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Euroland's Trade with Third Countries: An Estimation Based on NIPA Data

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Summary

One major shortcoming in Euroland's National Income and Product Accounts (NIPA) consists in the missing distinction between exports (imports) on the one hand and dispatches (arrivals) between the member states on the other hand. In this paper "true" NIPA trade is derived from official figures. The observation period only starts in 1989: 1 due to the availability of Eurostat export volume indices. Cointegration analysis is then applied to draw preliminary conclusions on price and income elasticities of Euroland's real exports. The initial equation system contains one cointegration relationship and is reduced to a parsimonious error correction model. Two versions of the latter are presented each characterized by one over-identifying restriction derived from economic theory. The real-exchange-rate elasticity in both the "constant-market-share" model 1 and the "constant-returns-to-scale" model 2 amounts to –0.6, and in the latter the response to the globalization variable (+0.6) is in line with the empirical observation of a declining share of Euroland in world trade.

1. Conceiving Euroland as an Economic Entity

Since the start of European Monetary Union (EMU) on 1 January 1999, the European Central Bank (ECB) has been stressing her intention to concentrate on area-wide developments of money, prices and economic growth as one common interest-rate policy does not allow for fine-tuning economic conditions in single member states. Focusing on Euro-area-wide averages ultimately implies conceiving Euroland as an economic entity. This understanding has created a substantial need of investigation into the existence and the behavior of a common business cycle in Euroland. Despite the fruitful work of academic researchers, central bank and research institute economists and not withstanding the improving data collection by statistical offices, some important questions remain unsettled.

One of these open questions concerns the calculation of foreign trade figures in Euroland's National Income and Product Accounts (NIPA). So far total exports and imports of goods and services from the member states' NIPAs are simply added together. Thus Euroland's NIPA foreign trade contains dispatches to and arrivals from other member states just as if shipments from Hamburg to Bavaria accounted for exports in the NIPA of Germany.

This paper presents a practitioner's solution to the problem of isolating the amount of "true" aggregate exports and imports from Eurostat's NIPA figures, which may serve as a useful approximation until the statistical authority will have accomplished this task by sectors of economic activity and by types of product.

The knowledge of "true" NIPA exports and imports (in addition to customs' statistics) is useful for a consistent analysis of the impact of external shocks on the business cycle in Euroland. First, it allows to know the evolution of meaningful export shares in GDP over time and thus Euroland's dependence on foreign business cycles. Second, one obtains a more realistic estimate for the *level* of the area's degree of openness by the inclusion of real trade in services. Despite its growing importance, the latter is only available within the NIPA system.[1]

The basic strategy of obtaining Euroland's "true" exports and imports consists of multiplying Eurostat's official NIPA exports and imports with the correct average weight of third countries in Euroland's exports and imports, given here by a weighted arithmetic average of the extra-trade

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[1] About 20% of Euroland's total exports were services in 1996, ranging from 10.1% (Ireland) to 36.7% (Austria). The contribution of services to overall imports of the eleven member states was 21%, ranging from 14.3 (Portugal) to 26.8 (Ireland).

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shares for each member state. Therefore, one needs to know the weight of each member state in the area's external trade in each quarter. The length of the historical time series is restricted to 1989: 1 to 2000: 4 by the availability of export volume indices. However, the number of observations is sufficient to draw preliminary conclusions on price and income elasticities of Euroland's real exports by means of cointegration analysis. This delivers important elements to answer the question of how strongly Euroland's GDP depends on international economic fluctuations and may improve short- and medium-term business cycle forecasts.

The remainder of the paper is organized as follows: Chapter 2 presents the calculation of the average share of the rest of the world in the sum of the member states' exports and imports for each period. In Chapter 3 the levels of exports and imports and the degree of openness are computed. Then the determinants of demand for European exports are discussed (Chapter 4) and the series of Euroland's real exports (obtained in Chapter 3) is used in Chapter 5 for cointegration analysis. Chapter 6 concludes.

2. The Average Share of Third Countries in the Member States' Real Exports

It would be easy to construct Euroland's real exports to third countries if each member state published its real exports distinguishing by the status of the recipient country (EMU member versus non EMU member). However, such a distinction does not exist either in national NIPAs or in Euroland's NIPA. As I want nevertheless keep as close as possible to the official NIPA trade figures published by Eurostat (which are simply the sum of the member states' total exports (imports) in millions of Euro (at constant prices and current exchange rates), $X_{i,t}$ $(M_{i,t})$, with i = 1, 2,…, 11), my strategy outlined in formulae [1a] and [1b] is to multiply the official NIPA figure by an appropriate average share of third countries in the eleven member states' exports (imports).[2] This yields Euroland's NIPA exports to and imports from third countries, labeled X_t and M_t,

$$X_t = g^{EMU11}_{Xextra,t} \sum_{i=1}^{11} X_{i,t} \quad [1a]$$

$$M_t = g^{EMU11}_{Mextra,t} \sum_{i=1}^{11} M_{i,t} \quad [1b]$$

where $\sum_{i=1}^{11} X_{i,t} (\sum_{i=1}^{11} M_{i,t})$ are the series of real exports (imports) published in Euroland's NIPA. If there had been no currency revaluations between member countries in the sample period, $g^{EMU11}_{Xextra,t}$ could be correctly represented by dividing the sum of the eleven member states' export volumes to third countries (in a common currency) by the sum of the eleven member states' total export volumes. The calculation of Euroland's nominal NIPA exports to third countries would analogously use the sums of nominal trade figures ("values") to obtain g. In the presence of currency changes between member countries, however, taking the simple sum of national exports in current Euro leads to a bias in g. This is why the derivation of g is done via aggregation over the eleven shares of the rest of the world in national exports.[3]

In principle, $g^{EMU11}_{Xextra,t}$ $(g^{EMU11}_{Mextra,t})$ is a weighted average of the ratio of exports to (imports from) third countries in each member state's total exports (imports) $[g^{i}_{Xextra,t}$ $(g^{i}_{Mextra,t}$ $])$ as expressed in equations [2a] and [2b]. These dimensionless ratios are obtained from the respective customs statistics on goods trade in national currency.[4] The respective weights of country i in quarter t are $w_{X,i,t}$ and $w_{M,i,t}$.

$$g^{EMU11}_{Xextra,t} = \sum_{i=1}^{11} w_{X,i,t} \cdot g^{i}_{Xextra,t} \quad [2a]$$

$$g^{EMU11}_{Mextra,t} = \sum_{i=1}^{11} w_{M,i,t} g^{i}_{Mextra,t} \quad [2b]$$

Two remarks have to be made on [2a] (and [2b], respectively). The first one is on how $g^{i}_{Xextra,t}$ $(g^{i}_{Mextra,t})$ is obtained in practice. The only unified data source for quarterly trade in goods at constant prices offering the crucial distinction between intra-EMU and extra-EMU destinations (and origins, respectively) is the COMEXT database (Eurostat, 2001a). This database contains intra-EMU, extra-EMU, and total trade for each member country as index numbers (equal to 100 in 1995). These index numbers are available for trade at constant prices ("volumes"), trade at current prices ("values") and for the price index ("unit value index") with the latter being constructed in a way that makes the identity "volume" times "unit value" = "value" hold in each quarter. To obtain $g^{i}_{Xextra,t}$ one additionally needs to know the absolute level of real exports to third countries and the one of total exports (each in units of a given currency) for a base year which I choose to be 1995. I draw this information from the *nominal* figures of the SITC database (OECD, 2001a)[5] thereby fixing 1995 as the base year for all series at constant prices. As the

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2 Greece joined the EMU only on 1 January 2001 and is not considered as an EMU member in this paper. The analysis can easily be adopted to Greece being a member, of course.

3 In the following all four series are computed (nominal and real "true" NIPA exports and imports) but the steps of calculation are exemplified only for the series in constant prices. Refer to appendix I for more details on data sources and calculation methods.

4 We have to make the simplifying assumption that for each member state the weight of third countries in trade in services equals the one in trade in goods because there is no unified source for regionally disaggregated trade in services for the eleven countries of the Eurozone.

5 This database is referred to because the COMEXT database only starts in 1996 for two EMU member states (Austria and Finland). How I address this data scarcity is described in appendix I.

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SITC values are denominated in a common currency (US dollars[6]), the "true" NIPA figures at constant prices to be derived in this section (X_t, M_t) are therefore "at average prices and exchange rates of 1995". Given the share of third countries in country i's total exports in the base period (1995: 1)[7], the rates of change in the *volume* indices of extra-EMU and total exports from COMEXT are used to compute the share of third countries in real exports for all quarters of the sample, while the rates of change in the *value* indices enter the computation of the share of third countries in *nominal* exports. As the COMEXT indices are only available from 1989: 1 onwards, the length of the sample is restricted to the 12 years from 1989: 1 to 2000: 4.[8]

The second remark concerns the country weights [$w_{X,i,t}$ ($w_{M,i,t}$)], i. e. each EMU member's percentage contribution to Euroland's trade with third countries. An easy way of computing it would consist of expressing country *i*'s real NIPA exports (imports) in Euro or ECU at current exchange rates and of dividing them by $\sum_{i=1}^{11} X_{i,t}\ (\sum_{i=1}^{11} M_{i,t})$ from [1a] ([1b]). For practical purposes this procedure might yield satisfying results because, as Beyer, Doornik and Hendry (2001) argue, changes in exchange rates within Euroland have been small from 1989 to 1998 compared to those between member countries and third countries. However, especially during the EMS crisis in 1992/93, intra-EMU changes in exchange rates were quite important making it desirable to look for an unbiased expression of $w_{X,i,t}$. Such an expression is obtained for each member country *i* in [3a] and [3b] following Beyer, Doornik and Hendry (2001, 108, formula 6): given the common-currency country weight in the base period 1995: 1, the country weight for 1995: 2 is computed with the help of rates of change derived from the series in national currency. For Euroland as a whole the growth rate of exports to third countries required in [3a] is the weighted average of all national growth rates in national currencies, again taken from the COMEXT volume index. The known $w_{X,i,1995:1}$ serves as initial weight for country *i* (i = 1, 2, ..., 11) (see [3b]). Once $w_{X,i,1995:2}$ has been obtained in this way, the value is used to derive $w_{X,i,1995:3}$, which itself enters the computation of $w_{X,i,1995:4}$, and so on. Starting in 1995: 1 this iteration exercise is also done backwards to get the $w_{X,i,t}$ for 1994: 4, for 1994: 3, and so on.

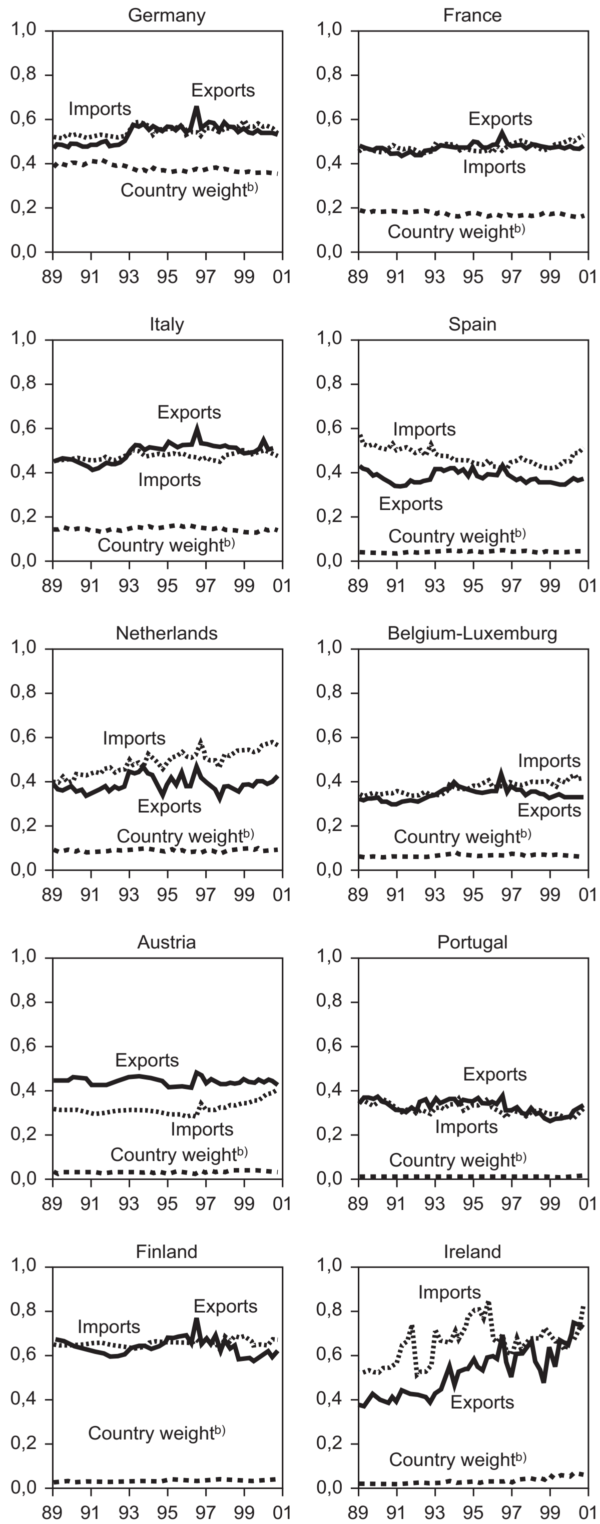
6 For the determination of the $g^i_{Xextra,t}$, it makes no difference whether the 1995 exports are expressed in US dollars or in ECU (or in units of any other currency).

7 In the SITC database only annual numbers are available. Refer to appendix I for the distribution of $g^i_{Xextra,t}$ over the quarters of 1995.

8 Strauß (1998) obtains longer real NIPA exports and imports series using third-country shares from *nominal* trade statistics, which is obviously wrong as can be understood at the example of an oil price shock: a growing weight of oil exporting countries in nominal (not real) imports would wrongly inflate the expression of real imports from the rest of the world in equation [1b].

Figure 1

Share of third countries in EMU members' real merchandise trade[a)]



a) Ratio of real exports (imports) to countries outside Euroland to the respective member state's total real exports (imports).
b) The country's contibution to Euroland's total real exports to third countries.

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Figure 2a

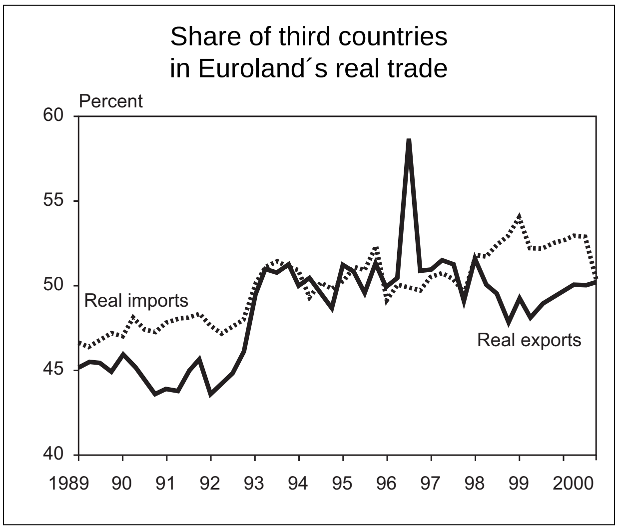
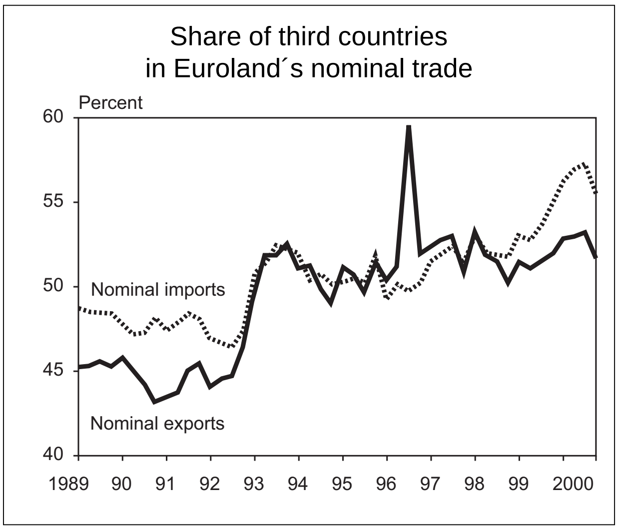


Figure 2b



$$w_{X,i,t} = \frac{X_{i,extra,t}}{\sum_{i=1}^{11} X_{i,extra,t}} = \frac{X_{i,extra,t-1}\left(1+\hat{X}_{i,extra,t}\right)}{\left(\sum_{i=1}^{11} X_{i,extra,t-1}\right)\left(1+\hat{X}_{extra,t}^{EMU11}\right)} \quad [3a]$$

where

$$\hat{X}_{extra,t}^{EMU11} = \sum_{i=1}^{11} w_{X,i,t-1} \cdot \hat{X}_{i,extra,t} \quad [3b]$$

A hat symbolizes the quarter-on-quarter rate of change.

The advantage of this procedure is that temporary misalignments of national currencies with respect to the ECU do not *per se* lead to variations in the respective country weights. For instance, if the Deutsche Mark was overvalued in the immediate aftermath of the 1992/93 EMS crisis, this would raise, *ceteris paribus*, Germany's $w_{X, i, t}$ in the simple computation (where [3a] and [3b] are not used because all national series are in ECU). By taking rates of change from the export series in DM one makes sure that only the "real" effects of the appreciation on German exports (e. g. a loss in intra-European market shares lowering Germany's $w_{X, i, t}$) be taken into account.

The contribution of each member state to Euroland's real merchandise exports to the rest of the world (country weight) is represented by the dotted lines in figure 1. The solid lines represent the share of third countries in each state's real goods exports and imports.

As one can see, country weights are definitely not constant. Most strikingly, the weight of Germany declines over time while the Irish one rises in accordance to strong economic growth and the increasing importance of trade with third countries (especially due to transactions of multinational firms with the USA). In the other EMU countries the share in trade held by the rest of the world is relatively stable except for Spain and Portugal where the consequences of late accession to the European Community show up in a declining trend as trade relations within Euroland became tighter after 1986.

Having obtained all country weights $w_{X, i, t}$ ($w_{M, i, t}$) for both nominal and real trade figures with the help of [3a] and [3b], the average nominal and real shares of third countries in Euroland's exports and imports can now be computed according to [2a] (and [2b], respectively); the average real shares are represented in figure 2a, the nominal shares in figure 2b. One peculiarity in the export shares is the extraordinarily brisk hike in 1996: 3 which can already be seen in most countries' export shares. The main reason for the hike is unplausibly low levels of export volume indices for intra-EMU11-trade reported by Eurostat. Apart from this outlier the shares of third countries reproduce Euroland's business cycle history of the nineties quite well: due to U.S. recession and German reunification the shares are low in 1990 but surge in 1993 in the course of European recession; the shares decline with the breakdown of south-east Asian and Russian demand in 1998 but have been climbing back towards 50 percent since 1999 helped by the devaluation of the Euro.

3. Euroland's Exports, Imports and Degree of Openness

As the average shares of third countries in Euroland's trade have been computed, we are now able to derive Euroland's "true" NIPA exports and imports at current prices and at prices and exchange rates of 1995 according to formulae [1a] and [1b]. As the average shares are dimensionless and the official NIPA figures published by

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Eurostat ($\sum_{i=1}^{11} X_{i,t}$ and $\sum_{i=1}^{11} M_{i,t}$) are denominated in Euro, the “true” NIPA exports and imports are in Euro, as well. They are shown in figure 3.

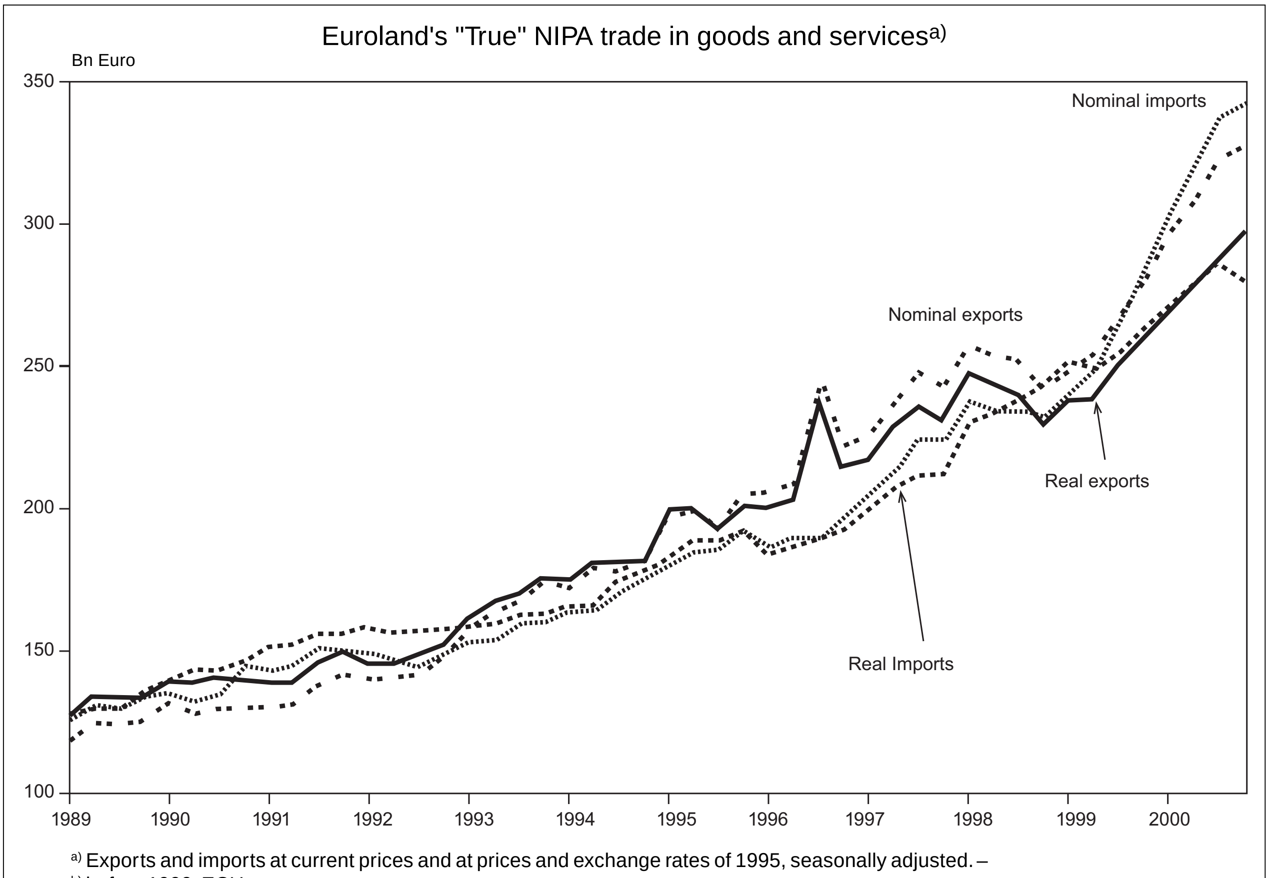
In accordance to [1a] and [1b] the remaining ($1-g^{EMU11}_{Xextra,t}$) times Eurostat’s NIPA exports (series not shown here) are considered as intra-Euroland dispatches between member states, the corresponding import series (($1-g^{i}_{Mextra,t}$) times Eurostat’s NIPA imports) are intra-Euroland arrivals from other member states. "True" *net* NIPA exports and the resulting intra-Euroland net exports just sum up to the trade balance published in Eurostat’s NIPA (Eurostat, 2001b). Theoretically there should be no difference between "true" net NIPA exports and net exports by Eurostat but in practice the requirement of dispatches equaling arrivals in intra-trade does not hold due to systematic underreporting of arrivals by European firms (see Eurostat, 2001c, footnote 4).[9] The positive gap between dispatches and arrivals has even grown bigger in recent years. As a consequence, the use of official NIPA net trade figures to speculate about the "impulse" of net foreign trade on Euroland’s GDP growth is highly misleading because a substantial part of the positive net trade figure is due to a statistical artifact. To get a more realistic idea of real trade surpluses, of the openness of Euroland’s economy and of the evolution of these indicators during the nineties, "true" NIPA exports and imports are put in relation to GDP (table 1).

4. The Determinants of the Demand for Euroland’s Exports

Having generated the NIPA series of interest for the analysis of foreign trade when Euroland is conceived as an economic entity we now use one of these time series, real NIPA exports (called *X* in the following), for a structural analysis of the area’s exports to third countries. Given the relatively high openness of the Eurozone it is important to know what drives exports not only to get a better understanding of recent economic history but also to improve future business-cycle forecasts. Before turning to cointegration analysis we derive the theoretical deter-

[9] Between 1989 and 2000 net exports within Euroland become negative only once (in the "peculiar" quarter of 1996: 3).

Figure 3



a) Exports and imports at current prices and at prices and exchange rates of 1995, seasonally adjusted. –
b) before 1999: ECU.

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Table 1

Euroland's net trade and degree of openness in percent, 1989 – 2000

Year	Real exports / GDP	Real imports / GDP	Net exports / GDP	Degree of openness[a)]
1989	11.2	11.0	0.2	22.2
1990	11.4	11.6	–0.2	23.0
1991	11.5	12.3	–0.8	23.7
1992	11.7	12.3	–0.7	24.0
1993	13.4	12.7	0.6	26.1
1994	13.9	13.2	0.7	27.1
1995	15.0	14.2	0.8	29.2
1996	16.0	14.0	1.9	29.9
1997	16.6	15.1	1.5	31.7
1998	17.0	16.7	0.3	33.7
1999	17.1	17.6	–0.5	34.6
2000	18.9	18.6	0.3	37.5
Memorandum item:				
2000 USA	12.1	16.5	–4.5	28.6
2000 Japan	11.2	8.7	2.5	19.9

[a)] Sum of real exports and real imports relative to real GDP.

Sources: Eurostat (2001b); OECD (2001b); own calculations.

minants of the demand for exports and construct the macroeconomic time series by which these determinants might be represented best.[10]

Exports from Euroland to foreign countries can be seen as being caused by the buying decision of a foreign firm that uses European products as inputs in its production process.[11] Let the foreign firm produce goods and services combining a bundle of its own (foreign) factors (H*) and European goods (X) using a technology characterized by a constant elasticity of substitution (CES):[12]

$$Y^* = \left(a_1 H^{*-\gamma} + a_2 X^{-\gamma}\right)^{-\frac{\varphi}{\gamma}} \qquad [4]$$

where φ is the scale elasticity (φ =1 for constant returns to scale) and $[-1/(1+\gamma)]$ is the elasticity of substitution between H* and X. The asterisk symbolizes foreign variables. The foreign firm maximizes its profits (revenues less costs) according to

$$\pi^*\left(H^*, X\right) = P^* Y^* - P_{H^*} H^* - P_X \cdot W \cdot X \qquad [5]$$

where P* is the price level of foreign output, P_{H^*} is the price of one unit of the foreign factor and $P_X \cdot W$ is the price for one unit of European exports in foreign currency (W being the nominal exchange rate in units of foreign currency per Euro). Substituting the right hand side of [4] into [5], deriving the first-order condition with respect to exports ($\delta\pi^*/\delta X = 0$), and using $a_1 H^{*-\gamma} + a_2 X^{-\gamma} = Y^{*-\frac{\gamma}{\varphi}}$ from [4] yields

$$\varphi a_2 Y^{*\frac{\varphi+\gamma}{\varphi}} \cdot X^{-(1+\gamma)} = \frac{PX \cdot W}{P^*} \qquad [6]$$

Taking the logarithms (symbolized by small letters) and solving for x gives

$$x = \eta_0 + \eta_1 y^* - \eta_2 e \qquad [7]$$

where $\eta_0 = [1/(1+\gamma)] \ln(\varphi a_2)$; $\eta_1 = (\varphi+\gamma)/[\varphi(1+\gamma)] = \eta_2(\varphi+\gamma)/\varphi$ and $\eta_2 = 1/(1+\gamma)$; $e = px - (p^* - w)$ is the logarithm of the real effective exchange rate of the Euro.

As one can see in this model, the price and income elasticities of exports are not independent from one another. They are interlinked via φ, the scale elasticity. When production in the foreign economy occurs at constant returns to scale, $\eta_1 = 1$ whatever elasticity of substitution prevails. In the presence of increasing returns to scale ($\varphi > 1$) the elasticity of European exports with respect to foreign production (η_1) is above 1 only if demand for Euroland's exports is price elastic ($-1 < \gamma < 0$). A low price elasticity ($\gamma > 0$, i. e. $0 < \eta_1 < 1$) and a production elasticity above 1 can simultaneously be observed only if returns to scale are decreasing. However it is difficult to imagine how in growing economies with technological progress doubling all inputs over a time span of, say, 20 years should yield less than twice the initial output. For theoretical reasons one would therefore

[10] We abstract from supply-side considerations as is done in most empirical studies on exports and imports (Sawyer and Sprinkle, 1999, 10–11). This is a legitimate simplification if the supply curve is infinitely elastic (Goldstein and Khan, 1978, 284, and 1985, 1089). This prerequisite might hold, if anything, in the long run.

[11] This reasoning also englobes trade in finished goods if the latter are considered as inputs for the foreign wholesale and retail sectors.

[12] The following analysis is inspired by Sandermann (1975, 41 ff.). Clostermann (1998, 204 f.) applies the theory of production to derive the demand for German imports and exports.

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expect a long-run elasticity of exports with respect to foreign production of one or slightly below (allowing for increasing returns to scale) if the aggregate real-exchange-rate elasticity is comprised between 0 and 1.

This theoretical requirement sharply contrasts with the empirical observation of exports growing faster than production all over the world since World War II. Not surprisingly this stylized fact translates into above-unity income elasticities of foreign trade in most country studies (e. g. Goldstein and Khan, 1978; Lapp et al., 1995; Senhadji and Montenegro, 1998).[13]

The picture becomes clearer if one realizes that the simple export demand derived from the CES production function does not contain all the other conditions that favorably influenced export quantities in the past decades. The successive abolishment of tariff barriers under the GATT and then the WTO boosted exports far beyond what can be captured by production figures. Furthermore the export demand function [7] stresses the role of *relative* prices of European exports neglecting that exporters during the last twenty years saved huge amounts of costs by slicing up the production chain ("outsourcing"), by buying inputs internationally rather than locally ("global sourcing"), and by creating networks of multinational firms, which usually leads to growing trade in intermediate inputs (Kleinert, 2001). The integration process can also be understood as the opening-up or the further intensification of trade between two economies producing heterogenous products with increasing returns to scale for consumers with a love for variety: this always leads to a greater variety for each consumer, lower product prices because of higher output per variety and higher intra-industry exports relative to GDP, i.e. a higher degree of openness of the economy (Helpman and Krugman, 1985, 141 f.).

As it is not our purpose here to explain the globalization process per se but to focus on its implications on the demand for European exports, we implement the share of real world exports in the world's real GDP (called "World trade intensity of production" or simply *"World"*) as an additional variable in the empirical model thus making the assumptions of the CES model compatible with real world data.[14] When applied to German exports this approach has the virtues of both reconciling the theory with the data (resulting in estimates of η_1 closer to 1) and of improving the statistical fit of the model (Strauß, 2001). A variable such as *World* thus seems more promising in capturing the globalization effect than earlier attempts which simply included a deterministic time-trend in the cointegration space (Döpke and Fischer, 1994; Strauß, 2000).

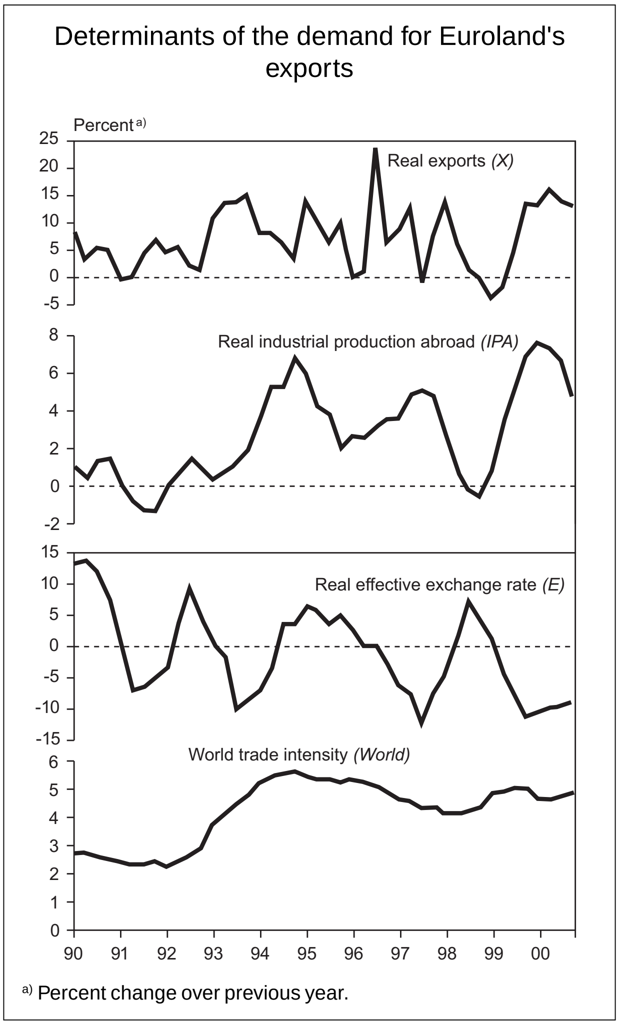
In the empirical model y* from [7] is expressed by the logarithm of an index of industrial production in 27 partner countries (*IPA*). *IPA* is a weighted average of national production volumes with the share of the respective country in Euroland's exports in 1999 serving as a weight. For details see appendix I. Industrial production reflects the evolution of demand for tradeables better than the more global measure GDP. Furthermore it is available much faster than the latter, which is important if the model is to be used in business cycle forecasts.[15] The relative price variable is the real effective exchange rate of the Euro relative to the currencies of the most important trading partners, as published in the Monthly Bulletin of the ECB (2001, 64, column 2: basket of 12 currencies). Figure 4 illustrates the evolution of the time series during the estimation period (1989 to 2000).

13 A preliminary attempt to estimate [7] without modification yields a production elasticity of about 1.5 in case of Euroland.

14 A technical description of how *world* is constructed is given in appendix I.

15 Some authors use the volume of world trade as the activity variable (see e. g. Clostermann (1998, 208). In this case, the supplementary variable *world* would not have been necessary. However, if exports are seen as input flows as in [6] and [7] it seems economically more convincing to me to explain European exports by the output decision of the representative foreign firm rather than by the sum of other input flows.

Figure 4



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5. Estimation Results from Cointegration Analysis

Euroland's "true" real NIPA exports are now analyzed econometrically. As the levels of the time series used (*x, ipa, e* and *world*) can be considered as integrated of order one (see appendix II), cointegration analysis is the appropriate tool. Starting with a vector error correction model (VECM) it is demonstrated that the system contains one cointegration vector and that it is justified to view this vector as an export demand relation. Furthermore the data accept two alternative restrictions on the long-run elasticities which we use to propose two alternative error-correction models which are both parsimonously parameterized.

5.1 Tests for reduced rank, weak exogeneity and restrictions on the β-vector

Following the procedure suggested by Johansen (1991) as well as Johansen and Juselius (1994) the analysis starts with the unrestricted VECM of the form

$$\Delta z_t = \prod z_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \psi D_t + \mu + u_t \qquad [8]$$

where *z* is the vector of the *p* I(1) variables (p = 4) mentioned above, *D* is the impulse dummy *d963* which equals 1 in 1996: 3 (0 else) and serves to "ignore" the data anomaly discussed in chapter 2; μ is the unrestricted constant ("Model 3" in the terminology of Hansen and Juselius, 1994, 6), and *u* the vector of iid residuals. The rank of the coefficient matrix Π indicates the number *r* of cointegration relations in the system (Johansen, 1988). If Π has reduced rank it can be decomposed into a (p*r)-matrix β of long-run equilibrium relationships ("cointegration vectors") and the (p*r)-matrix α of loading coefficients, $\Pi = \alpha\beta'$. The lag length *(k)* is chosen such as to minimize the Hannan-Quinn information criterion *(k = 2)*. According to the trace test (table 2) the hypothesis that only one cointegration vector is in the system cannot be rejected.

The cointegration rank of 1 is a necessary but not sufficient condition for reducing the system to a single-equation error correction model (SEECM) because the latter assumes that deviations of exports from their long-run level are corrected by changes in exports alone and do not affect the long-run equilibrium level of the Euro exchange rate and foreign production. This is why I test for weak exogeneity of all variables but exports (table 3, column 6, lines 2 and 3): the hypothesis cannot be rejected at the 10-percent level.

As in the CATS procedure one needs to set at least one over-identifying restriction in order to get standard deviations for the long-run coefficients, two theoretically interesting cases are looked at. "Model 1" restricts β_{world} to 1 implying that Euroland's share on the world market has remained constant during the nineties. This hypothesis is not rejected ($\chi^2(1) = 0.29$, probability [0.59]). The resulting long-run relationship is (standard deviations in brackets):

$$x = \underset{(0.14)}{0.57}ipa - \underset{(0.19)}{0.24}e + world \qquad [9]$$

The second case of interest ("Model 2") consists of setting $\beta_{ipa} = 1$ which may be interpreted as an implicit test for constant returns to scale in aggregate foreign production ($\varphi = 1$, see [7]). This hypothesis, too, is accepted by the data ($\chi^2(1) = 1.31$, probability [0.25]). The resulting long-run relationship shows a plausible coefficient of world trade intensity of near to but smaller than 1, which corresponds to the long-run expectation of declining world-market shares for European firms as exports from emerging economies (especially in East Asia) grow faster than European ones. The long-run relationship now reads

$$x = ipa - \underset{(0.19)}{0.19}e + \underset{(0.10)}{0.71}world \qquad [10]$$

Table 2

Test of cointegration rank in the export model (k = 2)

Null hypothesis	Eigen value	Trace statistic	Critical value[b)]	λ_{max}-statistic	Critical value[b)]
r = 0	0.3594	45.42[a)]	43.84	20.49[a)]	17.15
r ≤ 1	0.2547	24.94	26.70	13.52[a)]	13.39[c)]
r ≤ 2	0.2127	11.41	13.31	11.00[a)]	10.60[c)]
r ≤ 3	0.0089	0.41	2.71	0.41	2.71

[a)] Means rejection of the null at the 10 percent significance level. — [b)] Taken from Hansen and Juselius (1994, p. 81, Model 3). — [c)] The critical values according to MacKinnon et al. (1999) resulting from more powerful Monte-Carlo simulations are 19.25 (p – r = 3) and 13.05 (p – r = 2), respectively. Given these critical values the null of one cointegration vector is not rejected.

Source: own calculations.

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Table 3

Coefficients and test statistics in the unrestricted export model (k = 2)

Coefficient / test statistic	Equation Δx	Equation Δipa	Equation Δe	Equation $\Delta world$	System[a)]
Loading[b)] α	–0.366	–0.027	–0.160	0.002	$\alpha_2 = \alpha_3 = \alpha_4 = 0$
t-value of α	–3.829	–1.315	–1.684	0.432	[0.31]
R^2	0.64	0.59	0.38	0.86	–
Standard deviation [%]	2.41	0.48	2.16	0.10	–
Autocorrelation L-B (11)	–	–	–	–	[0.00][c)]
Autocorrelation LM (1)	–	–	–	–	0.61
Autocorrelation LM (4)	–	–	–	–	0.39
Arch(2)[d)]	0.41	2.73	0.65	6.24	–
Normality[e)]	1.77	2.79	4.57	5.90	[0.04][f)]

[a)] Probabilities in square brackets. — [b)] Under the restriction of one cointegration vector. — [c)] Reestimation of the partial model (*ipa, e, world* exogenous) leads to near-acceptance of the freedom of autocorrelation hypothesis [0.04]. In that partial model there is no lag length with better autocorrelation results; I refrain from adding more impulse dummies because of the small number of observations (T = 46). The problem disappears (L-B probability of [0.75]) if the over-identifying restriction of unit-elasticity with respect to foreign production is implemented (see “model 2” below). — [d)] Test for autoregressive conditional heteroscedasticity (Engle, 1982). — [e)] Univariate and multivariate tests for normality according to Doornik and Hansen (1994). — [f)] As with the L-B (11)-test, the problem disappears in the partial model.

Source: own calculations.

5.2 Results from Single-Equation Error Correction Models (SEECMs)

Having found a single cointegration vector and weak exogeneity of the explaining variables in the preceding sector it is now possible to proceed to the estimation of SEECMs according to the technique first outlined by Stock (1987). I propose two models according to the over-identifying restrictions $\beta_{world} = 1$ and $\beta_{ipa} = 1$, respectively.[16] The usual strategy would now consist in restricting the ECM to the long-run relationships given in [9] and [10] before eliminating insignificant short-run parameters from the equation. However, given the small number of degrees of freedom (34) in the estimation of [9] and [10], I am convinced to obtain more reliable long-run elasticities for the non-restricted coefficients (especially for the real effective exchange rate) by fixing the long-run relationship only after eliminating all coefficients that are insignificant at the 10-percent level. The number of degrees of freedom thereby increases to 41 in both scenarios. Being aware of the fact that the β-coefficients may change quite substantially compared to the initial models, I once again test for cointegration in the final model. Along these lines the elimination process for the "constant-world-market-share" model 1 leads to (t-values in brackets):

$$\Delta x_t = \underset{(-4.26)}{-0.42}\left[x_{t-1} - \left(\underset{(6.66)}{0.47} ipa_{t-1} - \underset{(-8.01)}{0.54} e_{t-1} + world_{t-1}\right)\right] - \underset{(-1.60)}{0.17}\Delta x_{t-1} \quad [11]$$

$$+ \underset{(2.95)}{5.92}\Delta world_t + \underset{(5.54)}{0.15} d963 + \hat{u}_t$$

According to the test suggested by Banerjee et al. (1998) the null of "no cointegration" (H_0: $\alpha = 0$) is rejected at the 10-percent significance level as the *t*-value of the loading coefficient lies below the critical value for two regressors (q = 2) and 50 observations (T = 50) in the model with constant and without trend ($t(\alpha) = -4.26 < -3.20$). Boswijk’s (1994) cointegration test (H_0: $\alpha = \beta_1 = \ldots = \beta_q = 0$) leads to the same conclusion as the statistic of the corresponding Wald coefficient test, $\chi^2(3) = 19.09$, exceeds the critical value at the 10-percent level for q = 2, T = 50, in the model where the intercept is unrestricted under both H_0 and the alternative hypothesis ($\zeta_\mu = 12.22$). The t-values of the long-run coefficients are obtained from the Bewley-transformed ECM (Bewley, 1978) with $v_t \equiv x_t - world_{t-1}$ as the dependent variable. While β_{ipa} is still quite low (0.47) but significant and nearly unchanged compared to the initial model, the long-run effect of a variation in the real effective exchange-rate becomes more pronounced and significant. It comes very close to earlier estimates for Euroland under a different specification (Strauß,1998, 16) and corresponds to roughly the average of the elasticities resulting from studies for the biggest member states of the EMU (see e. g. Lapp et al., 1995, 6; Seifert, 2000, 355). Despite the very parsimonious short-run relationship the OLS-residual assumptions as well as the stability of the models still hold, as is shown in figure 5 and table 4.

[16] The "just" identified case is not presented here as the long-run elasticity of *world* is above unity and the production elasticity — although positive — is quite small. This might be due to the small sample size.

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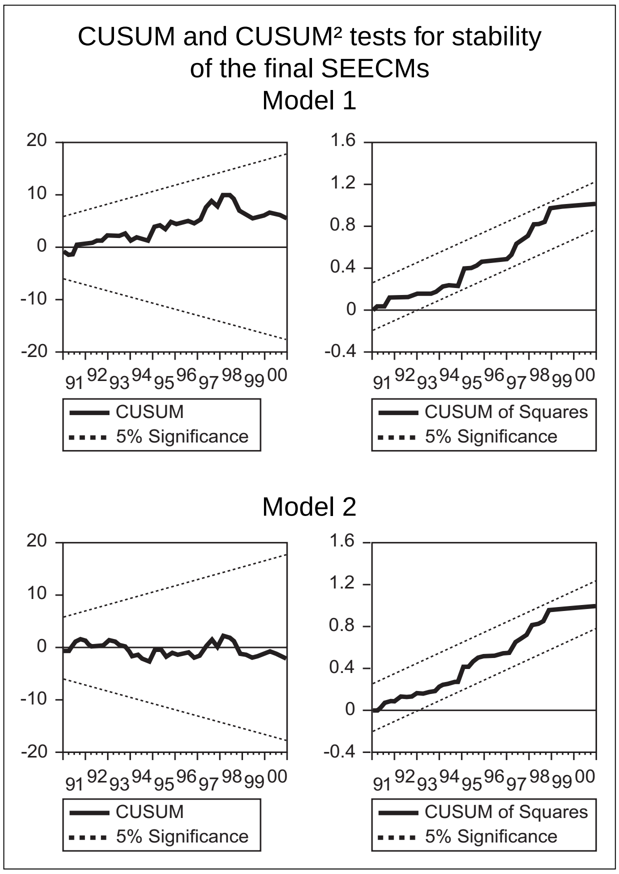
Table 4

Statistical properties of the final SEECMs [11] and [12]

Test / Statistic	Realization[a)]	
	SEEC Model 1	SEEC Model 2
Adjusted R^2	0.56	0.54
Log likelihood	104.17	103.07
F-statistics on eliminated parameters[b)]	[0.55]	[0.44]
Standard deviation of regression [%]	2.70	2.76
DW-statistic	1.71	1.72
LM (1) test on autocorrelation	[0.34]	[0.37]
LM (4) test on autocorrelation	[0.42]	[0.39]
Normality (Jarque-Bera)	[0.57]	[0.78]
Heteroscedasticity (White)	[0.71]	[0.73]
Arch (1)	[0.95]	[0.99]
Arch (4)	[0.29]	[0.46]

[a)] Probabilities in square brackets. — [b)] *F*-test on the joint hypothesis that all parameters eliminated equal zero.
Source: own calculations.

Figure 5



The final specification of the "constant-returns-to-scale" model 2 is given by (*t*-values in brackets):

$$\Delta x_t = \underset{(-3.98)}{-0.34}\,[x_{t-1} - (ipa_{t-1} - \underset{(-9.39)}{0.64}e_{t-1} + \underset{(8.09)}{0.58}world_{t-1})] \qquad [12]$$

$$\underset{(-2.04)}{-0.22}\Delta x_{t-1} + \underset{(2.76)}{6.03}\Delta world_t + \underset{(5.50)}{0.15}d963 + \varepsilon_t$$

Again both the test by Banerjee et al. (1998) and the one by Boswijk (1994) reject the null of no cointegration as $t(\alpha) = -3.98$ and $\chi^2(3) = 16.33$ (H_0: $\alpha = \beta_e = \beta_{world} = 0$) given the same critical values as above. The speed of adjustment to new equilibrium export levels is slightly lower than in model 1, the real-exchange-rate elasticity is once again significant and of comparable size as in [11]; the long-run effect of a higher share of world trade in world GDP is only a little smaller than in the initial model 2 given in [10]. One should not be surprised by the high contemporaneous short-run coefficients of *world* because by construction each change in world trade relative to world GDP in quarter *t* is equally distributed on all quarters from *t* until (t + 11) (see appendix I). Thus *world* contemporaneously rises by only 1/12 of the change in world trade. From this it follows that a one percent increase in real world exports (leaving world GDP unchanged) contemporaneously raises Euroland's exports by (1/12) * 1% * 6.03 = 0.50% according to [12].

As a final application of models [11] and [12] the dynamic long-run multipliers are presented in figures 6 and 7, respectively. Corresponding to the high short-run elasticity of *world*, changing trends in international trade are felt quite directly by European exporters and exhibit some overshooting dynamics. In contrast, adjustments to new foreign production levels and those to a Euro appreciation

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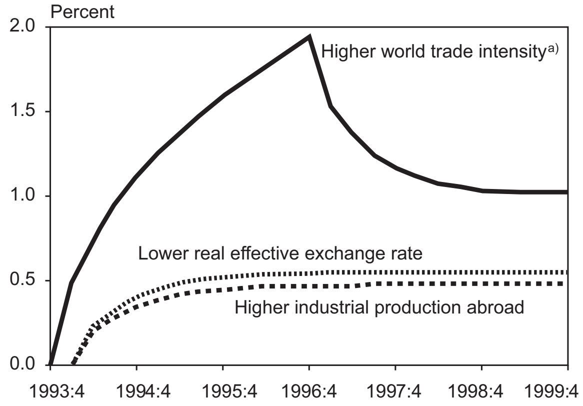
Figure 6

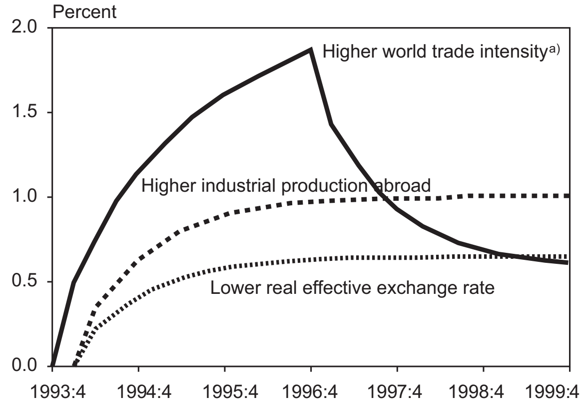
Reaction of exports to permanent one-percent changes in its determinants: Model 1



a) The Ratio of real world exports to real GDP rises by one percent in 1994:1. By construction World increases by 1/12 of a percentage point in each of the 12 quarters until 1996: 4.

Figure 7

Reaction of exports to permanent one-percent changes in its determinants: Model 2



a) The Ratio of real world exports to real GDP rises by one percent in 1994:1. By construction World increases by 1/12 of a percentage point in each of the 12 quarters until 1996: 4.

(or depreciation) work through the models more steadily. As no short-run coefficients of *ipa* and *e* remain neither in [11] nor in [12], production and exchange-rate adjustments have the same speed and take several quarters to be fully felt. The adjustment process is further slowed down by the presence of the negative influence of the lagged first difference of the endogenous variable: one can see in figure 7, for example, that only two thirds of the long-run increase in exports following a one percent increase in, say, foreign production occurs within the first four quarters after the shock, not the more than 80 percent that would result from the pure interaction of α and β'.[17, 18] As experience accumulates, the short-run parts of the structural export models presented here have every chance of becoming richer. For the time being the long-run equilibrium which is in line with economic theory and the experience made by single member states may serve as a guideline for plausible business-cycle forecasts in Euroland.

6. Conclusion

This paper presents a practitioner's solution to the lack of NIPA exports and imports for Euroland that would satisfy the conception of EMU as an economic entity. The series are derived from original quarterly foreign trade statistics for the period 1989: 1 to 2000: 4 and distinguish between country shares in real trade and those in nominal trade. The knowledge of "true" NIPA figures for foreign trade is crucial in assessing the dependence of a region on external shocks. The calculations underscore the findings from Döpke et al. (1998, 9), of Euroland being much more of an open economy than the United States and Japan. A well founded analysis of the determinants of European exports thus represents one cornerstone for successful business cycle forecasts in the European monetary union. The econometric part of this paper contributes to this effort using the NIPA series of real exports previously computed. It turns out that foreign production, the real effective exchange rate and the "trade intensity" of world output are weakly exogenous to Euroland's exports and that the latter can be analyzed in a single-equation error correction framework (SEECM). Two alternative SEECM specifications are proposed. Especially the second version, where the elasticity of exports with respect to foreign production is restricted to one according to the hypothesis of constant returns to scale in the production function of the rest of the world, shows most plausible long-run properties: The value of the real exchange-rate elasticity is familiar from earlier studies for major EMU members, and the share of Euroland in world export markets slightly declines over time.

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17 The accumulated "pure" disequilibrium correction in exports (in percent) after four quarters amounts to $[1 - (1-\alpha)^4]$ *times*β_{ipa} times the initial percentage shock on *IPA*.

18 From a business-cycle perspective one would prefer to see more short-run dynamics from *ipa* and *e* and to drop the Δ*world* as *world* was only introduced to capture the "secular" trend of globalization. However, dropping all the Δ*world* leads to final specifications (not reported here) which fail to reject the null of no cointegration at the 10-percent level either for the Banerjee test (in case of [11']) or for both the Banerjee test and the Boswijk test (in case of [12']).

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Appendix I: Data Sources and Methods of Calculation

In the calculation of Euroland's "true" NIPA exports and imports some details have not been mentioned in chapters 2 and 3. They concern the availability of NIPA data before 1991, the computation of the starting value of export (import) levels in US dollars in 1995: 1, and the treatment of Finland and Austria.

As Eurostat NIPA data are not available before 1991, I have computed the levels for the missing eight quarters (1989: 1 to 1990: 4) with the rates of change from the historical time series provided by Fagan et al. (2001).

As far as the starting values for iterations are concerned, I choose 1995 as the base year for the level of exports and therefore set real trade in US dollars from OECD (2001a) equal to nominal trade for this base year. The starting values (1995: 1) required for the first iteration in [3a] and [3b] are obtained for real total and for real extra-EMU11-exports (-imports) by multiplying the 1995 value with the seasonally adjusted[19] volume index of total and extra-EMU11-exports (-imports) of 1995: 1, respectively. The starting value for nominal exports (imports) requires multiplication with the corresponding value indices of 1995: 1. Once the starting values for 1995: 1 are obtained, the eight synthetic time series for total and extra-EMU11 trade (exports and imports, each nominal and real) are computed by iteration for each country (denominated in US-dollars of 1995), and the dimensionless shares $gi_{(.)extra,t}$ used in [2a] and [2b] are derived from these series by division.

For Finland and Austria, which joined the EU in 1995, volume, unit value and value indices disaggregated by extra- and intra-EMU11-trade are only available since 1996: 1. For these two countries, I again choose 1995 as the base year for which the real export figure can be set equal to the nominal one (the latter taken from OECD, 2001a). This value of the year 1995 is then combined with the rates of change in annual volumes of total and extra-EMU11-trade (OECD, 2001a, "volumes" series) in order to obtain an annual series of real exports from 1989 to 1996. These annual figures are then interpolated with the "quadratic match average" option in EViews 4.0 to generate quarterly data from 1989 to 1996.[20] For the period 1996 to 2000 the calculation methods correspond to the ones applied to the other countries. For each category (real and nominal, total and extra-EMU11-exports and -imports) the earlier series (the one from 1989 through 1996) is chained to the more recent one with 1996 being the overlapping year. The last step is to rebase the merged series to 1995 = 100.[21]

The index of industrial production (*IPA*) is a weighted arithmetic average of national indices for the 27 countries shown in table A1. The criteria for a country to be chosen are its importance for Euroland's trade and the availability of long time series. Country figures originate from OECD (2001c) and from IMF (2001).[22] These countries have absorbed more than 80 percent of Euroland's exports in 1999. The weights correspond to the share of each country in Euroland's nominal merchandise exports to the whole group of 27 in 1999 (OECD, 2001d). For Russia production figures are only available from 1993: 1 onwards. To minimize the break in the time-series all national series are brought to the basis 1993 = 100 before aggregation; afterwards they are rebased to 1995 = 100

Table A1

Absolute shares of major trading partners in Euroland's merchandise exports (1999)

Country	Share in %
United Kingdom	19.3
Sweden	4.0
Denmark	2.6
Greece	2.0
Switzerland	6.7
Norway	1.4
Turkey	2.0
Czech Republic	2.0
Hungary	2.1
Poland	3.1
Russia	1.6
United States	16.3
Canada	1.4
Mexico	1.0
Brazil	1.5
Japan	3.3
Korea	1.1
Hong Kong	1.4
Chinese Taipeh	1.2
Singapore	1.0
Indonesia	0.3
India	0.9
Malaysia	0.6
Thailand	0.4
Israel	1.3
Australia	1.1
South Africa	0.9
Sum	80.4

Source: OECD (2001d).

[19] The indices from Eurostat (2001a) are seasonally adjusted using the multiplicative census-X-11 procedure in EViews 4.0.

[20] Prior to 1996 the Finish and Austrian series in figure 1 therefore exhibit an atypically smooth development.

[21] Extraction of the index numbers from Eurostat (2001a) has been kindly effected by Eurostat and is available from the author upon request, together with all computations described by equations [1a] through [3b].

[22] For some countries seasonally adjusted figures were not available; in these cases I run the census-X-11 multiplicative seasonal adjustment program in EViews 4.0.

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just as the real effective exchange rate and real NIPA exports. The real effective exchange rate of the Euro is taken from ECB (2001, 64*) and corresponds to the nominal effective exchange rate with respect to the currencies of major trading partners, corrected for differences in consumer price inflation.

The "trade intensity of world production" is the ratio of world merchandise trade in prices and exchange rates of 1995 to world GDP at prices and exchange rates of 1995. World real exports are annual figures from IMF (2001), world real output annual figures from Worldbank (2001). The theoretical intention expressed in the text would require to subtract both Euroland's exports in the numerator and Euroland's GDP in the denominator. However, as Euroland is a relatively small country in the global context, I refrain from these subtractions for the sake of simplicity. As *world* only captures the part of trade growth that outpaces world production there should be no problem of long-run multicollinearity between *world* and *ipa*. In the short run, however, the fluctuations in world trade are stronger than the ones in global GDP, so that a high correlation between *world* and *ipa* would not be surprising. To avoid this some kind of smoothing is required; thus *world* is computed as a three-year moving average of the trade-output ratio. Quarterly data are then obtained by the "quadratic match average" option in EViews 4.0.

Appendix II: Testing for the Order of Integration

The results of the unit root tests according to Dickey and Fuller (1981) are summarized in table A2. All test equations contain an intercept and a linear time trend except the real effective Euro exchange rate for which a long-run deterministic trend is implausible both on economic grounds and upon visual inspection of the data. The number of lags in the test equations is chosen minimal subject to the freedom-of-autocorrelation requirement.

The log of world trade intensity (*world*) seems to be a case in between I(1) and I(2). Whereas the ADF test fails to establish both mean stationarity and trend stationarity of the first differences, the KPSS tests allow not to reject the null of difference stationarity for high truncation parameters; the latter are justified because the very construction of *World* implies autocorrelation up to the 12th order. Moreover, economic intuition makes us think that every increase in *World*, not only an acceleration, positively affects the equilibrium level of Euroland's aggregate exports. Therefore the I(1)-ness of the globalization variable is carefully maintained for our estimation purposes.

The most unconfortable and surprising result is the trend stationarity of the log of Euroland's real NIPA exports (as calculated in this paper) according to the univariate ADF test.[23] Only the $KPSS_{\mu}$ test result defies this finding, but only for unplausibly short lag truncation parameters. How-

[23] Phillips-Perron (1988) unit-root tests confirm this result for the specification with trend and intercept; for any width of the Bartlett kernel from 1 to 7, the test statistics lie around the value of –3.91 given in table A1.

Table A2

Results of the augmented Dickey Fuller (ADF) unit-root tests

Variable	Test for I (0)		Test for I (1)		Result
	Specification[a)]	ADF test statistics[b)]	Specification[a)]	ADF test statistics[b)]	
x	T, 0	–3.91**	C, 0	–9.39***	I (0)[c)]
ipa	T, 1	–2.63	C, 0	–3.21**	I (1)
e	C, 0	0.23	N, 0	–4.56***	I (1)
world	T, 1	–2.93	T, 0	–1.85	I (2)[d)]

* (**,***) means rejection at the 10% (5%, 1%) significance level. — [a)] T: model with drift and trend; C: model with drift; N: model without drift and trend. The figure indicates the number of lagged variables in the test equation. — [b)] Augmented Dickey-Fuller t-test. — [c)] The KPSS test (Kwiatkowski et al., 1994) rejects the null of stationarity at the 10% level for lag truncation parameters 0 and 1 but cannot reject for higher ones ($\mu_t(1) = 0.132 > 0.119$; $\mu_t(2) = 0.107$). — [d)] The $KPSS_{\tau}$ test rejects the null of difference stationarity of *world* at the 10% level for truncation parameters up to 7 but cannot reject for higher lags. The KPSSµ test fails to reject the hypothesis of difference stationarity for truncation parameters of 10 and higher. At the 5% level both mean and trend stationarity of *Δworld* are not rejected for tuncation parameters of 6 and more.

Source: own calculations.

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Table A3

Multivariate stationarity tests statistics conditional on the cointegration rank

Rank r	p – r	5% critical value for χ^2 (p – r)	x	ipa	e	world
1	3	7.82	14.71	17.03	17.71	15.77
2	2	5.99	11.44	12.25	11.29	10.97
3	1	3.84	9.89	10.59	9.52	10.03

Source: own calculations.

ever, despite this unanimous rejection of the assumption of non-stationarity, one should bear in mind the difficulty of distinguishing between deterministic and stochastic trends in small samples (Harris 1995, 39). As Campbell and Perron (1991, 157) point out, "any trend-stationary process can be approximated arbitrarily well by a unit root process [...]". This is why I additionally report the results of multivariate tests for stationarity from the CATS "time-series properties" menu (Hansen and Juselius, 1994, 65) in table A.2. For each rank r it is tested if the data support the (p * r)-cointegration vector β to be partitioned into one stationary time series and a (p * (r–1)) subvector φ. If this is not the case it is concluded that the series under investigation is nonstationary. The case r = 0 implies all variables to be nonstationary and therefore is not reported. As the table shows there is overwhelming evidence for nonstationarity to hold for all the variables composing the cointegration vector of Euroland's long-run export equilibrium. Therefore the estimation strategy presented in chapter 5 is appropriate.

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Zusammenfassung

„Echte“ VGR-Exporte und -Importe für Euroland

Eine erhebliche Schwäche in der Volkswirtschaftlichen Gesamtrechnung Eurolands liegt in der fehlenden Trennung zwischen „echten“ Exporten (Importen) und Versendungen innerhalb der Eurozone. In diesem Aufsatz werden über eine Schätzung des Anteils der Drittländer am nominalen bzw. realen Warenhandel der EWU-Mitgliedsländer die „echten“ VGR-Exporte und -Importe Eurolands ermittelt. Der Stützbereich beginnt 1989: 1, da Volumen- und Einheitswertindizes für den regional disaggregierten Außenhandel der Euroländer für die Zeit davor nicht verfügbar sind. Die so berechneten realen Exporte und ihre Bestimmungsgründe (Auslandsproduktion, realer Wechselkurs und ein Globalisierungsmaß) werden einer Kointegrationsanalyse unterzogen: Das Viergleichungssystem lässt sich auf ein sparsam parametrisiertes Fehlerkorrekturmodell der Nachfrage nach europäischen Exporten reduzieren, das unter zwei alternativen Restriktionen geschätzt wird. Die Wechselkurselastizität beläuft sich in beiden Fällen auf –0.6, und in Modell 2 („konstante Skalenerträge“) wird der im Trend abnehmende Weltmarktanteil Eurolands am Koeffizienten der Globalisierungsvariable sichtbar.

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