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Euro area exports and imports: Do determinants of intra- and extra-EMU trade differ?

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Abstract:

The attempt is to explain EMU exports and imports, treating the euro area as one single economy. EMU trade is analysed separately for intra- and extra-EMU trade. One result of this approach is that extra- and intra-EMU trade seem to follow a different pattern. Therefore, a separate estimation seems preferable. This is especially true for exports. For imports, the mistake made seems to be smaller. Interestingly, the aggregate of intra- and extra-EMU trade seems to be dominated by the pattern of extra-EMU trade, although both sub-aggregates are of a similar size: Estimation equations for aggregate EMU exports are quite similar to those for extra-EMU exports and the equations for aggregate EMU imports resemble those for extra-EMU imports.

1 Introduction

Foreign trade topics are well represented in economic research for a number of countries and regions, yet euro area exports and imports are less frequently analysed. The main reason is that the creation of the European Monetary Union (EMU) is a very recent phenomenon, at least from a statistical point of view: Since the euro has been introduced in 1999, available time series for the euro area as an aggregate are rather short for econometric analysis, even on a quarterly basis. The artificial construction of longer time series using national data for the time before 1999 from countries that now form the euro area not only raises the problem of how to aggregate the national data but also increases the probability of several structural breaks in the time series.

Due to the mentioned data issues, export and import equations for the EMU mainly focus on (selected or all) countries that now form the euro area.[1] In contrast to multi-country approaches, the paper presented here analyses EMU trade treating the euro area as one single economy. All equations refer to EMU aggregates. Studies with a one-country approach for the euro area often use artificially prolonged time series with more data points before the introduction of the euro than afterwards.[2] Instead, the sample considered here starts in the first quarter of 1995 and ends in the last quarter of 2006. Therefore, only one third of the observations belongs to the period before the launch of the euro. This sample reduces the probability of structural breaks, although one potential candidate for it, the introduction of the euro in 1999, is still included.

As in most studies, the focus is on exports and imports of goods. The level of aggregation is high: the analysis concentrates on aggregated exports and imports, with no breakdowns by industry, product, or production (i.e. labour intensity) for

[1] Approaches treating the euro area in a multi-country framework are e.g. Bundesbank 2000, De Bondt et al. 1997, Anderton et al. 2005. Multi-country approaches might be motivated by Marcellino et al. (2003), who find evidence that pooling country specific forecasts outperforms forecasting at the aggregate level – albeit not for trade series and for a sample before the introduction of the euro.

[2] See for example the Area-Wide Model of the ECB (Fagan et al. 2001) that is based on data starting in the first quarter of 1970. Nevertheless, a higher percentage of data points before the introduction of the euro might be adequate, if the focus is on the evolution of euro area trade in the run-up to the European Monetary Union, like in Anderton et al. 2005.

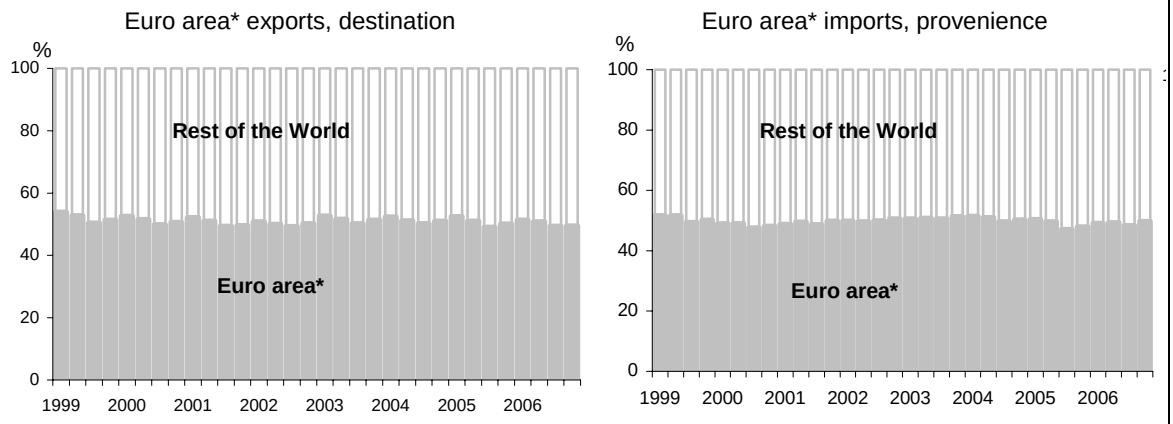
which newer micro-founded trade theories would call for.[3] Yet, exports from the euro area to countries outside of it ("extra-EMU trade") and exports from single EMU countries to other countries in the common currency area ("intra-EMU trade") are analysed separately. The same distinction into "intra-" and "extra-"EMU trade is applied for imports. This is for example in contrast to the trade equations used in the Area-Wide Model of the ECB (Fagan et al. 2001) where aggregated exports and imports include intra-EMU trade, but not a totally new feature.[4]

Intra- and extra-EMU exports of goods as well as imports are roughly equal in magnitude: Since 1999, a constant share of roughly 50% of all EMU goods exports (imports) has gone to (has come from) euro area countries (see figure 1). The main aim of this paper is to show that intra- and extra-EMU trade follow a different pattern and, hence, should be estimated separately. The behaviour of EMU trade aggregates, however, is very similar to the one of the extra-EMU figures.

Figure 1

Provenience and destination of euro area* trade of goods

Quarterly data, percentage of total exports (imports), respectively



*Euro area consisting of the 13 members at the start of 2007.
Source: IMF direction of trade statistics, own calculations.

Section 2 shortly explains the theoretical background for import and export equations. Section 3 describes the data. Most of the interesting time series are

[3] Yet, a descriptive analysis for extra-EMUexports by Baumann/di Mauro (2007) shows that the shares of labour-intensive, research-intensive, capital-intensive, and raw material-intensive exports have hardly changed since 1993.

[4] Ca` Zorzi/Schnatz (2007) focus on extra-EMU exports and consider a similar time period (1992-2006). Anderton et al. 2005 also distinguish between intra- and extra-EMU trade, but in a multi-country framework and for a different time period (1989-2000). Baumann/di Mauro (2007) focus on extra-EMU trade, but only in a descriptive way.

instationary. Hence, a single equation error-correction approach has been chosen, as section 4 summarizes. Section 5 describes the empirical results for exports, section 6 for imports. Section 7 concludes.

2 Export and import demand equations

The theoretical background for export and import equations is relatively uncontroversial. The prevailing approach for foreign trade explains exports as well as imports in form of a demand equation for imports. Consequently, the demand functions for **real goods exports** (*xg*) are modelled in the following way:

$$xg = F(y^*, {}^{pxg}/_{p^*}),$$

where y^* represents an activity variable as a proxy for income of the importing economies,[5] *pxg* stands for the export goods price index, and *p** is a broad price index of the importing economies, measured by their foreign GDP deflators or their foreign consumer price indices (CPI). The ratio of the prices thus serves as a proxy for the price competitiveness of the exported goods. Alternative competitiveness measures based on unit labour costs or producer prices have not been tested as Ca` Zorzi/Schnatz (2007) demonstrate for the EMU in a comparable sample that they do not perform better and differ only marginally from the indicators used here.

Instead of using the price ratio directly, the export price index and the variable for the importing economies' price level could have been considered separately in the equation, because exports may react differently to changes in the export price level as opposed to the price level in the importing economies.[6] Yet probably due to the small sample for the euro area, a distinction among the effects of the individual price term components did not yield convincing results. The same holds for splitting the price index in three components (export price level, price level in the importing economies, and exchange rate).

[5] We use the term "importing" economies instead of the more common term "foreign" economies on purpose: Treating the euro area as one single country implies that intra-EMU exports (from one euro area country to another) do not involve a foreign country.

[6] See for example Sawyer et al. (1996) where the advantages of splitting both price effects and also the benefits of including the exchange rate separately into the equation are discussed.

The activity variable can be measured by importing countries' GDP (or its components)[7] or importing countries' import volumes. Here, the focus is on GDP and its components, as importing countries' import volumes were outperformed by their GDP or their gross fixed capital formation. In addition, reliable import volumes are only published with a long time lag. Foreign countries' GDPs or imports are sometimes weighted according to their export share at a base year. Similarly, the price of competing foreign products may be gained by weighting the foreign national price levels according to their export share. The approach presented here abstracts from a weighting scheme as the relative importance of extra-EMU export destination countries has considerably changed during the forecasting horizon (see figure 2 for the main export destination countries outside the EMU).[8]

The standard approach models the long-run demand for **real goods imports** (*mg*) as a function of domestic activity (*y*) and a proxy for the price competitiveness of imported goods:

$$mg = F(y, {}^{pmg}\!/_{p})$$

The activity variable can be expressed as real GDP, but (weighted) GDP components like gross fixed capital formation and/or private consumption may lead to better results.[9] For EMU imports, real EMU GDP and the subcomponent gross fixed capital formation have been chosen. Explaining imports by EMU private consumption did not lead to convincing results and is therefore not reported.

Following the theoretical approach, the price term for EMU imports should consist of the ratio of EMU import prices (*pmg*) versus an overall EMU price index – expressed by the GDP deflator or the CPI. However, a ratio of EMU import prices in relation to world prices leads to better results for the explanation of intra-EMU imports (see 6.2). Again, splitting the price ratio in the two individual price terms (or in three, also

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[7] If GDP components like gross fixed capital formation are used as a proxy for the importing countries income, an alternative version of the price ratio would include the deflator of this subcomponent (e.g. the deflator for gross fixed capital formation) instead of the GDP deflator.

[8] The explanation of extra-EMU exports by export-share weighted world import volumes excluding the euro area has been tested, but is outperformed by unweighted GDP and gross fixed capital formation.

[9] Stephan (2007) shows that implausible high income elasticities for German import demand functions prevailing in several studies are due to highly aggregated activity variables. Using GDP components instead yields elasticities that are more in line with theoretically convincing values. The author also discusses weighting schemes for GDP components.

analysing the exchange rate effects separately) should provide more insight.[10] Yet this approach was not successful for the data considered here, probably due to the small sample size.

3 Data

The approach applied here treats the euro area as one single economy that is assumed to consist of the 13 member countries[11] at the beginning of 2007. As there are – up to now – almost no satisfactory databanks with long spans of time series for the euro area, especially not on a higher frequency, mainly official Eurostat data have been used. Most of these data are only available from the first quarter of 1995 onwards. Consequently, these data have been chosen as the starting point for all equations. Although longer spans of data are preferable for proper estimation techniques, Eurostat data have several advantages: One is the availability of quarterly data (which AMECO, the Annual Macro-Economic data base, for instance, or other sources do not offer). Another is the wide coverage of important time series.

Starting in 1995 not only avoids the time consuming and problematic construction of artificial historic series. It also reduces the probability of structural breaks, not only in the series themselves (e.g. during the exchange rate crises in 1992/93), but also in the estimated relations of economic variables, for instance because of the convergence process in the run-up to the European Monetary Union.[12] Nevertheless, the event of introducing the euro in 1999 seems to have influenced almost all considered euro area data.[13] Although the introduction of the European Monetary Union might constitute a structural break, accounting for it by the use of dummy variables either did not improve the regressions (apart from negligible cases) or led to instable regressions.

For the focus of this paper, intra- and extra-EMU exports and imports were calculated on the basis of the IMF direction of trade statistics (DOTS).[14] As the IMF DOTS offer

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[10] See again Sawyer et al. (1996).

[11] Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Span, Slowenia.

[12] In addition, data problems due to the German reunification do not have to be considered.

[13] By graphical analysis, most series seem to slightly change their patterns in 2001.

[14] In June 2007, Eurostat has started to publish annual and quarterly national sector accounts data that includes nominal exports and imports, separated for intra- and extra-EMU trade. Those time

nominal exports and imports of goods[15] for each country by nationality of the receiving country starting before 1999, EMU exports (and imports) data have been constructed by summing up national exports (imports) of all 13 member countries for intra- and extra EMU trade for the period 1995-2006. The construction of the series and the adjustments for seasonality are described in detail in Appendix 1. The series were deflated using EMU aggregate export and import price indices, respectively, since deflators for intra- and extra-EMU exports (imports) are not available.

To assure a consistent data base for the explanatory variables, all data are taken from the national accounts statistics or are at least consistent with these data. Eurostat data are seasonally and calendar adjusted. Real Eurostat data are generally considered in the form of chain-linked volumes with reference year 2000, deflators/price indices are equally chain-linked indices with reference year 2000.[16] A list of names and sources of the used variables can be found in Appendix 1, table 1 and 2, together with a description of those data that is not directly from Eurostat but transformed or constructed instead. All variables are measured in euro.

As this paper treats the euro area as one single economy and focuses on the separate estimation of intra- and extra-EMU trade, some variables for the long-run relationship had to be constructed. This is mainly the case for world GDP excluding the euro area which is necessary for explaining extra-EMU exports. The best performing version is based on data from the International Monetary Fund (IMF).[17] It would have been interesting to test if GDP subcomponents like gross fixed capital formation performed better. Unfortunately, this variable is not available for all

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series only start in 1999 and are neither seasonal nor calendar adjusted, but they were helpful for cross-checking the calculations based on IMF DOTS from 1999 onwards. The calculated IMF data are roughly consistent with Eurostat national accounts. DOTS data for goods exports and imports are slightly higher than the corresponding Eurostat data. The small differences in the level (not in the trend) might be due to valuation problems, as DOTS data are reported in US dollar and Eurostat data are reported in euro.

[15] As in most other approaches, the focus is on goods exports and imports. Trade of services could be treated as a function of goods trade.

[16] In some cases, Eurostat price indices had to be rebased from reference year 1995 to reference year 2000.

[17] As an alternative to world GDP, OECD GDP (excluding the euro area) has been constructed (see Appendix 1). This variable performed worse than the world GDP excluding the euro area, which is in all probability due to the fact that important destination countries for euro area exports like Russia, China, and Brazil are no OECD members and, hence, not included in the OECD data.

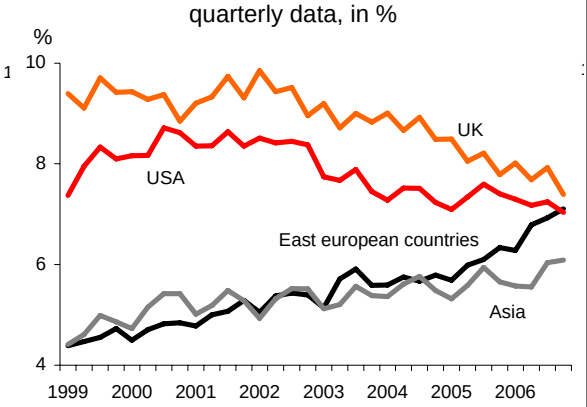
countries and hence could not be constructed for the rest-of-the-world.[18] The use of weighted world import volumes excluding the euro area as an alternative proxy for rest-of-the-world income did not lead to convincing results and is therefore not reported. Attempts have been made to only consider activity in the main export destination countries (UK and the US, see figure 2), but proved unsuccessful (see chapter 5).

Figure 2

Extra-euro area* export destination

as a percentage of total exports

quarterly data, in %



*Euro area consisting of the 13 members of 2007.
Source: IMF DOTS, own calculations.

Price variables for the rest-of-the-world should ideally exclude the EMU; due to a lack of data world price indices including the euro area have been used. In addition, the correct price index for extra-EMU exports is not available. Therefore, the index for aggregate EMU exports (i.e. of extra- and intra-EMU exports) has been used.

As with exports, Eurostat does not provide separate deflators for extra- and intra-EMU imports, respectively. Instead, the price index for aggregate EMU imports has been used.

4 Estimation approach

The results of the augmented Dickey-Fuller tests show that almost all considered variables are integrated of order one in their levels and stationary in their first differences (see Appendix 2, table 3).[19] Because of this property, ordinary least squares estimates could run into a spurious regressions problem. Following Engle/Granger (1987), an error correction approach has been applied which implies that the variables considered for the long-run relationship are co-integrated.

[18] Nevertheless, this does not seem to cause a problem, as world gross fixed capital formation does not help in explaining aggregate exports, although it performs well for intra-EMU exports.

[19] For three variables (indicated in Appendix 2, table 3), the null hypothesis of a unit root could be rejected for the level, but only for the augmented Dickey-Fuller test, not for the Phillips-Perron test. For all other variables, the Phillips-Perron test yielded the same results, therefore the test results are not displayed in the table.

Besides being the adequate approach, the error correction representation has the advantage to differentiate between short-run effects and the long-run equilibrium. Dynamic adjustment processes are explicitly modelled. The long-run equilibrium would be expected to be in line with the theoretical relationships presented in chapter 2.

Although the error correction representation seems to be adequate, this approach requires more observations than ordinary least squares estimates. Hence, the rather short time series for the euro area are a major drawback. Due to the limited number of observations, only single equation error correction (in contrast to vector error correction) models were estimated, following Banerjee/Dolado/Mestre (1998).[20] The equations presented are stable with regards to shocks and yield convincing coefficient signs and estimates. Because of the limited number of observations, it has not been tested if parameter estimates are robust for alternating sample sizes. In contrast to the unit root tests, correct finite sample critical values are not available for the single equation approach, only those for infinite samples. Yet the adjustment coefficient is highly significant (mostly at the one percent level) such that the equations can be regarded as reliable.

The single equation approach is only adequate if the variables explaining exports or imports in the long-run are all weakly exogenous. This has been assured for all equations presented. Testing for it is important as the variables on the right hand side of an error correction equation can otherwise not be interpreted as explanatory. Instead, causality could run both ways.

All time series were transformed in log-terms before starting the regression analysis. The estimated parameters can thus be interpreted as elasticities. Since no calibrations have been used, a new steady-state does not necessarily imply that a market clearing equilibrium is reached. Due to the limited number of observations, it has not been tested, if coefficient estimates are in line with theoretically expected unitary income elasticities.

The form of the equations is determined according to the “general to specific”-approach: Four (if necessary: eight) lags of differences in each variable were

[20] The single equation approach has also been followed by Ca` Zorzi/Schnatz (2007) who analyse a similarly short sample.

included in the regression before insignificant ones were eliminated one by one. The judgement on the performance of the equations was based on the Akaike information criterion. Furthermore, all equations (including the ones listed in the Appendix) proved to be stable according to the Cusum-, Cusum of squares- and RESET-test, they can be assumed to be homoscedastic according to the White-test[21] and an ARCH-LM-test up to order one in the residuals. All residual series are free of autocorrelation up to lag 10 according to the LM-test-statistics and the assumption of normally distributed residuals cannot be rejected by the test of Jarque and Bera. For all equations, t-values of the estimated coefficients are indicated in parenthesis. For the residual and specification tests, p-values are given in brackets.

5 Export equations

For **extra-EMU exports**, activity of importing economies is measured by world GDP excluding the euro area. The explanation of **intra-EMU exports** by EMU GDP proved less convincing than by of one of its subcomponents, EMU gross fixed capital formation. If this GDP subcomponent is included in the regression, its deflator has been used for the competitiveness term as an alternative to the CPI or the GDP deflator. Explaining **aggregated EMU exports** by global gross fixed capital formation was unsuccessful; only the explanation by world GDP yields a stable co-integration relation. Alternative specifications for the price term do not markedly change the estimation results.

The best performing equation for extra-, intra- and total EMU exports respectively are presented below. Further estimations with alternative variables for the activity and price indices for the long-run equilibrium and the short-run dynamics are listed in Appendix 3.

[21] Due to the limited number of observations, the White-test has only been applied without cross-terms.

5.1 Extra-EMU exports

In the long-run, EMU exports to countries outside the euro area (xg_{extra}) are supposed to depend on a variable accounting for the economic activity outside the EMU and on the ratio between EMU export prices (PXG)[22] and an index on world prices.

$$\Delta xg_{extra,t} = \underset{4.64}{2.69} - \underset{(-5.24)}{0.67}\left[xg_{extra,t-1} - \underset{(-27.98)}{1.20}\, rowgdp_{IMF,t-1} + \underset{(13.41)}{0.53}\, comp_{PXG/WCPI,t-1} \right] + \underset{(2.36)}{0.32}\,\Delta xg_{extra,t-1} + \underset{(2.35)}{2.32}\,\Delta rowgdp_{IMF,t-1} - \underset{(-1.69)}{0.03}\,\Delta oil_{t-1} + \hat{u}_t \quad (1)$$

R^2=0.52, AIC=-5.37, Cusum and Cusum² stable, RESET=[0.34], ARCH(1)=[0.12], White=[0.40], LM(1)=[0.12], LM(4)=[0.12], LM(8)=[0.12], JB=[0.30]

Equation (1) confirms the theoretical expectations. In the long-run, the rest-of-the-world GDP based on IMF data excluding the euro area ($rowgdp_{IMF}$, see Appendix 1) has a positive impact whereas a rising price competitiveness variable (indicating a rise in export prices relative to world CPI) reduces extra-EMU exports. In the short-run, lagged changes in extra-EMU exports as well as lagged changes in extra-EMU GDP increase exports. The oil price (oil) shows the expected sign as well: In response to a rise in its value (in euro), exports decrease.

Variations of this equation include commodity price indices, including or excluding energy prices, as an alternative to the oil price, the world GDP deflator as a substitute for world CPI, and OECD based extra-EMU GDP instead of the IMF based series. They are presented in Appendix 3.1. None of the variations significantly alter the estimated long-run income and price elasticities, except that the use of the extra-EMU GDP based on OECD data leads to implausibly high income elasticities with values close to two.[23] At the same time, the estimated price elasiticities are lower.

The attempt to explain extra-EMU exports using data for the United Kingdom and the United States as two major trading partners is not successful: parameter estimates are insignificant or no co-integration relation can be found.

[22] As already mentioned, the price index for all euro area exports (including intra-EMU exports) has been used.

[23] Income elasticity reaches implausibly high levels of two and above. This may be due to the fact that important trading partners of the euro area are not included in the OECD data (see Appendix 1).

5.2 Intra-EMU exports

Following the theoretical approach presented in chapter 2, intra-EMU exports (xg_{intra}) should be a function of a EMU activity variable and the ratio of EMU export prices (PXG) and a EMU overall price index as a proxy for price competitiveness. Yet, the demand for EMU exports could also depend on the price index of EMU exports of goods relative to a world price index. Rising world prices could motivate a concentration on intra-EMU trade.

As equation (2) and its variations demonstrate, estimations including export goods prices relative to global prices (here: the world GDP deflator, WPGDP) indeed perform better (see also Appendix 3.2).

$$\begin{aligned}\Delta xg_{intra,t} &= \underset{(2.88)}{4.69} - \underset{(-4.95)}{0.57}\left[xg_{intra,t-1} - \underset{(-3.22)}{0.52}\, ifc_{t-1} + \underset{(4.26)}{0.30}\, comp_{PXG/WPGDP,t-1} - \underset{(-12.27)}{0.01}\, trend \right] \\ &+ \underset{(2.90)}{0.24}\left(\Delta xg_{intra,t-1} + \Delta xg_{intra,t-3}\right) + \underset{(2.08)}{0.30}\,\Delta ifc_{t-4} + \underset{(2.63)}{0.06}\,\Delta stoxx_{t-1} + \underset{(4.38)}{0.09}\,\Delta stoxx_{t-3} \\ &- \underset{(-1.61)}{0.04}\,\Delta stoxx_{t-4} + \hat{u}_t\end{aligned} \qquad (2)$$

R^2=0.67, AIC=-6.01, Cusum and Cusum² stable, RESET=[0.65], ARCH(1)=[0.55], White=[0.52], LM(1)=[0.97], LM(4)=[0.75], LM(8)=[0.87], JB=[0.73]

A significant linear trend in the long-run - as included in equation (2) - signalizes a permanent rise in intra-EMU exports over time which can be interpreted as a proxy for a continued integration of EMU economies. In analogy to other studies on export behaviour, the gross fixed capital formation of the EMU (ifc), as a sub-component of GDP, leads to income elasticity estimates which are in a reasonable range.[24] A rise of the investment activity in the euro area has in the long and in the short-run positive effects on intra-EMU exports. An increase in the ratio between export prices and world prices indicates that exporters located in the EMU lose price competitiveness, hence exports decrease. The effect of the European stock market index for the 50 largest listed companies (stoxx) is in line with the impact of the activity variable: A stronger stock market increases exports.

[24] See Stephan *(2007).*

Alternative indices for world prices in the price competitiveness term and variations in the explanatory variables for the short-run dynamics confirm the elasticity-estimates in equation (2).[25]

The only stable equation describing intra-EMU exports as a function of gross fixed capital formation and price competitiveness of export prices and an EMU price index ($comp_{PXG/CPI}$) is presented in equation (3).

$$\Delta xg_{intra,t} = \underset{(-2.39)}{-2.11} \underset{(-4.40)}{-0.33}\left[xg_{intra,t-1} \underset{(-11.48)}{-1.48}\, ifc_{t-1} \underset{(6.17)}{+1.53}\, comp_{PXG/CPI,t-1} \right] + \underset{(2.51)}{0.39}\, \Delta ifc_{t-4} + \underset{(3.13)}{0.12}\, \Delta commod_{t-2} + \hat{u}_t \quad (3)$$

R^2=0.48, AIC=-5.79, Cusum and Cusum² stable, RESET=[0.14], ARCH(1)=[0.35], White=[0.47], LM(1)=[0.83], LM(4)=[0.41], LM(8)=[0.14], JB=[0.82]

The parameters of both long-run variables, gross fixed capital formation and the export prices relative to EMU CPI, have the expected sign.[26] Nevertheless, coefficient estimates significantly differ from those in equation (2). And the linear trend, which is necessary when export prices are set in relation to world prices, is no longer significant. In the short-run, investment and commodity prices (commod) further exports.

5.3 Total EMU exports

In the previous sections, extra- and intra-EMU exports were modelled separately. As the equation specifications demonstrate, both export series do not seem to follow the same behavioural pattern. Not only the activity variables differ: Economic activity outside the euro area can be represented by extra-EMU GDP, whereas the activity variable for the euro area needs to be a subcomponent of GDP, namely gross fixed capital formation.[27] Moreover, when both series are explained with the same price competitiveness ratio (EMU export prices relative to a world price), a stable co-integration relation for intra-EMU exports requires the integration of a linear trend.

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[25] Alternative estimations are listed in Appendix 3.2. A co-integration relation among exports, a price ratio with export- and world prices and the euro area GDP could not be found.

[26] Yet, a rise in exports caused by higher commodity prices including energy is a surprising estimation output.

[27] Although the rest-of-the-world gross fixed capital formation could not be constructed, the following estimation results for total exports seem to indicate that it would not have outperformed rest-of-the-world GDP.

The best fit for total EMU exports (xg_{aggr}) is attained by explaining them with world GDP and a price ratio of EMU export prices and world CPI. Again, a rise in this ratio implies a loss in price competitiveness of EMU exports. The signs of the estimated parameters in equation (4) are all in line with theoretical expectations.

$$\Delta xg_{aggr,t} = \underset{(4.16)}{1.84} - \underset{(-4.30)}{0.52}\left[xg_{aggr,t-1} - \underset{(-28.59)}{1.28}\, worldgdp_{IMF,t-1} + \underset{(12.12)}{0.47}\, comp_{PXG/WCPI,t-1} \right] + \underset{(2.44)}{2.02}\,\Delta worldgdp_{IMF,t-3} + \underset{(2.35)}{0.08}\,\Delta hwwi_{EE,t-1} + \underset{(2.19)}{0.03}\,\Delta oil_{t-2} + \hat{u}_t \quad (4)$$

R^2=0.57, AIC=-5.95, Cusum and Cusum² stable, RESET=[0.48], ARCH(1)=[0.63], White=[0.95], LM(1)=[0.44], LM(4)=[0.51], LM(8)=[0.33], JB=[0.59]

While the estimated income elasticity in equations with world GDP based on IMF data is in line with theoretical expectations, estimates for world GDP based on OECD data lead to implausibly high values close to two (see equation 4 and Appendix 3.3). At the same time, price elasticities in OECD data equations are peculiarly low. This phenomenon is akin to the one for extra-euro exports. In contrast to intra-EMU exports, GDP subcomponents do not form a stable co-integration relationship with aggregate exports: The estimated equations with worldwide gross fixed capital formation are not stable according to the CUSUM/CUSUM^2-test, and/or suffer from autocorrelation, even, if a time trend is included.

Alternative global price indices in the competitiveness variable confirm the elasticity estimates (see Appendix 3.3). As has been the case for extra-EMU exports, no linear trend is required for stable co-integration.[28] With regards to the explanatory variables and the corresponding parameter estimates, modelling aggregate EMU exports seems to be more in line with extra- than with intra- EMU exports.

6 Import equations

As shown, extra- and intra-EMU exports do not only differ in the way they depend on activity and price variables, but also in the variables themselves. Contrary to exports, **extra- and intra-EMU imports** should (in the long-run) depend on almost the same variables, if one takes the theoretical approach presented in section 2 as a basis: a proxy for EMU activity and the ratio of EMU import prices and an (overall) EMU price

[28] Instead, a linear trend leads in most cases to instability or autocorrelation.

index. Ideally, only the import price deflator would differ for extra- and intra-EMU imports, yet only the one for extra- and intra-EMU imports is available.

The explanation of extra- as well as intra- and total-EMU imports by EMU gross fixed capital formation outperforms the one with EMU GDP. In addition, a time trend proves necessary in several equations. This may be due to the continuously grown openness of the euro area during the observation period, measured as the ratio of imports to GDP. Hence, the time trend may capture the reduction of (implicit) trade barriers and the increasing specialisation.

If extra- and intra-EMU import demand equations yield significantly different coefficient estimates, the dis-aggregation of total EMU imports would thus be useful. This chapter shall demonstrate that this is the case. Again, the Akaike Information Criterion determines the best performance. The corresponding equation will thus be presented below, while variations are listed in detail in Appendix 4.

6.1 Extra-EMU imports

Equation (5) proved to perform best in modelling extra-EMU import demand. In the long-run, imports of goods (mg) relate positively to gross fixed capital formation in the EMU. A rise in the ratio of import prices relative to EMU CPI ($comp_{PMG/CPI}$) implies a loss in the price competitiveness of import goods. The decreasing effect on imports in the long-run hence corresponds to the theoretical expectations given in chapter 2.

$$\Delta mg_{extra,t} = \underset{(-1.72)}{-1.63} - \underset{(-4.09)}{0.20}\left[mg_{extra,t-1} - \underset{(-6.68)}{1.60}\, ifc_{t-1} + \underset{(3.69)}{1.45}\, comp_{PMG/CPI,t-1} \right] + \underset{(2.02)}{0.23}\,\Delta mg_{extra,t-1} + \underset{(2.76)}{0.52}\,\Delta comp_{PMG/CPI,t-2} + \underset{(4.09)}{0.16}\,\Delta hwwi_{EE,t-1} + \hat{u}_t \quad (5)$$

R^2=0.68 , AIC= -5.83, Cusum and Cusum² stable, RESET=[0.46], ARCH(1)=[0.81], White=[0.63], LM(1)=[0.98], LM(4)=[0.60], LM(8)=[0.85], JB=[0.51]

No co-integration was found when EMU GDP was used as activity variable. Variations in the overall EMU price index lead to results that are similar to the long-run coefficient estimates in equation (5). The astonishing positive impact of commodity prices on imports in the short-run was confirmed in other equations where commodity prices excluding energy prices have been replaced by oil prices or an overall commodity price index.

6.2 Intra-EMU imports

On a first glance, the equation describing intra-EMU imports (mg_{intra}) supports the assumption that both extra- and intra-EMU imports depend on the same explanatory variables in the long-run. Again, gross fixed capital formation raises real imports, while the proxy for price competitiveness has a negative influence. The best performing EMU price index in relation to import prices is the CPI.

$$\begin{aligned}\Delta mg_{intra,t} &= \underset{(-2.10)}{-2.44} - \underset{(-5.16)}{0.80}\left[mg_{intra,t-1} - \underset{(-12.37)}{1.19}\, ifc_{t-1} + \underset{(4.56)}{0.45}\, comp_{PMG/CPI,t-1} - \underset{(-8.56)}{0.01}\, trend \right] \\ &+ \underset{(3.11)}{0.36}\left(\Delta mg_{intra,t-1} + \Delta mg_{intra,t-2}\right) + \underset{(2.34)}{0.33}\,\Delta mg_{intra,t-3} - \underset{(-1.95)}{0.46}\,\Delta ifc_{t-1} \\ &+ \underset{(1.93)}{0.35}\,\Delta ifc_{t-4} + \hat{u}_t \end{aligned} \quad (6)$$

R^2=0.53 , AIC=-5.59, Cusum and Cusum² stable, RESET=[0.66], ARCH(1)=[0.25], White=[0.90], LM(1)=[0.32], LM(4)=[0.51], LM(8)=[0.35], JB=[0.45]

Intra-EMU imports can also be explained by EMU GDP instead of gross fixed capital formation (see Appendix 4.2). However, the resulting income elasticity estimates are implausibly high. Comparing the equations for intra- and extra-EMU trade based on capital formation as activity variable, differences in the behavioural pattern in the long-run as well as the obvious differences in the short-run dynamics need to be stressed. Income elasticity estimates take more reasonable values for the case of intra-EMU than for extra-EMU imports. Already elevated income elasticity estimates are even higher for extra-EMU trade. Price elasticities are also higher for extra- than for intra-EMU trade. The necessity of a linear trend makes the major difference between intra- and extra-EMU imports for stable co-integration: Intra-EMU imports increase consistently over the observation period, and this trend cannot be accounted for by the considered explanatory variables. The proceeding integration of the EMU economy inherent in the data for intra-EMU trade is a potential reason for this result.

6.3 Total EMU imports

Not only the linear trend which is required for modelling stable intra-EMU import equations, but also the size of the estimated income and price elasticities of imports underline differences in extra-EMU and intra-EMU import developments. Focussing on the long-run relation, estimates for total imports of goods in the euro area are more in line with those for extra-EMU imports than for intra-EMU imports.

$$\Delta mg_{aggr,t} = \underset{(2.61)}{-1.94} - \underset{(-4.04)}{0.19}\left[mg_{aggr,t-1} - \underset{(-11.32)}{1.84}\, ifc_{t-1} + \underset{(4.29)}{1.22}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(1.88)}{0.23}\,\Delta mg_{aggr,t-1} - \underset{(-3.17)}{0.36}\,\Delta mg_{aggr,t-4} + \underset{(2.48)}{0.38}\,\Delta comp_{PMG/CPI,t-2} \qquad (7)$$
$$+ \underset{(2.91)}{0.04}\left(\Delta stoxx_{t-1} + \Delta stoxx_{t-3}\right) + \hat{u}_t$$

R^2=0.65 , AIC=-6.28, Cusum and Cusum² stable, RESET=[0.35], ARCH(1)=[0.47], White=[0.16], LM(1)=[0.30], LM(4)=[0.36], LM(8)=[0.60], JB=[0.75]

In equation (7), the direction of the effects confirms the expectation: a rise in gross fixed capital formation stimulates imports, while an increase in relative import prices has the opposite effect. The income elasticity of imports amounts to nearly two, and also the price elasticity signals levels of above one. In the short-run, additional influence besides lagged long-run variables originates from the evolution of stock market prices which have the expected positive impact on imports.

Variations which replace the CPI with either the EMU GDP deflator or the deflator for gross capital formation all underpin the range of elasticity measures. Explaining total imports using EMU GDP does not lead to stable co-integration relations. Regarding the short-run dynamics, commodity prices instead of the Stoxx50 index show ambiguous results: The oil price or commodity prices including oil lower imports in the short-run, while commodity prices excluding oil have a positive effect.

7 Concluding remarks

The paper presented here tries to explain EMU exports and imports, treating the euro area as one single economy. In addition, EMU trade is analysed separately for intra- and extra-EMU trade. This is not only different to the prevailing multi-country approaches, but also to the treatment in the Area-Wide Model of the ECB, where only aggregated exports and imports are estimated. A further distinction is due to the observation period: Instead of using artificially prolonged data for the euro area (building on the national countries' data), rather short time series starting in 1995 are used. This observation period assures that the majority of observations belongs to the existing euro area. The motive behind this sample selection is to avoid structural breaks. However, the approach admittedly runs the risk that the time series are too short for robust estimation results. Therefore, the limited number of observations calls for careful interpretation of the estimation results.

Nevertheless, the presented equations seem to be quite stable and the estimated coefficients for income and price elasticities are broadly in line with those from other studies for exports and imports. If intra- and extra-EMU trade followed the same pattern, explanatory variables and estimated coefficients should not differ significantly. However, extra- and intra-EMU trade does seem to follow a different pattern. Therefore, a separate estimation of intra- and extra-EMU trade seems preferable. This is especially true for exports. For imports, the mistake made seems to be smaller.

Interestingly, the aggregate of intra- and extra-EMU trade seems to be dominated by the pattern of extra-EMU trade, although both sub-aggregates are of a similar size: Estimation equations for aggregate EMU exports are quite similar to those for extra-EMU exports and the equations for aggregate EMU imports resemble those for extra-EMU imports.

Appendix 1: Variable list, data sources and descriptions

Tab. 1: List of Variables (alphabetical order)	
Abbreviation	**Variable description**
commod	Reuters world commodity price index including energy
$comp_{PMG/CPI}$	price ratio: EMU import goods deflator relative to EMU CPI
$comp_{PMG/PGDP}$	price ratio: EMU import goods deflator relative to EMU GDP deflator
$comp_{PMG/PIFC}$	price ratio: EMU import goods deflator relative to EMU gross fixed capital formation (IFC) deflator
$comp_{PXG/CPI}$	price ratio: EMU export goods deflator relative to EMU CPI
$comp_{PXG/WCPI}$	price ratio: EMU export goods deflator relative to world CPI
$comp_{PXG/WPGDP}$	price ratio: EMU export goods deflator relative to world GDP deflator
$comp_{PXG/WPIFC}$	price ratio: EMU export goods deflator relative to world IFC deflator
cpi	EMU consumer price index
gdp	EMU gross domestic product
$hwwi_{EE}$	HWWI EMU commodity price index excluding energy
ifc	EMU gross fixed capital formation, real
mg_{aggr}	total EMU imports of goods, deflated by pmg
mg_{extra}	extra-area imports of goods, deflated by pmg
mg_{intra}	intra-area imports of goods, deflated by pmg
oil	oil price
pgdp	deflator for EMU GDP
pifc	deflator for EMU IFC
pmg	deflator for EMU import goods
pxg	deflator for EMU export goods
$rowgdp_{IMF}$	IMF-world GDP excluding EMU, real (rest-of-the-world, calculation see below)
$rowgdp_{OECD}$	OECD-GDP excluding EMU, real (rest-of-the-world, calculation see below)
stoxx	Dow Jones Euro Stoxx50 index
wcpi	world CPI
$worldgdp_{IMF}$	IMF world GDP, real
$worldgdp_{OECD}$	OECD world GDP, real (index)
worldifc	OECD world IFC, real (index)
wpgdp	world GDP deflator
wpifc	world IFC deflator
xg_{aggr}	total EMU exports of goods, deflated by pxg
xg_{extra}	extra-area EMU exports of goods, deflated by pxg
xg_{intra}	intra-area EMU exports of goods, deflated by pxg

Tab. 2: Source of variables and of seasonal adjustment (alphabetical order)		
Abbreviation	**Source and explanations**	**Seasonal adjustment**
commod	Reuters, in current euros	None
$comp_{PMG/CPI}$	See pmg, see cpi	
$comp_{PMG/PGDP}$	See pmg, see pgdp	
$comp_{PMG/PIFC}$	See pmg, see pifc	
$comp_{PXG/CPI}$	See pxg, see cpi	
$comp_{PXG/WCPI}$	See pxg, see wcpi	
$comp_{PXG/WPGDP}$	See pxg, see wpgdp	
$comp_{PXG/WPIFC}$	See pxg, see wpifc	
cpi	OECD	Demetra Tramo/Seats
gdp	Eurostat	Eurostat
$hwwi_{EE}$	Hamburg Institute of International Economics (HWWI)	None
ifc	Eurostat	Eurostat
mg_{aggr}	Eurostat	Eurostat
mg_{extra}	IMF Direction of Trade Statistics (DOTS)	Demetra Tramo/Seats
mg_{intra}	IMF DOTS	Demetra Tramo/Seats
oil	Reuters, in current euros	Demetra Tramo/Seats
pgdp	Eurostat	Eurostat
pifc	Eurostat	Eurostat
pmg	Eurostat	Demetra Tramo/Seats
pxg	Eurostat	Demetra Tramo/Seats
$rowgdp_{IMF}$	IMF World Economic Outlook (WEO) database, yearly data, frequency conversion to quarterly data with EViews (quadratic match sum), in fixed 2000 euros, calculation see below	None
$rowgdp_{OECD}$	OECD, in fixed 2000 euros, calculation see below	Demetra Tramo/Seats?
stoxx	Stoxx Limited, in current euros	None
wcpi	OECD, in current euros	None
$worldgdp_{IMF}$	IMF World Economic Outlook (WEO) database, yearly data, frequency conversion to quarterly data with EViews (quadratic match sum)	None
$worldgdp_{OECD}$	OECD	None
worldifc	OECD	None
wpgdp	OECD, in current euros	None
wpifc	OECD, in current euros	None
xg_{aggr}	Eurostat	Eurostat
xg_{extra}	IMF DOTS, calculation see below	Demetra Tramo/Seats
xg_{intra}	IMF DOTS, calculation see below	Demetra Tramo/Seats

Calculation of xg_{extra}, xg_{intra}, mg_{extra}, mg_{intra}

Eurostat national accounts cover exports and imports of goods. Unfortunately, they include extra-EMU and intra-EMU trade. The recently published Eurostat quarterly sector accounts offer exports (and imports) of goods excluding intra-EMU trade, but only start in 1999.

The IMF direction of trade statistics (DOTS) offer nominal exports and imports of goods for each country by nationality of the receiving country starting before 1999. EMU exports (and imports) of goods data have been constructed based on this data, by simply summing up national exports (imports) of all 13 member countries for intra- and extra-EMU trade for the entire estimation period.[29] The constructed data are roughly consistent with the Eurostat national accounts data, yet DOTS data for goods exports and imports are slightly higher than Eurostat data. The small differences in the level (not in the trend) might be due to valuation problems, as DOTS data are reported in USD and Eurostat data in EUR.

As the IMF DOTS data provide only nominal exports and imports of goods, real series of EMU goods exports and imports excluding intra-EMU trade have been constructed using the Eurostat EMU-13 export and import deflators, respectively. The index for total exports (imports) has been used, because the price indices for intra- and for extra-EMU exports (imports) are not available. Seasonal adjustment has been conducted using Tramo/Seats, offered by the software program DEMETRA (using the default setting).

Calculation of rowgdp

As a proxy for the demand from outside EMU, real world GDP excluding the euro area has been constructed using as one source IMF World Economic Outlook (**IMF WEO**) data that is only published on a yearly basis. The annual data has been converted into quarterly data using the frequency conversion function "quadratic match sum" in EViews 6. Real GDP in 1995 US-dollar was converted into euro with the fixed average 2000 USD/EUR exchange rate. Real Eurostat EMU-13 GDP was subtracted at last. Adjustment for seasonality seemed unnecessary and has not been conducted.

As an alternative source for comparative purposes, extra-EMU GDP has been based on quarterly OECD Economic Outlook (**OECD EO**) data in the following form: Nominal GDP in national currency, divided by the respective GDP deflator, and

[29] For the years 1997 and 1998, exports to and imports from Belgium-Luxembourg/Belgium/ Luxembourg are missing. The missing data for euro area exports to/imports from those countries were estimated assuming that the fracture of euro area good exports (respective good imports) to (from) these countries on total good exports (respective imports) of the euro area would stay roughly the same as two years before and later.

converted into euro with fixed year 2000 exchange rates has been aggregated by simple summation for the following countries: Australia, Czech Republic, Denmark, Hungary, Iceland, Japan, Mexico, New Zealand, Poland, Slovak Republic, South Korea, Sweden, Switzerland, Turkey, United Kingdom, United States, Norway. A major disadvantage of using the OECD Economic Outlook data is that potentially important trading partners for the euro area are no OECD members and hence not included. That is especially problematic for Brazil, China, and Russia. This may explain why the variable for the rest-of-the-world GDB based on IMF WEO data performed slightly better.

Appendix 2: results of the unit root tests

Augmented Dickey-Fuller Tests						
	Level			First difference		
	Deterministic	Lags	t-Stat	Deterministic	Lags	t-Stat
Exports						
xg_{extra}	c, t	-	-1.66	c	-	-5.86***
xg_{intra}	c, t	2	-1.63	c	-	-5.91***
xg_{aggr}	c, t	1	-1.62	c	-	-5.12***
Imports						
mg_{extra}	c, t	1	-2.05	c	-	-3.62***
mg_{intra}	c, t	-	-1.43	c	-	-6.36***
mg_{aggr}	c, t	1	-1.64	c	3, 7	-3.76***
Income variables						
gdp	c, t	1, 2	-2.00	c	-	-3.69***
ifc	c, t	2	-1.79	c	1	-3.41**
$rowgdp_{IMF}$	c, t	-	-0.62	c	-	-3.46***
$rowgdp_{OECD}$	c, t	1	-2.53	c	-	-4.64***
$worldgdp_{IMF}$	c, t	1, 4, 5, 8, 9	-0.19	c	-	-3.29**
$worldgdp_{OECD}$	c,t	1	-2.44	c	-	-3.85***
worldifc	c, t	1	-2.24	c	-	-3.60***
Price terms						
$comp_{PXG/CPI}$	c, t	1	-2.83	c	4	-3.29**
$comp_{PXG/WCPI}$	c	9	-2.43	-	-	-5.20***
	c, t	-	-0.59	c	-	-5.47***
$comp_{PXG/WPGDP}$	c, t	9	-1.86	c	-	-5.63***
	c	-	-2.11	-	-	-5.47***
$comp_{PXG/WPIFC}$	c, t	-	-0.66	c	-	-5.67***
	c	-	-1.83	-	-	-5.67***
$comp_{PMG/CPI}$[1]	c	1	-1.79	-	2, 3	-4.09***
	c, t	1, 2	-3.32*	-	-	-3.83***
$comp_{PMG/PGDP}$[1]	c	1	-1.87	-	4	-3.35***
	c, t	1, 3	-3.66**	c	-	-4.20***
$comp_{PMG/PIFC}$	c	1	-1.82	-	3	-4.13***
Dynamics						
commod	c	1	-1.63	-	-	-4.14***
$hwwi_{EE}$	c	1	-1.49	-	-	-4.35***
	c, t	1	-1.93	c	-	-4.38***
oil[1]	c, t	1, 3	-3.95**	c	-	-5.27***
stoxx	c	1	-2.00	-	-	-4.41***
	c, t	1	-1.78	c	-	-4.60***

c: constant, t: trend, t-Stat: test statistics. ***/ **/ *: level of significance at 1%/ 5%/ 10%

All variables are transformed in logarithms; lag length selected by the Schwarz information criterion.

Finite sample critical values according to MacKinnon (1996) have been used.

[1)] Phillips-Perron test with trend and intercept: Unit root cannot be rejected for the level.

Appendix 3: Alternative Export estimation equations

The equation with the best value for the Akaike information criterion has been presented in the main text. Alternative estimation equations achieved through varying explanatory variables are listed below.

3.1 Extra-EMU exports:

For extra-EMU exports, the activity variable rest-of-the-world GDP is constructed based on either IMF or OECD data. Price competitiveness is measured as the export goods deflator relative to world-CPI as well as the world-GDP deflator (both variables measured in euro). For the short-run dynamics, a commodity price index of Reuters including energy prices, a price index for commodities excluding energy costs, and the oil price (all variables in euro) have been considered.

Using IMF-based rest-of-the-world GDP as activity variable:

Contrary to the OECD-based GDP for the rest-of-the-world, the IMF-data leads to fairly reasonable estimation results for income and price elasticities of the EMU exports to the rest-of-the-world. Other co-integrating relationships including commodity prices in the short-run dynamics – besides the one presented in the main text – could not be found. Different choices in the world price index used for the competitiveness variable only slightly alter the estimation results.

Equation 3.1.1

$$\Delta xg_{extra,t} = \underset{(4.28)}{2.48} - \underset{(-4.85)}{0.61}\left[xg_{extra,t-1} - \underset{(-24.73)}{1.19}\, rowgdp_{IMF,t-1} + \underset{(11.85)}{0.53}\, comp_{PXG/WCPI,t-1} \right]$$
$$+ \underset{(1.79)}{0.22}\,\Delta xg_{extra,t-1} + \underset{(2.13)}{2.14}\,\Delta rowgdp_{IMF,t-3} + \hat{u}_t$$

R^2=0.48 , AIC= -5.34 , Cusum and Cusum² stable, RESET=[0.25], ARCH(1)=[0.94], White=[0.88], LM(1)=[0.67], LM(4)=[0.60], LM(8)=[0.62], JB=[0.24]

Equation 3.1.2

$$\Delta xg_{extra,t} = \underset{(4.32)}{3.89} - \underset{(-4.68)}{0.60}\left[xg_{extra,t-1} - \underset{(-25.54)}{1.23}\, rowgdp_{IMF,t-1} + \underset{(11.32)}{0.57}\, comp_{PXG/WPGDP,t-1} \right]$$
$$+ \underset{(1.67)}{0.21}\Delta xg_{extra,t-1} + \underset{(2.03)}{2.06}\,\Delta rowgdp_{IMF,t-3} + \hat{u}_t$$

R^2=0.47 , AIC=-5.31, Cusum and Cusum² stable, RESET=[0.20], ARCH(1)=[0.92], White=[0.88], LM(1)=[0.66], LM(4)=[0.66], LM(8)=[0.66], JB=[0.22]

Using OECD-based rest-of-the-world GDP as activity variable:

Consistently through all approaches and thus independently from the price term or the variables in the short-run dynamics, the estimated income elasticity of extra-EMU exports is implausibly high once the rest-of-the-world GDP based on OECD data is used. Different specifications for the short-run dynamics with commodity prices do not alter the estimation results to a considerable degree.

Equation 3.1.3

$$\Delta xg_{extra,t} = \underset{(-5.64)}{-14.82} - \underset{(-5.82)}{0.69}\left[xg_{extra,t-1} - \underset{(-35.61)}{2.21}\, rowgdp_{OECD,t-1} + \underset{(7.83)}{0.37}\, comp_{PXG/WPGDP,t-1} \right] + \underset{1.23}{0.14}\, \Delta xg_{extra,t-1} + \hat{u}_t$$

R²=0.47 , AIC= -5.21, Cusum and Cusum² stable, RESET=[0.30], ARCH(1)=[0.35], White=[0.26], LM(1)=[0.75], LM(4)=[0.89], LM(8)=[0.67], JB=[0.71]

Equation 3.1.4

$$\Delta xg_{extra,t} = \underset{(-5.18)}{-12.93} - \underset{(-4.94)}{0.55}\left[xg_{extra,t-1} - \underset{(-26.19)}{2.22}\, rowgdp_{OECD,t-1} + \underset{(6.02)}{0.31} comp_{PXG/WCPI,t-1} \right] - \underset{(-2.54)}{0.27}\, \Delta comp_{PXG/WCPI,t-3} + \underset{(3.36)}{0.16}\, \Delta com\,mod_{t-2} - \underset{(-2.41)}{0.14}\, \Delta com\,mod_{t-3} + \hat{u}_t$$

R²=0.58, AIC=-5.51, Cusum and Cusum² stable, RESET=[0.31], ARCH(1)=[0.46], White=[0.97], LM(1)=[0.20], LM(4)=[0.45], LM(8)=[0.49], JB=[0.57]

Equation 3.1.5

$$\Delta xg_{extra,t} = \underset{(-5.65)}{-13.29} - \underset{(-5.54)}{0.56}\left[xg_{extra,t-1} - \underset{(-31.54)}{2.23}\, rowgdp_{OECD,t-1} + \underset{(6.80)}{0.32}\, comp_{PXG/WCPI,t-1} \right] - \underset{(-3.03)}{0.29}\, \Delta comp_{PXG/WCPI,t-3} + \underset{(4.00)}{0.15}(\Delta hwwi_{EE,t-2} - \Delta hwwi_{EE,t-3}) + \hat{u}_t$$

R²=0.60 , AIC=-5.61, Cusum and Cusum² stable, RESET=[0.95], ARCH(1)=[0.49], White=[0.98], LM(1)=[0.13], LM(4)=[0.55], LM(8)=[0.31], JB=[0.98]

Equation 3.1.6

$$\Delta xg_{extra,t} = \underset{(-5.68)}{-12.75} - \underset{(-5.30)}{0.57}\left[xg_{extra,t-1} - \underset{(-34.48)}{2.26}\, rowgdp_{OECD,t-1} + \underset{(6.83)}{0.34}\, comp_{PXG/WPGDP,t-1} \right] - \underset{(-3.05)}{0.30}\, \Delta comp_{PXG/WPGDP,t-3} + \underset{(4.01)}{0.15}(\Delta hwwi_{EE,t-2} - \Delta hwwi_{EE,t-3}) + \hat{u}_t$$

R²=0.61, AIC= -5.62, Cusum and Cusum² stable, RESET=[0.97], ARCH(1)=[0.49], White=[0.99], LM(1)=[0.13], LM(4)=[0.55], LM(8)=[0.30], JB=[0.56]

3.2. Intra-EMU exports

Several attempts to explain exports among EMU member states failed due to autocorrelation problems in the residuals. The only activity variable avoiding this problem and leading to a stable co-integration relation is EMU gross fixed capital formation. While only one significant long-run relation is found with a price index given by export prices relative to EMU CPI (see chapter 5), estimations with global price indices were more successful. The only exception is worldwide CPI, that did not lead to a stable co-integration relation.

The justification for the Stoxx50-index to be accounted for in the short-run dynamics is given by its positive impact on the activity variable in the euro area. Commodity prices excluding energy may influence intra-EMU exports in the short-run via their impact on production costs.

Equation 3.2.1

$$\Delta xg_{intra,t} = \underset{(1.93)}{3.32} - \underset{(-4.85)}{0.66}\left[xg_{intra,t-1} - \underset{(-4.35)}{0.69}\, ifc_{t-1} + \underset{(2.90)}{0.18}\, comp_{PXG/WPGDP,t-1} - \underset{(-11.70)}{0.01}\, trend \right]$$
$$+ \underset{(2.86)}{0.38}\, \Delta xg_{intra,t-1} + \underset{(2.53)}{0.34}\, \Delta xg_{intra,t-2} + \underset{(2.83)}{0.48}\, \Delta ifc_{t-4} + \hat{u}_t$$

R²=0.49 , AIC=-5.71, Cusum and Cusum² stable, RESET=[0.14], ARCH(1)=[0.40], White=[0.18], LM(1)=[0.20], LM(4)=[0.37], LM(8)=[0.40], JB=[0.40]

Equation 3.2.2

$$\Delta xg_{intra,t} = \underset{(1.71)}{3.17} - \underset{(-4.63)}{0.63}\left[xg_{intra,t-1} - \underset{(-3.98)}{0.69}\, ifc_{t-1} + \underset{(2.51)}{0.19}\, comp_{PXG/WPIFC,t-1} - \underset{(-10.31)}{0.01}\, trend \right]$$
$$+ \underset{(2.72)}{0.37}\, \Delta xg_{intra,t-1} + \underset{(2.41)}{0.33}\, \Delta xg_{intra,t-2} + \underset{(2.69)}{0.46}\, \Delta ifc_{t-4} + \hat{u}_t$$

R²=0.47 , AIC=-5.68, Cusum and Cusum² stable, RESET=[0.12], ARCH(1)=[0.38], White=[0.20], LM(1)=[0.20], LM(4)=[0.37], LM(8)=[0.40], JB=[0.37]

Equation 3.2.3

$$\Delta xg_{intra,t} = \underset{(1.63)}{2.93} - \underset{(-4.07)}{0.55}\left[xg_{intra,t-1} - \underset{(-3.42)}{0.66}\, ifc_{t-1} + \underset{(2.07)}{0.17}\, comp_{PXG/WPIFC,t-1} - \underset{(-9.41)}{0.01}\, trend \right]$$
$$+ \underset{(2.75)}{0.37}\, \Delta xg_{intra,t-1} + \underset{(2.34)}{0.33}\, \Delta xg_{intra,t-2} + \underset{(2.27)}{0.39}\, \Delta ifc_{t-4} - \underset{(-2.02)}{0.21}\, \Delta comp_{PXG/WPIFC,t-3)}$$
$$- \underset{(-1.70)}{0.08}\, \Delta hwwi_{EE,t-3} + \hat{u}_t$$

R²=0.54 , AIC=-5.71, Cusum and Cusum² stable, RESET=[0.20], ARCH(1)=[0.70], White=[0.16], LM(1)=[0.48], LM(4)=[0.56], LM(8)=[0.43], JB=[0.29]

Equation 3.2.4

$$\Delta xg_{intra,t} = \underset{(2.30)}{4.24} - \underset{(-4.48)}{0.53}\left[xg_{intra,t-1} - \underset{(-2.84)}{0.55}\, ifc_{t-1} + \underset{(3.30)}{0.29}\, comp_{PXG/WPIFC,t-1} - \underset{(-9.89)}{0.01}\, trend \right]$$
$$+ \underset{(2.02)}{0.26}\,\Delta xg_{intra,t-1} + \underset{(1.81)}{0.22}\,\Delta xg_{intra,t-3} + \underset{(1.89)}{0.30}\,\Delta ifc_{t-4} + \underset{(2.28)}{0.05}\,\Delta stoxx_{t-1} + \underset{(3.95)}{0.09}\,\Delta stoxx_{t-3}$$
$$- \underset{(-1.94)}{0.05}\,\Delta stoxx_{t-4} + \hat{u}_t$$

R^2=0.65 , AIC=-5.94, Cusum and Cusum² stable, RESET=[0.49], ARCH(1)=[0.38], White=[0.64], LM(1)=[0.81], LM(4)=[0.85], LM(8)=[0.95], JB=[0.72]

3.3. Aggregate EMU exports

Total exports of the EMU cannot be explained by world gross fixed capital formation, as the resulting estimations are either unstable with regard to the CUSUM/CUSUM^2-test or inhibit a high degree of autocorrelation. Instead, world GDP (or based on IMF data or based on the index published by the OECD) leads to a stable co-integration relation. The relative price term has been constructed using export prices in relation to world CPI or the world GDP deflator. Elasticity estimates are quite stable for the different explanatory variables, but the estimated income elasticities are implausibly high, once the world GDP based on OECD data is used.

Using IMF-based global GDP as activity variable:

Equations based on this activity variable lead to income elasticities with values around 1.3 (see equations 3.3.1 and 3.3.2). The slightly elevated level (compared with the theoretical expectation of a value of one) may be due to the short time series. Alternative specifications of the price term do not significantly alter the estimated elasticities.

Equation 3.3.1

$$\Delta xg_{aggr,t} = \underset{(3.39)}{1.76} - \underset{(-3.86)}{0.54}\left[xg_{aggr,t-1} - \underset{(-30.32)}{1.30}\, worldgdp_{IMF,t-1} + \underset{(11.23)}{0.47}\, comp_{PXG/WCPI,t-1} \right]$$
$$+ \underset{(4.20)}{3.66}\,\Delta worldgdp_{IMF,t-3} - \underset{(-2.40)}{0.10}\,\Delta commod_{t-4} + \hat{u}_t$$

R^2=0.51 , AIC=-5.85, Cusum and Cusum² stable, RESET=[0.39], ARCH(1)=[0.11], White=[0.35], LM(1)=[0.74], LM(4)=[0.71], LM(8)=[0.74], JB=[0.35]

Equation 3.3.2

$$\Delta xg_{aggr,t} = \underset{(2.39)}{1.76} - \underset{(-2.97)}{0.37}\left[xg_{aggr,t-1} - \underset{(-21.82)}{1.38}\, worldgdp_{IMF,t-1} + \underset{(7.70)}{0.48}\, comp_{PXG/WPGDP,t-1} \right]$$
$$+ \underset{(3.94)}{3.40}\, \Delta worldgdp_{IMF,t-2} - \underset{(-2.83)}{0.25}\, \Delta comp_{PXG/WPGDP,t-3} - \underset{(-2.66)}{0.12}\, \Delta commod_{t-3} + \hat{u}_t$$

R²=0.56, AIC=-5.92, Cusum and Cusum² stable, RESET=[0.55], ARCH(1)=[0.23], White=[0.85], LM(1)=[0.78], LM(4)=[0.93], LM(8)=[0.37], JB=[0.61]

Using OECD-based global GDP as activity variable

Equation results using the world GDP volume index published by the OECD confirm previously presented results using IMF-based world GDP. Again, estimated income elasticities are quite high. Once more, different price specifications only slightly alter the estimation results. They seem to have an influence, though, on modelling short term dynamics. Oil is only significant if it is included together with commodity prices excluding energy.

Equation 3.3.3

$$\Delta xg_{aggr,t} = \underset{(7.71)}{17.96} - \underset{(-7.96)}{1.14}\left[xg_{aggr,t-1} - \underset{(-92.88)}{2.19}\, worldgdp_{OECD,t-1} + \underset{(13.50)}{0.29}\, comp_{PXG/WPGDP,t-1} \right]$$
$$+ \underset{1.91}{0.20}\, \Delta xg_{aggr,\,t-1} + \underset{(2.14)}{1.08}\, \Delta worldgdp_{OECD,t-4} + \underset{(2.34)}{1.10}\, \Delta worldgdp_{OECD,t-7} + \underset{(1.85)}{0.06}\, \Delta commod_{t-2} + \hat{u}_t$$

R²=0.73, AIC=-6.31, Cusum and Cusum² stable, RESET=[0.88], ARCH(1)=[0.56], White=[0.43], LM(1)=[0.52], LM(4)=[0.70], LM(8)=[0.67], JB=[0.65]

Equation 3.3.4

$$\Delta xg_{aggr,t} = \underset{(6.63)}{11.93} - \underset{(-6.70)}{0.77}\left[xg_{aggr,t-1} - \underset{(-58.27)}{2.15}\, worldgdp_{OECD,t-1} + \underset{(9.45)}{0.26}\, comp_{PXG/WPGDP,t-1} \right]$$
$$+ \underset{(2.97)}{0.09}\, \Delta hwwi_{EE,\,t-1} + \hat{u}_t$$

R²=0.64, AIC=-6.14, Cusum and Cusum² stable, RESET=[0.60], ARCH(1)=[0.63], White=[0.70], LM(1)=[0.63], LM(4)=[0.96], LM(8)=[0.50], JB=[0.89]

Equation 3.3.5

$$\Delta xg_{aggr,t} = \underset{(5.92)}{9.82} - \underset{(-5.94)}{0.69}\left[xg_{aggr,t-1} - \underset{(-51.58)}{2.10}\, worldgdp_{OECD,t-1} + \underset{(9.40)}{0.25}\, comp_{PXG/WCPI,t-1} \right]$$
$$+ \underset{(1.94)}{1.03}\, \Delta worldgdp_{OECD,t-2} + \underset{(3.07)}{0.10}\, \Delta hwwi_{EE,t-1} - \underset{(-2.23)}{0.03}\, \Delta oil_{t-1} + \underset{(2.12)}{0.02}\, \Delta oil_{t-2} + \hat{u}_t$$

R²=0.71 , AIC=-6.29, Cusum and Cusum² stable, RESET=[0.28], ARCH(1)=[0.49], White=[0.56], LM(1)=[0.24], LM(4)=[0.22], LM(8)=[0.18], JB=[0.68]

Appendix 4: Alternative import estimation equations

The best performing equation for the three considered endogenous variables (extra-/intra-/aggregate EMU imports) has been presented in the main text. Again, the selection was based on the Akaike information criterion (AIC). Alternative specifications, which differ in the long-run variables as well as in the commodity-prices for the short-run dynamics, are listed below. As has been mentioned in chapter 6, extra- and total EMU imports only form a stable co-integration relation with gross fixed capital formation. Intra-EMU imports can also be explained by EMU GDP, but only at the cost of implausibly high income elasticity estimates.

4.1. Extra-EMU imports

In the case of extra-EMU imports, co-integration between imports, a price ratio, and an activity variable could only be found using gross fixed capital formation, a GDP sub-component, as the activity variable. Aggregate EMU GDP did not yield stable co-integration relationships. In addition, commodity prices have to be accounted for in short-run dynamics. Otherwise, the co-integration relation is unstable. All estimation outputs have implausibly high income elasticities with levels close to two. Price elasticities are also elevated.

Equation 4.1.1

$$\Delta mg_{extra,t} = \underset{(-1.96)}{-1.97} - \underset{(-4.11)}{0.22}\left[mg_{extra,t-1} - \underset{(-7.65)}{1.68}\, ifc_{t-1} + \underset{(3.56)}{1.30}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(2.57)}{0.30}\,\Delta mg_{extra,t-1} + \underset{(2.96)}{0.59}\,\Delta comp_{PMG/CPI,t-2} + \underset{(3.46)}{0.14}\,\Delta com\,mod_{t-1} + \hat{u}_t$$

R^2=0.64 , AIC=-5.74, Cusum and Cusum² stable, RESET=[0.76], ARCH(1)=[0.26], White=[0.63], LM(1)=[0.79], LM(4)=[0.81], LM(8)=[0.92], JB=[0.76]

Equation 4.1.2

$$\Delta mg_{extra,t} = \underset{(-2.55)}{-2.65} - \underset{(-3.93)}{0.21}\left[mg_{extra,t-1} - \underset{(-11.49)}{1.95}\, ifc_{t-1} + \underset{(3.40)}{1.49}\, comp_{PMG/PIFC,t-1} \right]$$
$$+ \underset{(2.81)}{0.32}\,\Delta mg_{extra,t-1} + \underset{(2.40)}{0.49}\,\Delta comp_{PMG/PIFC,t-2} + \underset{(3.17)}{0.13}\,\Delta com\,mod_{t-1} + \hat{u}_t$$

R^2=0.63 , AIC=-5.70, Cusum and Cusum² stable, RESET=[0.90], ARCH(1)=[0.31], White=[0.90], LM(1)=[0.91], LM(4)=[0.80], LM(8)=[0.85], JB=[0.76]

Equation 4.1.3

$$\Delta mg_{extra,t} = \underset{(-2.28)}{-2.28} - \underset{(-3.75)}{0.19}\left[mg_{extra,t-1} - \underset{(-9.88)}{1.89}\, ifc_{t-1} + \underset{(3.35)}{1.63}\, comp_{PMG/PIFC,t-1} \right]$$
$$+ \underset{(2.36)}{0.27}\, \Delta mg_{extra,t-1} + \underset{(1.98)}{0.40}\, \Delta comp_{PMG/PIFC,t-2} + \underset{(3.56)}{0.15}\, \Delta hwwi_{EE,t-1} + \hat{u}_t$$

R^2=0.65 , AIC=-5.76, Cusum and Cusum² stable, RESET=[0.43], ARCH(1)=[0.77], White=[0.71], LM(1)=[0.96], LM(4)=[0.74], LM(8)=[0.87], JB=[0.60]

4.2. Intra-EMU imports

Unlike the results for extra-EMU imports, EMU GDP is part of a long-run co-integration relation with intra-EMU imports and a price term. But similar to other studies and the previously presented estimation results, estimated income elasticities are implausibly high. Gross fixed capital formation yields more reasonable results. Interestingly, commodity or stock market prices – that lead to better performance in equations for extra-EMU imports – do not seem to play a role for the short-run dynamics.

Equation 4.2.1

$$\Delta mg_{intra,t} = \underset{(-3.20)}{-11.85} - \underset{(-3.59)}{0.48}\left[mg_{intra,t-1} - \underset{(-23.29)}{2.57}\, gdp_{t-1} + \underset{(5.05)}{0.89}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(3.18)}{2.27}\, \Delta gdp_{t-1} + \underset{(2.49)}{2.21}\, \Delta gdp_{t-4} + \hat{u}_t$$

R^2=0.38 , AIC=-5.47, Cusum and Cusum² stable, RESET=[0.68], ARCH(1)=[0.31], White=[0.59], LM(1)=[0.53], LM(4)=[0.36], LM(8)=[0.44], JB=[0.53]

Equation 4.2.2

$$\Delta mg_{intra,t} = \underset{(-3.08)}{-11.39} - \underset{(-3.42)}{0.44}\left[mg_{intra,t-1} - \underset{(-24.00)}{2.65}\, gdp_{t-1} + \underset{(4.55)}{0.85}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(3.67)}{2.34}\left(\Delta gdp_{t-1} + \Delta gdp_{t-4} \right) + \hat{u}_t$$

R^2=0.33 , AIC=-5.44, Cusum and Cusum² stable, RESET=[0.43], ARCH(1)=[0.39], White=[0.41], LM(1)=[0.69], LM(4)=[0.75], LM(8)=[0.88], JB=[0.62]

Equation 4.2.3

$$\Delta mg_{intra,t} = \underset{(-2.05)}{-2.62} - \underset{(-4.81)}{0.77}\left[mg_{intra,t-1} - \underset{(-11.21)}{1.22}\, ifc_{t-1} + \underset{(4.05)}{0.41}\, comp_{PMG/PGDP,t-1} - \underset{(-7.92)}{0.01}\, trend \right]$$
$$+ \underset{(3.13)}{0.38}\left(\Delta mg_{intra,t-1} + \Delta mg_{intra,t-2} \right) + \underset{(2.43)}{0.35}\, \Delta mg_{intra,t-3} - \underset{(-1.78)}{0.41}\, \Delta ifc_{t-1} + \underset{(1.93)}{0.36}\, \Delta ifc_{t-4} + \hat{u}_t$$

R^2=0.49 , AIC=-5.53, Cusum and Cusum² stable, RESET=[0.43], ARCH(1)=[0.28], White=[0.90], LM(1)=[0.46], LM(4)=[0.70], LM(8)=[0.43], JB=[0.35]

Equation 4.2.4

$$\Delta mg_{intra,t} = \underset{(-2.05)}{-3.22} - \underset{(-4.81)}{0.76}\left[mg_{intra,t-1} - \underset{(-11.21)}{1.29}\, ifc_{t-1} + \underset{(4.05)}{0.48}\, comp_{PMG/PIFC,t-1} - \underset{(-7.21)}{0.01}\, trend \right]$$
$$+ \underset{(3.13)}{0.37}\left(\Delta mg_{intra,t-1} + \Delta mg_{intra,t-3}\right) + \underset{(2.43)}{0.46}\,\Delta mg_{intra,t-2} - \underset{(-1.78)}{0.56}\,\Delta ifc_{t-1} + \hat{u}_t$$

R^2=0.53 , AIC=-5.45, Cusum and Cusum² stable, RESET=[0.12], ARCH(1)=[0.43], White=[0.56], LM(1)=[0.52], LM(4)=[0.64], LM(8)=[0.28], JB=[0.63]

Equation 4.2.5

$$\Delta mg_{intra,t} = \underset{(-4.20)}{-15.95} - \underset{(-4.42)}{0.59}\left[mg_{intra,t-1} - \underset{(-32.14)}{2.75}\, gdp_{t-1} + \underset{(4.91)}{0.68}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(2.28)}{0.32}\,\Delta mg_{intra,t-3} + \underset{(1.81)}{1.59}\,\Delta gdp_{t-4} + \underset{(3.79)}{0.07}\left(\Delta stoxx_{t-1} + \Delta stoxx_{t-3}\right) + \hat{u}_t$$

R^2=0.45 , AIC=-5.54, Cusum and Cusum² stable, RESET=[0.96], ARCH(1)=[0.41], White=[0.76], LM(1)=[0.12], LM(4)=[0.25], LM(8)=[0.51], JB=[0.59]

Equation 4.2.6

$$\Delta mg_{intra,t} = \underset{(-4.64)}{-19.63} - \underset{(-4.64)}{0.66}\left[mg_{intra,t-1} - \underset{(-34.49)}{2.95}\, gdp_{t-1} + \underset{(3.22)}{0.41}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(1.85)}{0.26}\,\Delta mg_{intra,t-1} + \underset{(2.93)}{0.42}\,\Delta mg_{intra,t-3} + \underset{(2.06)}{1.87}\,\Delta gdp_{t-4} - \underset{(-1.96)}{0.40}\,\Delta comp_{PMG/PGDP,t-3}$$
$$+ \underset{(4.26)}{0.09}\left(\Delta stoxx_{t-1} + \Delta stoxx_{t-3}\right) + \hat{u}_t$$

R^2=0.50 , AIC=-5.55, Cusum and Cusum² stable, RESET=[0.80], ARCH(1)=[0.55], White=[0.18], LM(1)=[0.98], LM(4)=[0.57], LM(8)=[0.87], JB=[0.94]

Equation 4.2.7

$$\Delta mg_{intra,t} = \underset{(-3.36)}{-5.43} - \underset{(-5.00)}{0.93}\left[mg_{intra,t-1} - \underset{(-14.16)}{1.41}\, ifc_{t-1} + \underset{(4.89)}{0.52}\, comp_{PMG/PIFC,t-1} - \underset{(-7.78)}{0.01}\, trend \right]$$
$$+ \underset{(3.37)}{0.48}\left(\Delta mg_{intra,t-1} + \Delta mg_{intra,t-2}\right) + \underset{(5.47)}{0.60}\,\Delta mg_{intra,t-3} - \underset{(-.318)}{1.01}\,\Delta ifc_{t-1} - \underset{(-2.19)}{0.59}\,\Delta ifc_{t-2} - \underset{(1.57)}{0.34}\,\Delta ifc_{t-3}$$
$$+ \underset{(2.58)}{0.06}\left(\Delta stoxx_{t-1} + \Delta stoxx_{t-3}\right) + \hat{u}_t$$

R^2=0.52 , AIC=-5.42, Cusum and Cusum² stable, RESET=[0.27], ARCH(1)=[0.21], White=[0.66], LM(1)=[0.56], LM(4)=[0.63], LM(8)=[0.23], JB=[0.50]

4.3. Aggregate EMU imports

Total EMU imports cannot be explained using EMU GDP. Instead, the GDP subcomponent gross fixed capital formation leads – together with a price ratio – to

stable co-integration relations. Estimated price and income elasticities resemble the high estimates for extra-EMU imports but not the more convincing ones for intra-EMU imports. As with extra-EMU imports, the inclusion of commodity prices in the short-run dynamics improve the fit of the equations.

Equation 4.3.1

$$\Delta mg_{aggr,t} = \underset{(-1.91)}{-1.53} - \underset{(-3.58)}{0.18}\left[mg_{aggr,t-1} - \underset{(-8.53)}{1.68}\, ifc_{t-1} + \underset{(3.99)}{1.34}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(3.36)}{0.40}\, \Delta mg_{aggr,t-1} - \underset{(-2.12)}{0.25}\, \Delta mg_{aggr,t-4} + \underset{(2.85)}{0.47}\, \Delta comp_{PMG/CPI,t-2} + \hat{u}_t$$

R^2=0.56 , AIC=-6.11, Cusum and Cusum² stable, RESET=[0.40], ARCH(1)=[0.57], White=[0.45], LM(1)=[0.43], LM(4)=[0.83], LM(8)=[0.80], JB=[0.90]

Equation 4.3.2

$$\Delta mg_{aggr,t} = \underset{(-2.35)}{-1.91} - \underset{(-4.33)}{0.18}\left[mg_{aggr,t-1} - \underset{(-10.69)}{1.84}\, ifc_{t-1} + \underset{(4.96)}{1.21}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(3.66)}{0.43}\, \Delta mg_{aggr,t-1} - \underset{(-2.91)}{0.22}\, \Delta mg_{aggr,t-4} + \underset{(2.24)}{0.39}\, \Delta comp_{PMG/PGDP,t-2} + \hat{u}_t$$

R^2=0.56 , AIC=-6.09, Cusum and Cusum² stable, RESET=[0.41], ARCH(1)=[0.61], White=[0.45], LM(1)=[0.37], LM(4)=[0.76], LM(8)=[0.75], JB=[0.90]

Equation 4.3.3

$$\Delta mg_{aggr,t} = \underset{(-2.38)}{-2.04} - \underset{(-3.42)}{0.18}\left[mg_{aggr,t-1} - \underset{(-12.14)}{1.93}\, ifc_{t-1} + \underset{(3.76)}{1.52}\, comp_{PMG/PIFC,t-1} \right]$$
$$+ \underset{(3.56)}{0.43}\, \Delta mg_{aggr,t-1} - \underset{(-1.91)}{0.23}\, \Delta mg_{aggr,t-4} + \underset{(2.34)}{0.39}\, \Delta comp_{PMG/PIFC,t-2} + \hat{u}_t$$

R^2=0.55 , AIC=-6.06, Cusum and Cusum² stable, RESET=[0.28], ARCH(1)=[0.70], White=[0.33], LM(1)=[0.19], LM(4)=[0.56], LM(8)=[0.62], JB=[0.94]

Equation 4.3.4

$$\Delta mg_{aggr,t} = \underset{(-1.87)}{-1.51} - \underset{(-3.27)}{0.17}\left[mg_{aggr,t-1} - \underset{(-8.59)}{1.74}\, ifc_{t-1} + \underset{(3.76)}{1.51}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(3.77)}{0.43}\, \Delta mg_{aggr,t-1} - \underset{(-2.41)}{0.29}\, \Delta mg_{aggr,t-4} + \underset{(3.28)}{0.44}\, \Delta comp_{PMG/PGDP,t-2} + \underset{(1.81)}{0.28}\, \Delta comp_{PMG/PGDP,t-3}$$
$$- \underset{(-2.23)}{0.08}\, commod_{EUR,t-3} + \hat{u}_t$$

R^2=0.63 , AIC=-6.16, Cusum and Cusum² stable, RESET=[0.59], ARCH(1)=[0.56], White=[0.14], LM(1)=[0.50], LM(4)=[0.95], LM(8)=[0.61], JB=[0.47]

Equation 4.3.5

$$\Delta mg_{aggr,t} = \underset{(-2.37)}{-2.04} - \underset{(-3.65)}{0.20}\left[mg_{aggr,t-1} - \underset{(-11.90)}{1.82}\, ifc_{t-1} + \underset{(4.53)}{1.63}\, comp_{PMG/PIFC,t-1} \right]$$
$$+ \underset{(1.94)}{0.26}\,\Delta mg_{aggr,t-1} - \underset{(-2.84)}{0.35}\,\Delta mg_{aggr,t-4} + \underset{(2.06)}{0.31}\,\Delta ifc_{t-3} + \underset{(2.75)}{0.40}\,\Delta ifc_{t-4}$$
$$+ \underset{(2.61)}{0.10}\,\Delta hwwi_{EE,t-2} + \underset{(2.15)}{0.08}\,\Delta hwwi_{EE,t-2} + \hat{u}_t$$

R²=0.64 , AIC=-6.16, Cusum and Cusum² stable, RESET=[0.62], ARCH(1)=[0.77], White=[0.52], LM(1)=[0.69], LM(4)=[0.48], LM(8)=[0.31], JB=[0.45]

Equation 4.3.6

$$\Delta mg_{aggr,t} = \underset{(-2.35)}{-1.84} - \underset{(-4.33)}{0.22}\left[mg_{aggr,t-1} - \underset{(-10.69)}{1.69}\, ifc_{t-1} + \underset{(4.96)}{1.33}\, comp_{PMG/CPI,t-1} \right]$$
$$+ \underset{(3.66)}{0.32}\left(\Delta mg_{aggr,t-1} - \Delta mg_{aggr,t-4}\right) + \underset{(2.24)}{0.49}\,\Delta comp_{PMG/CPI,t-2} + \underset{(2.54)}{0.41}\,\Delta comp_{PMG/CPI,t-2}$$
$$- \underset{(-2.17)}{0.04}\,\Delta oil_{t-1} + \hat{u}_t$$

R²=0.62 , AIC=-6.19, Cusum and Cusum² stable, RESET=[0.46], ARCH(1)=[0.83], White=[0.58], LM(1)=[0.25], LM(4)=[0.55], LM(8)=[0.46], JB=[0.80]

Equation 4.3.7

$$\Delta mg_{aggr,t} = \underset{(-2.88)}{-2.45} - \underset{(-4.17)}{0.23}\left[mg_{aggr,t-1} - \underset{(-14.51)}{1.87}\, ifc_{t-1} + \underset{(4.97)}{1.20}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(2.77)}{0.36}\,\Delta mg_{aggr,t-1} - \underset{(-2.56)}{0.27}\,\Delta mg_{aggr,t-4} + \underset{(1.89)}{0.41}\,\Delta comp_{PMG/PGDP,t-1} + \underset{(2.38)}{0.33}\,\Delta comp_{PMG/PGDP,t-2}$$
$$- \underset{(-1.95)}{0.04}\, oil_{t-1} + \hat{u}_t$$

R²=0.61 , AIC=-6.12, Cusum and Cusum² stable, RESET=[0.44], ARCH(1)=[0.98], White=[0.53], LM(1)=[0.16], LM(4)=[0.45], LM(8)=[0.39], JB=[0.83]

Equation 4.3.8

$$\Delta mg_{aggr,t} = \underset{(-2.92)}{-2.25} - \underset{(-3.96)}{0.19}\left[mg_{aggr,t-1} - \underset{(-14.08)}{1.98}\, ifc_{t-1} + \underset{(4.17)}{1.10}\, comp_{PMG/PGDP,t-1} \right]$$
$$+ \underset{(2.12)}{0.26}\,\Delta mg_{aggr,t-1} - \underset{(-2.91)}{0.34}\,\Delta mg_{aggr,t-4} + \underset{(2.94)}{0.32}\,\Delta comp_{PMG/PGDP,t-2} + \underset{(2.84)}{0.04}\left(\Delta stoxx_{t-1} + \Delta stoxx_{t-3}\right) + \hat{u}_t$$

R²=0.64 , AIC=-6.25, Cusum and Cusum² stable, RESET=[0.59], ARCH(1)=[0.56], White=[0.14], LM(1)=[0.50], LM(4)=[0.95], LM(8)=[0.61], JB=[0.78]

Equation 4.3.9

$$\Delta mg_{aggr,t} = \underset{(-3.60)}{-3.18} - \underset{(-4.75)}{0.27}\left[mg_{aggr,t-1} - \underset{(-20.25)}{1.95}\, ifc_{t-1} + \underset{(6.23)}{1.48}\, comp_{PMG/PIFC,t-1} \right]$$
$$+ \underset{(2.34)}{0.29}\,\Delta mg_{aggr,t-1} - \underset{(-2.89)}{0.33}.\Delta mg_{aggr,t-4} + \underset{(1.75)}{0.23}\,\Delta ifc_{t-4} + \underset{(2.25)}{0.55}\,\Delta comp_{PMG/PIFC,t-1}$$
$$+ \underset{(2.48)}{0.07}\left(\Delta hwwi_{EE,t-2} + \Delta hwwi_{EE,t-4}\right) - \underset{(-2.31)}{0.04}\,\Delta oil_{t-1} + \hat{u}_t$$

R^2=0.66 , AIC=-6.20, Cusum and Cusum² stable, RESET=[0.36], ARCH(1)=[0.58], White=[0.61], LM(1)=[0.46], LM(4)=[0.70], LM(8)=[0.45], JB=[0.27]

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