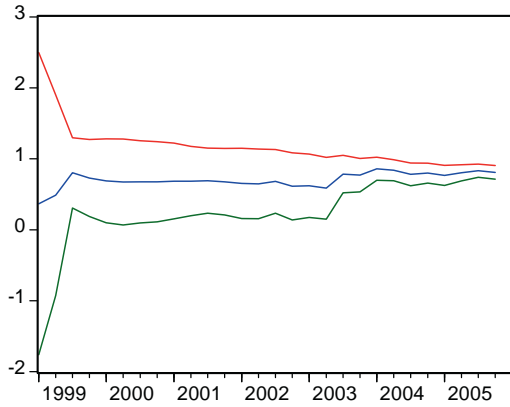
## Appendix A2.

**Table A1. ADF-tests**

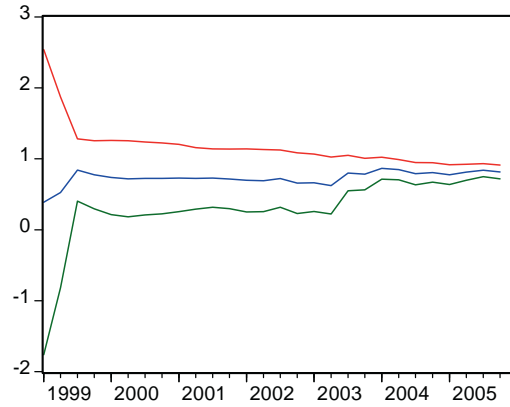
Variable	Levels			
	Lag=4		SIC	
Real exports	-1.357	0.596	-0.552	0.873
Foreign demand	0.928	0.995	1.830	1.000
<i>Competitiveness based on</i>				
• Consumer prices	-1.810	0.372	-1.581	0.486
• Producer prices	-1.984	0.293	-1.392	0.580
• GDP deflator	-1.812	0.371	-1.594	0.479
• ULC (manufacturing)	-1.875	0.341	-1.196	0.670
• ULC (total economy)	-1.925	0.319	-1.242	0.650
• Relative export prices	-1.236	0.652	-0.820	0.806
	First differences			
Real exports	-4.005	0.003	-5.857	0.000
Foreign demand	-3.344	0.018	-5.372	0.000
<i>Competitiveness based on</i>				
• Consumer prices	-2.957	0.046	-5.678	0.000
• Producer prices	-3.194	0.026	-5.825	0.000
• GDP deflator	-3.039	0.038	-5.704	0.000
• ULC (manufacturing)	-2.731	0.076	-5.699	0.000
• ULC (total economy)	-2.742	0.074	-5.895	0.000
• Relative export prices	-3.594	0.009	-6.331	0.000

## Appendix A3.

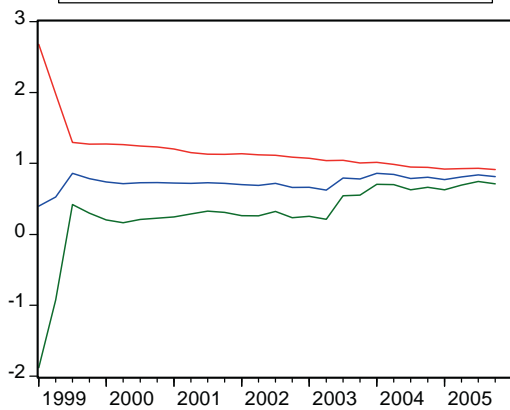
### Charts: Recursive parameter estimates for foreign demand and competitiveness indicators.



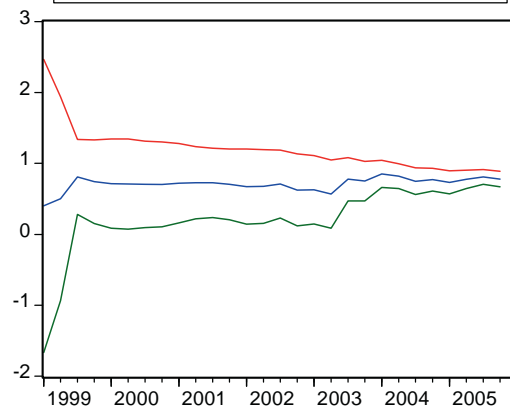
— BETA FD\_Q\_CPI\_N  
 — BETA FD\_Q\_CPI\_{N+1.5} \* SEFD\_Q\_CPI\_N  
 — BETA FD\_Q\_CPI\_{N-1.5} \* SEFD\_Q\_CPI\_N



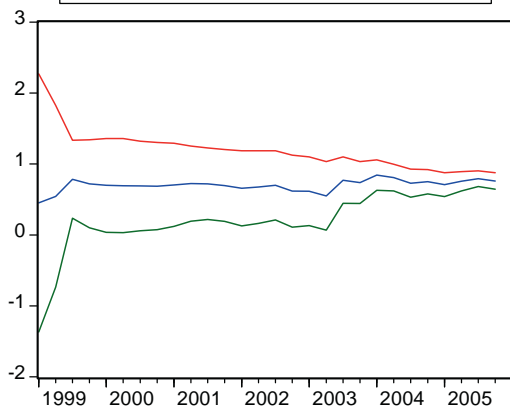
— BETA FD\_Q\_GDP\_N  
 — BETA FD\_Q\_GDP\_{N+1.5} \* SEFD\_Q\_GDP\_N  
 — BETA FD\_Q\_GDP\_{N-1.5} \* SEFD\_Q\_GDP\_N



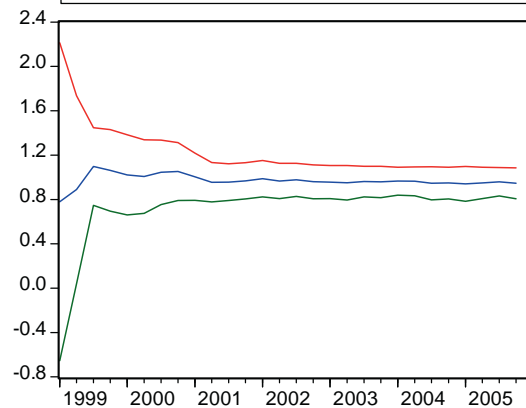
— BETA FD\_Q\_PPI\_N  
 — BETA FD\_Q\_PPI\_{N+1.5} \* SEFD\_Q\_PPI\_N  
 — BETA FD\_Q\_PPI\_{N-1.5} \* SEFD\_Q\_PPI\_N



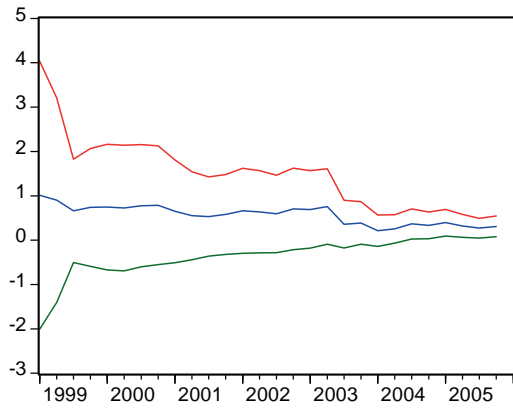
— BETA FD\_Q\_ULCT\_N  
 — BETA FD\_Q\_ULCT\_{N+1.5} \* SEFD\_Q\_ULCT\_N  
 — BETA FD\_Q\_ULCT\_{N-1.5} \* SEFD\_Q\_ULCT\_N



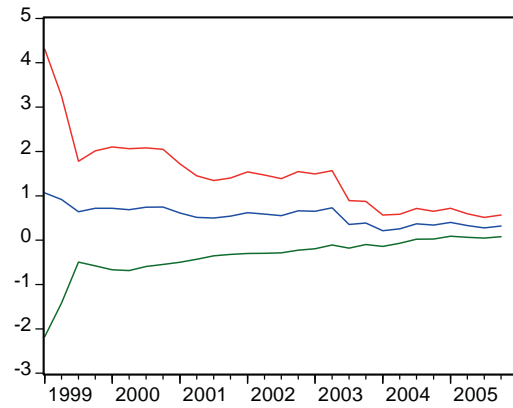
— BETA FD\_Q\_ULCM\_N  
 — BETA FD\_Q\_ULCM\_{N+1.5} \* SEFD\_Q\_ULCM\_N  
 — BETA FD\_Q\_ULCM\_{N-1.5} \* SEFD\_Q\_ULCM\_N



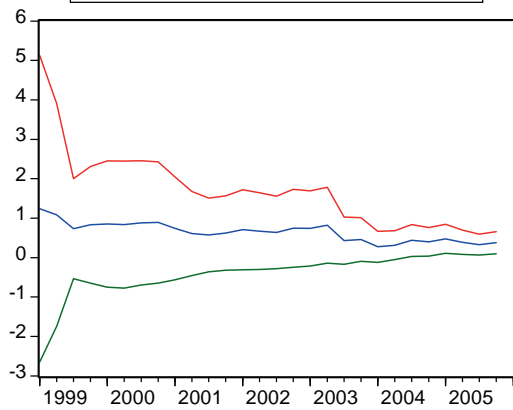
— BETA FD\_Q\_X\_N  
 — BETA FD\_Q\_X\_{N+1.5} \* SEFD\_Q\_X\_N  
 — BETA FD\_Q\_X\_{N-1.5} \* SEFD\_Q\_X\_N



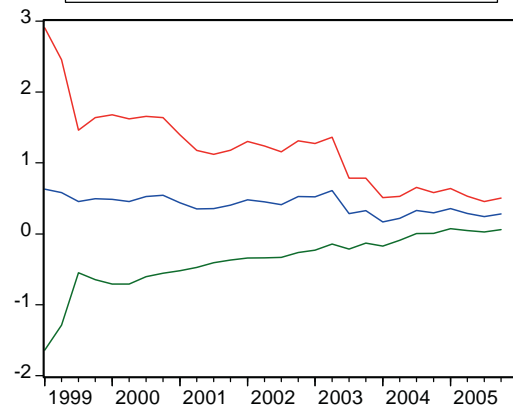
— BETAQ\_Q\_CPI\_N  
 — BETAQ\_Q\_CPI\_N+1.5\*SEQ\_Q\_CPI\_N  
 — BETAQ\_Q\_CPI\_N-1.5\*SEQ\_Q\_CPI\_N



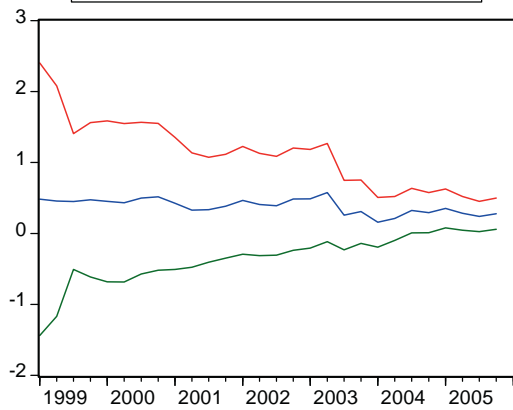
— BETAQ\_Q\_GDP\_N  
 — BETAQ\_Q\_GDP\_N+1.5\*SEQ\_Q\_GDP\_N  
 — BETAQ\_Q\_GDP\_N-1.5\*SEQ\_Q\_GDP\_N



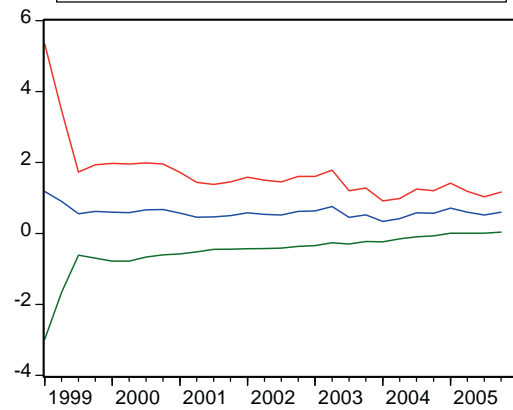
— BETAQ\_Q\_PPI\_N  
 — BETAQ\_Q\_PPI\_N+1.5\*SEQ\_Q\_PPI\_N  
 — BETAQ\_Q\_PPI\_N-1.5\*SEQ\_Q\_PPI\_N



— BETAQ\_Q\_ULCT\_N  
 — BETAQ\_Q\_ULCT\_N+1.5\*SEQ\_Q\_ULCT\_N  
 — BETAQ\_Q\_ULCT\_N-1.5\*SEQ\_Q\_ULCT\_N



— BETAQ\_Q\_ULCM\_N  
 — BETAQ\_Q\_ULCM\_N+1.5\*SEQ\_Q\_ULCM\_N  
 — BETAQ\_Q\_ULCM\_N-1.5\*SEQ\_Q\_ULCM\_N



— BETAQ\_Q\_X\_N  
 — BETAQ\_Q\_X\_N+1.5\*SEQ\_Q\_X\_N  
 — BETAQ\_Q\_X\_N-1.5\*SEQ\_Q\_X\_N

## Appendix A4.

**Table: RMSE across indicators and approaches**

<b>Approach A: Recursive estimates and perfect foresight</b>						
N=16	cpi	ppi	gdp	ulcm	ulct	x
RMSE 1	0.73	0.72	0.73	0.72	0.72	0.69
RMSE 2	0.79	0.78	0.78	0.76	0.76	0.75
RMSE 3	0.87	0.85	0.86	0.81	0.82	0.78
RMSE 4	0.86	0.83	0.84	0.80	0.80	0.76
RMSE 5	0.83	0.80	0.80	0.74	0.75	0.73
RMSE 6	0.92	0.87	0.88	0.83	0.84	0.77
RMSE 7	0.99	0.95	0.95	0.90	0.91	0.86
RMSE 8	1.07	1.01	1.03	0.97	0.98	0.90

<b>Approach B: Recursive estimates and forecast explanatory variables</b>						
N=16	cpi	Ppi	gdp	ulcm	ulct	X
RMSE 1	0.90	0.90	0.90	0.88	0.88	0.87
RMSE 2	1.06	1.06	1.06	1.02	1.02	1.01
RMSE 3	1.26	1.25	1.26	1.21	1.21	1.18
RMSE 4	1.46	1.43	1.45	1.38	1.38	1.32
RMSE 5	1.59	1.55	1.57	1.49	1.50	1.40
RMSE 6	1.68	1.62	1.65	1.57	1.58	1.44
RMSE 7	1.65	1.58	1.62	1.55	1.57	1.40
RMSE 8	1.63	1.53	1.59	1.54	1.55	1.37

<b>Approach C: Final estimates and perfect foresight</b>						
N=40	cpi	ppi	gdp	ulcm	ulct	x
RMSE 1	0.63	0.63	0.63	0.63	0.63	0.63
RMSE 2	0.63	0.63	0.63	0.63	0.63	0.64
RMSE 3	0.63	0.63	0.63	0.63	0.63	0.64
RMSE 4	0.57	0.57	0.57	0.57	0.57	0.58
RMSE 5	0.58	0.58	0.58	0.58	0.58	0.59
RMSE 6	0.65	0.65	0.65	0.65	0.65	0.65
RMSE 7	0.68	0.68	0.68	0.69	0.68	0.69
RMSE 8	0.68	0.68	0.68	0.69	0.68	0.70

<b>Approach D: Final estimates and forecast explanatory variables</b>						
N=40	cpi	ppi	gdp	ulcm	ulct	x
RMSE 1	0.73	0.74	0.74	0.73	0.73	0.75
RMSE 2	0.84	0.84	0.85	0.84	0.84	0.87
RMSE 3	0.94	0.94	0.94	0.94	0.94	0.97
RMSE 4	1.01	1.01	1.02	1.01	1.01	1.05
RMSE 5	1.07	1.07	1.07	1.06	1.07	1.11
RMSE 6	1.15	1.14	1.15	1.14	1.14	1.18
RMSE 7	1.19	1.18	1.19	1.19	1.20	1.22
RMSE 8	1.25	1.23	1.25	1.26	1.26	1.26

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