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In 2007 all ECB publications feature a motif taken from the €20 banknote.

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CONTENTS

Abstract

The paper proposes a modelling approach for euro area goods and services trade volumes and prices on the basis of a break-down of trade data into their intra- and extra-area components. Using the evidence from the newly estimated trade equations, the paper gives new insights into two important issues. The first issue concerns the exchange-rate pass-through (ERPT) to euro area import prices. The second issue relates to substitution effects between intra- and extra-area trade. These issues are further elaborated through simulation analyses using the ECB's area-wide model (AWM). The simulations illustrate the impact of external and domestic shocks to trade in the euro area, in particular on intra- and extra-area trade. The richer dynamics from this disaggregated perspective provide additional insights and elucidate transmission channels of shocks that are not detectable from an aggregate (i.e. total trade) perspective. For instance, one interesting finding is that an appreciation of the euro has a significant downward impact on intra euro area trade.

JEL classification: E31, F17, C5

Keywords: Intra-/ extra-area trade, euro area, competitiveness and trade substitution, exchange-rate pass-through, pricing-to-market.

Non-technical summary

This paper presents a constructed breakdown of trade variables, and proposes an approach to modelling them. The estimation of these trade equations then sheds some light on important aspects of trade in the euro area, particularly the exchange rate pass-through (ERPT) and substitution effects between intra- and extra-area trade. Using the new estimated trade equations in the trade block of the ECB's area wide model (AWM), simulation analysis provides further insight, where second round effects are then accounted for.

Previous analysis on trade developments in the euro area has mostly focused on total trade, without a distinction between intra- and extra-area trade. Indeed, until recently it was not possible to study the differential impact of intra- and extra-area trade in goods and services due to lack of data availability. This reflects the fact that euro area national accounts are thus far still compiled by summing the accounts in the individual countries. Having a breakdown of trade into intra- and extra-area trade provides an opportunity to have a greater understanding of developments in the euro area. In particular, it enables better understanding of the mechanisms through which developments outside of the euro area affect developments within the euro area, and enables some identification of possible long-term trends. Finally, the breakdown enables us to use trade variables which correspond more closely to the theoretical concepts and facilitate links with balance of payments forecasts, for which a more detailed breakdown is available.

Amongst the available options of either modelling *"top-down"*, i.e. starting from the aggregate figures and disaggregate afterwards, or to model *"bottom-up"*, i.e. starting with the disaggregated figures, the paper proposes a mixed approach. This choice of approach is mainly determined by the possibilities of disaggregating the explanatory variables of the equations.

Regarding the trade volume equations, the paper proposes behavioural equations for extra-area exports, total imports and the share between intra- and extra-area imports. The latter was considered to be the best possible way to utilise all available information. It may also shed light on possible effects from monetary union on this share, reflecting trade creation effects within the euro area and trade diversion effects from extra- to intra-area trade. On the basis of the estimation results and stability tests of the estimated equation, it was not directly possible to identify such effects. However, to the extent that the introduction of the euro had an impact on intra- versus extra-area trade competitiveness, the impact may be captured through the competitiveness term in the equation.

Regarding the trade deflators, behavioural equations are proposed for the extra-area export and import deflators and the intra-trade deflator. The latter was specified on the basis of the data for the intra-area import due to a slightly better fit compared to the intra-area import deflator. A particularly interesting feature arises through the estimation of the extra-area import deflator. Before the intra- / extra-area disaggregation of trade data it was not possible to derive estimates for the pricing-to-market effect in the euro area which are consistent with national account data. The estimate in this paper suggests a pricing-to-market effect of 0.26.

The disaggregation of the data into their intra- and extra-area components required a series of assumptions, which may have negative implications for the quality of the data. The modelling approach,

particularly the choice of *"top-down"* versus *"bottom-up"*, was in any event mainly based on theoretical considerations which are independent from the data. However, the estimation results turned out to be well-behaved in terms of signs and magnitudes of elasticities, so that any future improvements in data would probably not require a change in the modelling approach.

Using the adopted framework, within the AWM, various simulations were performed. These show the different responses of intra- and extra-area trade to different shocks to the economy. The simulations illustrated the various transmission channels, particularly in the case of an exchange rate shock to the euro area economy. These transmission channels can be quite different in magnitude and sign for the intra- and extra-area components. Through the disaggregated intra- / extra-area analysis it is thus possible to take explicit account of these channels, which leads ultimately to a richer understanding of the dynamics at work. This allows in particular to analyse the substitution between intra- and extra-area trade.

1 Introduction

Previous analysis on trade developments in the euro area has mostly focused on total trade, without a distinction between intra- and extra-area trade. Indeed, until recently it was not possible to study the differential impact of intra- and extra-area trade in goods and services due to lack of data availability. This reflects the fact that euro area national accounts are thus far still compiled by summing the accounts in the individual countries. Having a breakdown of trade into intra- and extra-area trade provides an opportunity to have a greater understanding of developments in the euro area. In particular, it enables better understanding of the mechanisms through which developments outside of the euro area affect developments within the euro area, and enables some identification of possible long-term trends. Finally, the breakdown enables us to use trade variables which correspond more closely to the theoretical concepts and facilitate links with balance of payments forecasts, for which a more detailed breakdown is available.

The aim of this paper is to present a constructed breakdown of trade variables, and to propose an approach to modelling them. The estimation of these trade equations then sheds some light on important aspects of trade in the euro area, particularly the exchange rate pass-through (ERPT) and substitution effects between intra- and extra-area trade. Using the new estimated trade equations in the trade block of the ECB's area wide model (AWM), simulation analysis provides further insight, where second round effects are then accounted for.

This paper starts in Section 2 below with a discussion of the background for this paper, specifically regarding the two issues that will be investigated with the new trade equations, namely on the one hand the substitution effects between intra- and extra-area trade, and on the other hand the ERPT. Section 3 provides an overview of the newly constructed data, as well as some further trade indicator variables needed for the estimation of the trade equations. Section 4 introduces a framework for an intra-/ extra-area trade model. Section 5 deals with the empirical estimation of the trade equations. Section 6 contains diagnostic simulation analyses that show how trade responds to external and domestic shocks to the euro area. Section 7 summarises and concludes. The appendices contain additional information on the data construction, and on the estimation and simulation results.

2 Background

Over the last 20 years there has been a process of integration of the EU that one would expect would have led to a trade diversion effect towards intra-area trade. A major step was the implementation of the Single Market Programme. This aimed at removing barriers to the free circulation of goods and services within the EU. Measures taken were mostly focused on the goods side, and include reducing tariff and non-tariff barriers as well as other impediments to trade such as differences in technical standards. These measures were expected to promote intra-EU trade as they decrease the costs of intra-European exports. In the 1990s the European exchange rate mechanism was implemented. This resulted in a considerable reduction in exchange rate volatility among European countries, which in turn was expected to promote intra-EU trade. This was then followed by the formation of monetary union and the launch of the euro in 1999.

At the same time, however, strong growth in the rest of the world and globalisation effects have led to a strong increase in export supply and import demand from outside the euro area. A further aspect of this globalisation works through the lower price levels prevailing in some emerging economies, which means that the import prices for imports from those countries would be lower.

To date, the evidence on intra-EU trade is limited, mainly because of data issues. However, a study by DeGrauwe and Verfaille (1998) found that the reduction in exchange-rate volatility due to the EMU had a positive effect on intra-EU trade, once factors such as the general economic slowdown were taken into account. Anderton *et al.* (2005) studied the key determinants of intra- and extra-euro area imports but only for manufactures, and so were missing trade in services which have played an increasingly important role. In this paper, using a new data set, we are going to focus on two (related) aspects of intra trade, firstly the substitution effects between intra and extra-area trade and secondly the impact of exchange rates.

2.1 Substitution between intra- and extra-area trade

Substitution effects between intra- and extra-area trade will be estimated with the trade model proposed in this paper. We investigate such effects via price differentials between intra and extra. These price differential effects could come via various factors such as increased competitiveness and efficiency, or reduced trade barriers etc. The non-price effects of the formation of a monetary union are regarded as an "off-model" effect. However, modelling intra-and extra-area trade sheds some new light onto this discussion by checking for structural breaks that may have occurred in the context of monetary union. It is therefore useful to review some of the existing literature related to trade effects of the euro.

The trade effect of currency union is often referred to as "Rose effect" (Rose, 2000 and 2004). Baldwin (2006) reviews the literature on trade effects of currency unions, and finds evidence that the euro probably increased intra-euro area trade by five to ten percent. Most of these findings are based on gravity models, where membership in a currency is tested for its impact on trade. The main mechanism for the impact from currency unions on trade is the elimination of exchange rate uncertainty and volatility. Baldwin *et al.* (2005) propose a theoretical model which shows that in a monopolistic competition set-up, the effect of exchange rate uncertainty on trade has non-linear features, suggesting that EMU and a standard measure for exchange rate uncertainty should be jointly significant. Faruqee (2004) finds also evidence that EMU has had a positive impact on intra-area trade. Anderton *et al.* (2005) in their study of imports find significant substitution effects between intra- and extra-euro area imports due to changes in their relative prices but only find limited evidence for any impact of EMU.

2.2 Exchange-rate pass-through (ERPT) and pricing-to-market effects (PTM)

A further aspect than can be investigated with the new break-down of trade into intra- and extra-area trade is that of the ERPT to import prices in the euro area. There is a large empirical literature addressing the impact of the ERPT, of which Menon (1995) provides a survey summarising 43 papers.

The Exchange rate pass-through is often also referred to as the PTM, because it is basically simply the other side of the same coin. This can be illustrated in the equation below, which shows the import deflator (MTD) as a function of foreign competitors' export prices (CMD)[2] and domestic prices (YFD):

$MTD = \beta_0 + \beta_1\ CMD + \beta_2\ YFD,$

Competitors' export prices are the weighted average of foreign export prices converted into the domestic currency, i.e. exchange-rate movements in the effective exchange rate are reflected one-to-one in CMD. This is apparent when splitting competitors' export prices CMD into competitors' export prices in US Dollar[3] (CMUD) and the exchange rate EXR, i.e.

$CMD = CMUD * EXR$

Homogeneity is required for steady-state compatibility, i.e. $\beta_1 + \beta_2 = 1$. β_1 is a measure of the ERPT. In the case of a complete ERPT to import prices, $\beta_1 = 1$ and domestic prices do not play a role. β_2 can be interpreted as the PTM, and it can thus be seen that the ERPT and PTM effects can be used as antonyms i.e. $\beta_1 = (1 - \beta_2)$.

Compared to the previous set-up, where variables included total trade, the interpretation of the above equation is different in case of the new set-up with intra- and extra-area variables being separated. The variable CMD contains in the total trade definition also the intra-area component (i.e. competitors' prices inside the euro-area), which is by definition not subject to changes in the exchange-rate, which means that β_1 is not the accurate measure for the exchange-rate pass-through. Warmedinger (2004) proposed a correction factor for the calculation of PTM on the basis of national accounts data for the largest five euro-area countries as well as for the euro area as a whole. The PTM is estimated to be just over one half. These estimates are slightly higher compared with those proposed in Anderton (2003). The trade data used in Anderton (2003) are unit value indices for manufacturing as a proxy for import prices. Campa *et al.* (2005) investigate the ERPT across euro-area countries and across product categories. They find evidence for a high ERPT in the short run, and even higher or close to one in the long run. An interesting finding in this study is that it finds no strong statistical evidence for a structural change in the ERPT through the introduction of the euro. Osbat *et al.* (2006) study the ERPT to euro area manufacturing import prices at the sectorally disaggregated level as well as for the manufacturing aggregate, using also import unit value indices to approximate the import deflator. Their finding on the ERPT is about 0.85 in the long-run, but not significantly different from 1 and very heterogeneous across sectors.

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2 For simplicity we ignore for the moment the role of energy prices because they play no specific role for this particular discussion. In this simple model they can be assumed to be part of CMD.

3 The US Dollar is in the trade block of the AWM used as numéraire currency.

Overall, the range of estimates for the ERPT varies significantly between about one half and close to one. It should be noted though that none of the available studies is fully consistent with national account data with a breakdown into intra- and extra-area trade. In comparison, estimates for the US (for instance Marazzi *et al.* (2005)) suggest a pass through in the US which is lower than one.

3 Data

3.1 Intra-/extra-area trade breakdown

Previously, time-series data for euro-area trade variables on a national accounts basis were available only with intra- and extra-area aggregated (i.e. total trade). This is because national account data were simply the aggregate of each countries trade, without netting out intra-trade. As services trade has become of greater importance, any analysis of impact of exchange rates or other external shocks needs to take account of not just the impact on trade in goods, but also on the impact on services. By using three different sources of data, namely, Eurostat national accounts, Eurostat external trade in goods and balance of payments data we constructed a breakdown of trade into two components: First the extra-area series, and second intra-area trade consistent with a national accounts definition both for real and nominal variables. More details are given in the Appendix. Figure 1 below shows the extra-area export and import variables as a share of total trade. In both cases the extra-area share increased from slightly below 40% in 1980 to slightly below 50% in 2004. Therefore, extra-euro area trade grew at a faster rate than intra-area trade.

This is at first sight not intuitive, because over this period there has been a process of integration of the EU that one would expect would have led to a trade diversion effect towards intra-area trade. However, the data shows that world trade is growing more rapidly than intra-trade, at least until 1998 where growth in intra-euro area trade seemed to catch up with extra-euro area trade, suggesting a possible effect from the introduction of the euro, but it could also be at least partly due to substitution effects arising from the decrease in the price of the intra-trade relative to extra-euro area imports, in response to the depreciation of the euro. When estimating the trade linkages it will be interesting to find out to what extent this decline in the intra-area import share can be attributed to changes in relative competitiveness.

The upper panel in Figure 2 below shows the ratio between the intra- and extra-area import deflators. It can be seen that this ratio is indeed moving in an opposite direction to the intra-/extra-area import ratio. However, the rise in the deflator ratio is only a feature of the earlier part of the sample, whereas the ratio between intra- and extra-area imports continues to decline throughout the sample, albeit also at a higher rate in the earlier part of the sample. The lower panel of figure 2 shows the ratio between the intra- and extra-area export deflators. The flat path in the first part of the sample is by construction due to the unavailability of sufficiently back-dated intra-extra data.

Figure 1: Graphs of extra-area trade volume shares

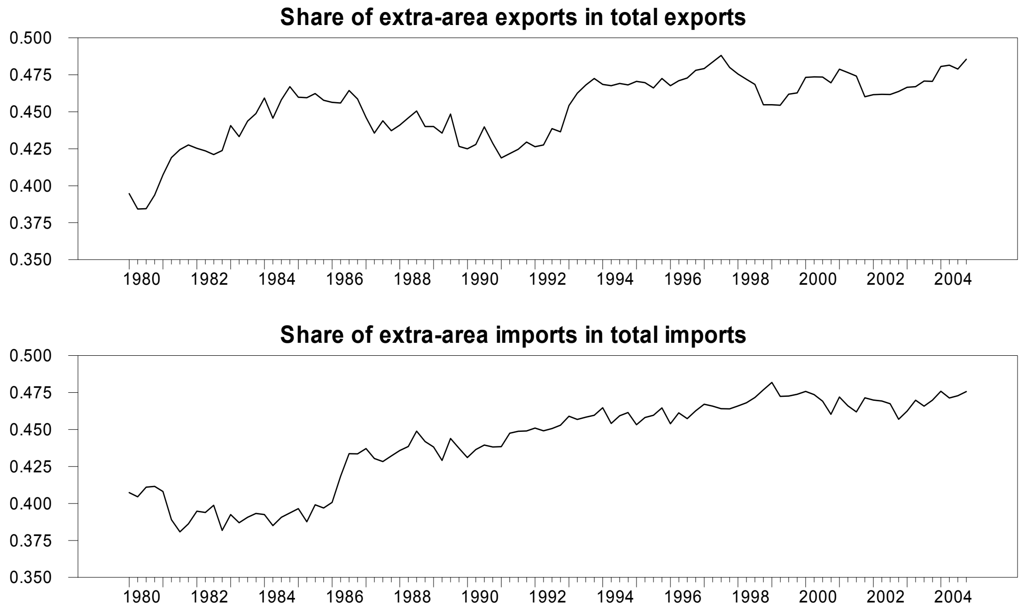
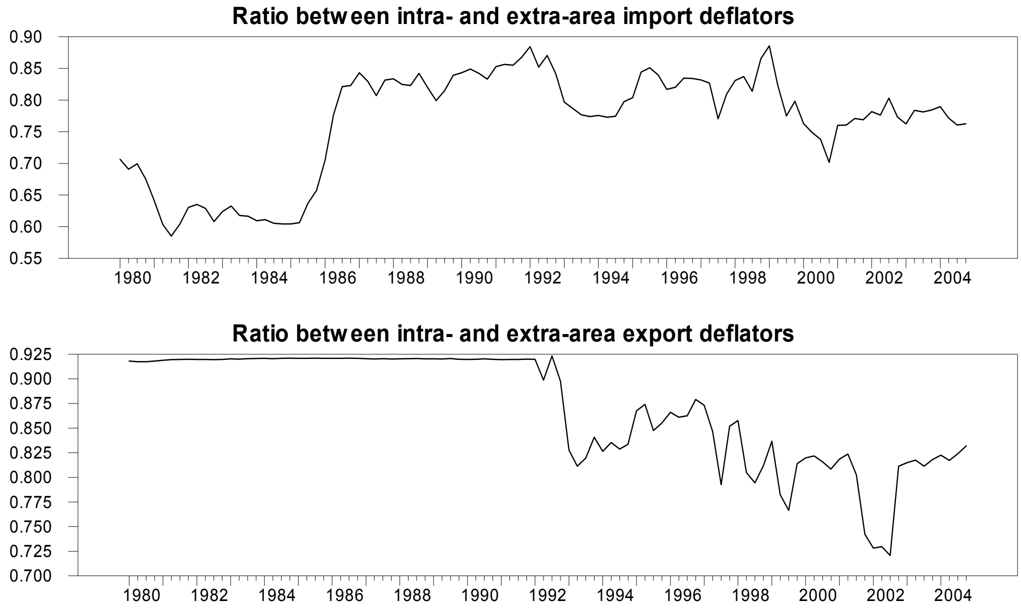
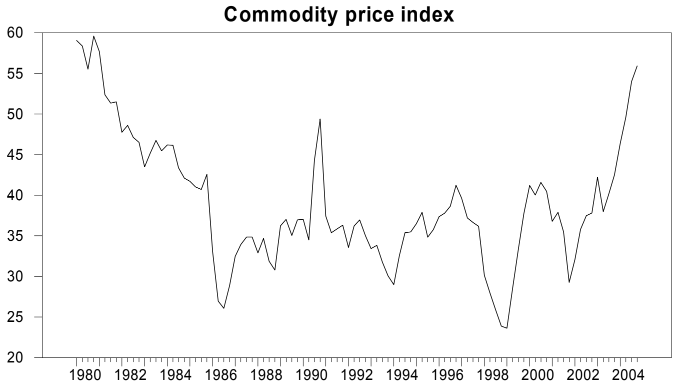


Figure 2: Intra- and extra- area trade deflators



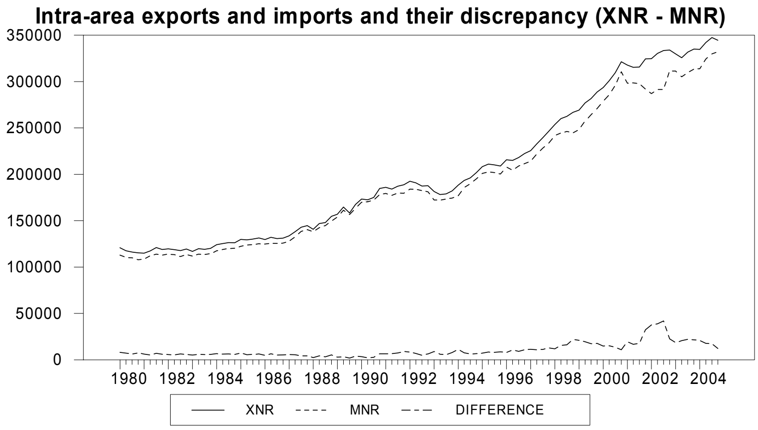
The increase in the ratio between intra- and extra-are import deflators, as shown in the upper panel of Figure 2, is due to a sharp drop in commodity prices at that time, as shown in Figure 3 below. As explained in Section 5, the impact of oil and commodity prices on intra- versus extra-area import price competitiveness will be taken specifically into account by constructing a trade deflator index excluding the price of commodities.

Figure 3: Commodity price index



It is important to note that for the historical data intra imports do not match intra exports, as might be expected a priory from a purely accounting perspective. There could be various reasons for this discrepancy, including different trade systems, different coverage, different classifications, different valuations, different treatment of cost of freight and insurance etc. The difference between the computed intra exports and intra imports is shown in Figure 4 below.

Figure 4: Intra-area trade discrepancy[4]



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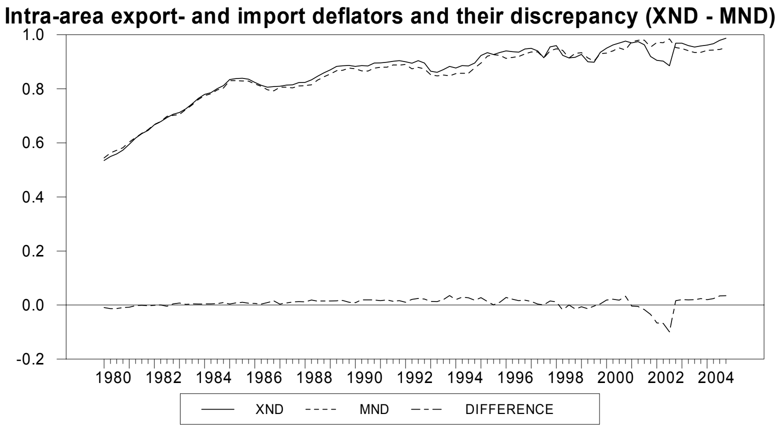
[4] XNR are intra-area real exports and MNR are intra-area real imports.

Figure 5: Intra-area trade deflator discrepancy[5]



Finally, a note of caution needs to be spelled out regarding the data. As outlined in the Appendix, the construction of intra- and extra-area data requires a series of assumptions which are in some cases rather limiting. However, on the euro-area level, as well as on the level of most euro-area countries, there is as yet no better data available on the intra- and extra-area breakdown of trade data. It will be shown below, however, that the constructed intra- and extra-area data fits the models reasonably well, which can serve as an indication that the constructed data are good approximations.

3.2 World demand indicator and competitors' prices[6]

In addition to the intra-/ extra-area trade split, we have constructed both a demand indicator and the competitiveness term. The world demand indicator (WDR) is constructed as the weighted average of the imports from the trading partners outside the euro area, and serves therefore as the world demand indicator for extra-area exports. The weights correspond to the export shares of the euro area to the respective trading partner countries[7]. Constructing a world demand indicator that corresponds to total exports requires to take into account the import demand from within the euro area. Such an intra-area import demand indicator could in principle be constructed analogously to the extra-area import demand indicator. However, there is no need to construct an indicator for a variable which is already known, that is intra-area exports are by definition equal to intra-area imports. Intra-area import demand is thus also by definition equal to intra-area imports. The composite (total) world demand indicator (WDRM) is an index variable and cannot be just defined by the sum of the two components, but would rather need to be constructed as follows:

$$LOG(WDRM) = \omega * LOG(WDR) + (1 - \omega) * LOG(MNR)$$

---

5 XND is the intra-area export deflator and MND the intra-area import deflator.

6 This part follows the approach suggested in Karlsson (2007).

7 The trade shares are taken from the IMF's Direction of Trade Statistics (Yearbook 1998), referring to the years 1995-97.

Where ω corresponds to the extra-area share of euro area exports.

There are two different series for competitors' prices: Both are calculated as the weighted average of euro area trading partners' export prices. The weights used for constructing the competitors' prices on the import side (CMD) correspond to the trading partners' shares in euro area imports, whereas the weights for the competitors' prices on the export side (CXD) correspond to the trading partners' shares in euro area exports[8]. Both variables follow by construction an extra-area definition. CMD can be used as a determinant for the extra-area import deflator, and CXD for the extra-area export deflator. Constructing the composite (total) competitors' price series can be done analogously to the world demand indicator described above:

$$LOG(CMDW) = \omega *LOG(CMD) + (1 - \omega) *LOG(XND)$$

$$LOG(CXDW) = \omega *LOG(CXD) + (1 - \omega) *LOG(XND)$$

Where XND is the intra-area export deflator.

4 Intra-/ extra-area trade modelling framework

Our approach to modelling intra-/extra-area trade is based on the analytical framework of Knetter (1995) where firms aim to maximise profits, which are given by[9]:

$$\sum p_i q_i - C[\sum q_i, pd_1, pm_1]$$

where p_i is the price (in local currency), q_i is the quantity sold in market i, and C[] is total cost as a function of total output sum q_i, the price of euro area inputs pd_i, and the price of imported inputs in terms of the firms local currency.

We assume that demand is a function of the price of the good relative to the average price of competing goods in the buyer's market, where the import prices are composed by the import prices in the exporter's currency, multiplied with the exchange rate, where the exchange rate is defined as units of importer's currency per unit of exporters currency. Maximising profits subject to demand conditions implies the price depends on both domestic costs and competitors costs.

In addition to the standard accounting identities, we also utilise the theory that intra imports are equal to intra exports, both for volumes and deflators. As noted in the in Section 3, this identity does not hold exactly for historical data, but there are no theoretical determinants of this gap other than a possible level

8 A double-weighting approach is used for competitors' export prices, reflecting the weights in euro area exports and the weights of other competitors in trading partners' countries.

9 This follows the model derived by Knetter (1995) and Marazzi *et al*. (2005)..

difference. Against this background, there are six behavioural equations needed for both (3 on the real side and 3 on the nominal side), the other variables are then derived using identities[10].

Given this analytical framework there are two basic approaches to modelling the trade variables and their intra- and extra-area components:

- A '*top-down*' aggregate approach, modelling total trade and then separating it into intra and extra.
- A '*bottom-up*' disaggregate approach, modelling intra and extra trade separately and aggregating to get total trade.

The theoretical literature addressing aggregate versus disaggregate modelling started with the seminal work of Theil (1954) where he undertook a formal analysis of the choice between aggregate and disaggregate modeling. Pesaran *et al.*, 1989, amongst others showed that Theil's conclusions were based on strong assumptions and have suggested that there is not a unique theoretical solution, and that it should be investigated empirically on a case-by-case basis, depending on the goals and objects of the study. More recently, Hendry and Hubrich (2006) find that the predictive value of disaggregate information can be off-set by model selection uncertainty, estimation uncertainty, changing collinearity, structural breaks over the forecast horizon and measurement errors. They show that including disaggregated variables in the aggregate model should increase forecast accuracy, but that model selection plays an important role in determining whether disaggregate information helps in forecasting.

There are a number of empirical studies that investigate aggregation issues in the euro area and the conclusions are mostly mixed. The forecasting accuracy of aggregating country-specific forecasts in comparison with forecasts based on aggregated euro area wide data has been analysed on the basis of a broad range of models in Marcellino, Stock & Watson (2003). They find that forecasts constructed by aggregating the country-specific models are more accurate than forecasts constructed using the aggregate data. Similarly Monteforte (2007) suggests that disaggregation dominates the aggregate in both fit and prediction abilities. On the otherhand, Hubrich (2004) finds that for modelling euro area HICP, aggregate forecasts by components do not necessarily help forecast inflation. Fabiani and Morgan (2003) in estimating Phillips curves conclude that if major advantages in undertaking national analysis exist, they are likely to be due to country-specific structures rather than from aggregation biases.

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[10] The system we are tying to model comprises of 18 variables: exports and imports, both for total, extra and intra trade and for real, nominal and prices. Most of these variables must be made consistent through accounting identities, e.g. total exports must equal intra exports plus extra exports, or the deflators must be consistent with the real and nominal variables.

It appears that the choice between an aggregate and a disaggregate strategy is a general issue where in practice, the choice is mostly driven by practical issues, in particular the availability and quality of the data as well as the specification and fit of the resulting model. Indeed, we will argue below that the two basic options ‘top-down’ and ‘bottom-up’ are not universally suitable for all four types of equations (imports and exports, volumes and deflators). The mixed approach can be adjusted to allow the best possible modelling and understanding of the key determinants of each equation.

Finally, because the construction of intra- and extra-area data required a series of assumptions it may not be regarded as fully accurate. Against this background, the modelling approach outlined below is, at least for a start, independent from actual data. It is instead based on theoretical considerations on how intra- / extra-area trade variables should be modelled. In a few cases, however, there are from a theoretical perspective several alternative approaches possible. The choice of the modelling approach is in those cases dependent on the fit to the data, and may be subject to revision when better data will be available.

4.1 Trade volumes

On the real side, both exports and imports have two basic determinants, which are an activity and a competitiveness term. In the case of exports, the activity variable is world demand, which is determined by foreign import demand (see Section 3.2 above). The competitiveness term for exports is given by the ratio between the export deflator and competitors’ export prices. In the case of imports, activity is presented by an import demand indicator, which is calculated from the weighted average of domestic demand components and exports. The competitiveness term for imports is given by the ratio between the import deflator and domestic prices.

4.1.1 Exports

Total exports are a function of total world demand (WDRM) and competitiveness, as defined by the ratio between the total export deflator (XTD) and total competitors’ export prices (CXDM).

$$XTR = f\left\{WDRM, {}^{XTD}\!/_{CXDM}\right\} \tag{1}$$

All variables in the above equation can be split into their intra- and extra-area components:

$$XTR = f\left\{\underset{\text{extra}}{XXR}, \underset{\text{intra}}{XNR}\right\},\ WDRM = f\left\{\underset{\text{extra}}{WDR}, \underset{\text{intra}}{MNR}\right\},\ XTD = f\left\{\underset{\text{extra}}{XXD}, \underset{\text{intra}}{XND}\right\},\ CXDM = f\left\{\underset{\text{extra}}{CXD}, \underset{\text{intra}}{MND}\right\}$$

It is thus possible to model extra-area exports as a function of extra-area determinants:

$$XXR = f\left\{WDR, {}^{XXD}\!/_{CXD}\right\} \tag{2}$$

Regarding intra-area exports, given that

$$MNR = XNR,\ MND = XND$$

The equation for intra-area exports would be

$$XNR = f\left\{XNR, {}^{XND}\!/_{XND}\right\} \tag{3}$$

Intra-area exports are thus only a function of itself, which means that they cannot be modelled. Against that background, the equation for total trade can be represented as

$$\underset{\text{extra}+\text{intra}}{[XXR+XNR]} = f\left\{\underset{\text{extra}-\text{area variables}}{\left[WDR, XXD/CXD\right]}, \underset{\text{intra}-\text{area variables}}{\left[XNR, XND/XND\right]}\right\}.$$

However, as shown above, the intra-area activity and competitiveness variables contain no information for intra-area exports, which means that the total export equation contains no additional information compared to the extra-area exports equation. This leaves on the export side only one possibility, which is equation (2) for extra-area exports.

4.1.2 Imports

Since it is only possible to model one equation on the export side, there are two further equations needed on the import side. Total imports are a function of activity and competitiveness. Activity is represented by an import demand indicator (WER). This import demand indicator is created using the relative import intensity of the various components of final demand calculated as:

$$\text{WER} = \beta_1 * \text{PCR} + \beta_2 * \text{GCR} + \beta_3 * \text{ITR} + \beta_4 * \text{SCR} + \beta_5 * \text{XTR}$$

where PCR is real consumption, GCR is Government consumption, ITR is investment, SCR is stocks, and XTR is total exports. The weights β_I are obtained from input-output tables and indicate the sum of the direct and indirect import content of the final demand components. The import contents are $\beta_1 = 0.239$, $\beta_2 = 0.083$, $\beta_3 = 0.321$, $\beta_4 = 0.557$ and $\beta_5 = 0.452$. The relatively high import content in stocks is due to the fact that there are often discrepancies in time between the moment that imports are recorded and when they are shipped to consumers or to other countries. The relatively high import content in exports is an important feature, as it implies a relatively strong effect from exports to imports. This reflects to some extent the fact that euro area firms locate parts of their production in other countries.

The basic equation for total imports as a function of the activity variable (WER) and relative import competitiveness (MTD/YFD) is given as

$$MTR = f\left\{WER, MTD/YFD\right\} \tag{4}$$

Analogously to the analysis of exports, it is first important to see which variables of equation (4) can be separated into their intra- and extra- area components. Contrary to the export equation (1), the intra-/ extra-breakdown is only possible for import volumes and the import deflator

$$MTR = f\left\{\underset{\text{extra}}{MXR}, \underset{\text{intra}}{MNR}\right\}, \quad MTD = f\left\{\underset{\text{extra}}{MXD}, \underset{\text{intra}}{MND}\right\},$$

The activity variable WER and domestic prices YFD can not be split into intra- and extra- components. This has implications for the modelling on the import side, as the choice between 'top-down' and 'bottom-up' is not straightforward. The choice between the two possible approaches is made on the basis of how all the available information can be utilised best. An important piece of information is thereby the relative competitiveness of intra- versus extra-area imports. Accordingly, a 'bottom-up' set-up would include two competitiveness terms as shown in the two equations for intra- and extra-area imports below:

$$MXR = f\left\{WER, \mathbf{MXD}/_{YFD}, MXD/_{MND}\right\} \tag{5}$$

$$MNR = f\left\{WER, \mathbf{MND}/_{YFD}, MND/_{MXD}\right\} \tag{6}$$

Equations (5) and (6) are identical except for the import deflators, which are intra-/extra-area specific. A further difference arises in case of different elasticities with respect to domestic activity (WER). The main drawback of this specification is that the substitution effect between intra- and extra-area imports is not sufficiently well modelled. For instance the elasticity with respect to intra-/extra-area competitiveness should be the same in both equations, unless there are factors other than relative price competitiveness that determine the substation between the two sub-components. In particular, the respective other import component is not taken into account in the 'bottom-up' framework. This indicates that the intra-/extra-area import shares should be modelled jointly. In the following, we show a 'top-down' approach that utilises all available information and provides a more precise treatment of the intra-/extra-area import substitution.

The total import equation (4) establishes the first part of the 'top-down' approach. The conventional second part would be to set up a behavioural equation for one of the two sub-components and to derive the other component as a residual. However, in order to address the requirement of a more specific treatment of the substitution between the two components, we propose to model the share between intra- and extra-area imports explicitly as follows:

$$MNR/_{MXR} = f\left\{MND/_{MXD}, WER\right\} \tag{7}$$

This specification entails the relative price competitiveness term (MND/MXD), which allows for a unique estimation of the price elasticity of substitution. Moreover, in order to allow for different elasticities of the two sub-components with respect to domestic activity (WER) this variable is also included in this share equation.

4.2 Trade deflators

4.2.1 Export deflator

The total export deflator (XTD) is modelled as a function of domestic prices (YFD), which reflect domestic cost pressures, and total competitors' export prices (CXDM) which capture the competitiveness effect. The competitors' export prices are calculated as the weighted average of competitors' export prices. They contain the extra-area component (CXD) and the intra-area component, which is simply the intra-area export deflator (XND). The equation for the total export deflator thus given as

$$XTD = f\left\{YFD, CXDM\right\} \tag{8}$$

The extra-area export deflator (XND) is given as

$$XXD = f\left\{YFD, CXD\right\} \tag{9}$$

Given that intra-area competitors' export prices are simply the intra-area export prices (XND), the equation for the intra-area export deflator does not make sense:

$$XND = f\{YFD, XND\} \tag{10}$$

This implies also for the total export deflator equation (8) that the intra-component is not explained, which suggests that the bottom-up approach should be used. However, because equation (10) does not make sense, only equation (9) can be retained from the export deflator side.

4.2.2 Import deflator

The import deflator is primarily a function of total competitors' prices on the import side CMDM[11], commodity prices PCOM, and domestic prices YFD. The inclusion of the latter captures the so called *pricing-to-market effect*, that is the extent to which foreign exporters have to adjust their prices to those prevailing in the importing country. The equation for total import prices is thus given as

$$MTD = f\{YFD, CMDM, PCOM\} \tag{11}$$

The extra-area import deflator (MND) is given as

$$MXD = f\{YFD, CMD, PCOM\} \tag{12}$$

Given that intra-area competitors' export prices are simply the intra-area export prices (XND), and that intra-area import prices are equal to export prices, the equation for the intra-area import deflator does not make sense:

$$MND = f\{YFD, MND, PCOM\} \tag{13}$$

Analogously to the export deflators, for the import deflators it is also only the extra-area deflator MXD) which can be modelled in the standard set-up.

4.2.3 Intra-area trade deflator

Given that only the extra-area trade deflators were derived above, the intra-trade deflator needs to be modelled. In spite of the statistical discrepancies observed, the intra-area import deflator (MND) must by definition be equal to the intra-area export deflator (XND). There is therefore a choice of either modelling the export deflator or the import deflator for intra-trade. Regarding the determinants, we follow the approach taken for most deflators in the AWM, which is to model the deflator as a function of the extra-area import deflator (MXD) and domestic prices (YFD). As it turns out, the estimation of the intra-area import deflator proves to be more efficient than the estimation of the export deflator.

$$MND = f\{YFD, MXD\} \tag{14}$$

11 The competitors' prices on the imports side CMDM are very similar to those on the export side (CXDM), as they are both derived as a weighted average of trading partners' export prices. The difference is in the weights, which are those from the euro area export shares for CXDM and the import shares for CMDM.

4.3 Summary of trade equations and remaining accounting identities

In summary, there are three behavioural equations on the real side, which are those for extra-area exports, total imports, and the ratio between intra- and extra-area imports. The three behavioural equations for the deflators are those for the extra-area import and export deflators and the intra-area import deflator.

Behavioural equations:

Extra-area exports: $XXR = f\left\{WDR, XXD/_{CXD}\right\}$

Total imports: $MTR = f\left\{WER, MTD/_{YFD}\right\}$

Intra-/extra-area import shares (solves for intra-area imports): $MNR/_{MXR} = f\left\{MND/_{MXD}, WER\right\}$

Extra-area export deflator: $XXD = f\{YFD, CXD\}$

Extra-area import deflator: $MXD = f\{YFD, CMD, PCOM\}$

Intra-area import deflator: $MND = f\{YFD, MXD\}$

Intra-area imports are in terms of growth rates equal to intra-area exports, a residual term (XNR_RES) captures the discrepancies observed in the past. For out-of-sample simulation exercises this residual would be set equal to zero.

Intra-area imports: ΔLOG(XNR) = ΔLOG(MNR) + XNR_RES (15)

The remaining accounting identities for the trade volumes are as follows

Total exports: XTR = XXR + XNR (16)

Extra-area imports: MXR = MTR – MNR (17)

Nominal extra-area imports: MXN = MXR * MXD (18)

Nominal intra-area imports: MNN = MNR * MND (19)

Nominal total imports: MTN = MXN + MNN (20)

Total import deflator: MTD = MTN / MTR (21)

Nominal intra-area exports: ΔLOG(XNN) = ΔLOG(MNN) + XNN_RES (22)

Intra-area export deflator: XND = XNN / XNR (23)

Nominal extra-area exports: XXN = XXR * XXD (24)

Nominal total exports: XTN = XNN + XXN (25)

Total export deflator: XTD = XTN / XTR (26)

All of the behavioural and accounting equations are summarised in the diagram below. Each cell corresponds to one of the 18 trade variables in the system. The grey shaded areas stand for the variables that are determined through behavioural equations. The arrows indicate the accounting identities, where the arrow points from the explanatory variable to the explained variable.

Figure 6: Summary of behavioural equations and accounting identities

	Imports			Exports		
	Intra	Extra	Total	Intra	Extra	Total
Real	MNR	MXR	MTR	XNR	XXR	XTR
Deflator	MND	MXD	MTD	XND	XXD	XTD
Nominal	MNN	MXN	MTN	XNN	XXN	XTN

5 Estimation of trade equations

By using the modelling framework of the ECB's Area-Wide-Model (AWM) we follow estimation method of the traditional two-step approach proposed by Engle and Granger (1987), which is typically used in large structural macro-econometric models. This consists of a co-integrating long-term relationship, and a dynamic short-term equation. As the equations are part of the AWM, it is important that the long-run equations are consistent with the long-run equilibrium of the AWM. This implies theoretical constraints on the specification used, in particular dynamic homogeneity. The individual series were all tested for their order of integration. Then co-integration was estimated/tested for the long-run relationships[12]. Taking the residual from the long-run equations (ECM) as an error-correction term results in the short-run dynamic equations. The short-run equations are estimated with the priority of providing a good fit to the data, and to capture adjustments to the long-run equilibrium. The main database used is the a version of

[12] It was assumed for most variables that they were I(1). ADF tests suggest that the real variables are indeed I(1), but for the deflator, the tests suggest the variables are I(0).

the AWM database which goes until 2004q4, and is based on ESA95 data supplemented with the intra-extra trade breakdown. For the trade equations, data were available from 1980q1 onwards, and most of the equations were estimated over the full sample.

The data may be subject to structural breaks, first due to different assumptions for the construction of the data in different periods, and second due to the aforementioned economic changes, such as the formation of Monetary Union or the Single Market Programme. Against the background of such possible structural breaks, recursive regressions have been carried out in order to assess the stability of the estimated coefficients. The results from these recursive regressions are reported in Appendix 3. As detailed in the Sections below, step dummies and trend variables for parts of the sample have been included in those cases where such structural breaks could be clearly identified. The recursive estimation results of both the long- and short-run equations give therefore an indication for possible instabilities in the equation that cannot be identified at a specific point in the sample period.

5.1 Trade volumes

5.1.1 Extra-area real exports

As argued above, real exports are modelled following the bottom-up approach. Long-run extra-area exports are modelled such that exports respond to developments in world demand outside the euro area and extra-area price competitiveness. The extra-area export equation can be interpreted as a market share equation, with deviations of exports from world demand conditional on the price competitiveness position.

A trend is not found significant suggesting that there is no need to include a trend to proxy non-competitiveness effects to explain market share developments at the euro area level, but a step dummy from 1991q1 onwards was found significant, which reflects changes due to German unification. The results from the estimation are reported below.

Box 1: Estimation results for extra-area real exports

Long-run equation $\text{LOG}\ (XXR\ /\ WDR) = 12.09 - 0.23\ {*}\text{LOG}\ (XXD\ /\ CXD) + 0.11\ {*}\ D911P$ $R^2 = 0.66$
Dynamic equation $\Delta\ \text{LOG}\ (XXR) = -0.38_{(-5.44)}\ {*}\ ECM_{-1} + 0.68_{(3.61)}\ {*}\ \Delta\ \text{LOG}\ (WDR)$ $+\ 0.32_{(1.69)}\ {*}\ \Delta\ \text{LOG}(WDR)_{-1} + 0.06_{(3.19)}\ {*}\ D903$ $R^2 = 0.46$ DW=2.26, t-values in brackets
XXR: Extra-area real exports *WDR*: World demand (weighted extra-area competitors' import volume) *XXD*: Extra-area export deflator *CXD*: Competitor's export prices *D911P:* Level dummy from 1991q1 onwards *ECM:* Error correction term (residual from the long-run equation) *D903:* Step dummy for 1990q3.

The estimation results suggest a long-run elasticity of market share developments with respect to price competitiveness of -0.23. Price competitiveness turned out not to be significant in the short-run dynamic equation. In the short-run there is a one-to-one adjustment to changes in world demand. This restriction has been imposed and was accepted by the data[13]. In general the equations seem to capture well the dynamics of history with a t-ECM of -5.4.

Regarding the stability of the estimation results, the recursive estimation results shown in Appendix 3 give no indication of any instability of the estimated coefficients.

5.1.2 Total real imports

The import deflator used in the competitiveness term contains energy and non-energy prices. Given that the price-elasticity of oil imports is substantially lower than that of other imports, we use an oil-price adjusted import deflator in the competitiveness term. This non-oil import deflator is defined as:

$$MTDNO = \frac{\log(MTD) - \beta \log(COMPR \times EXR)}{(1-\beta)}$$

Where COMPR is the commodity price variable expressed in euro using the bilateral euro-$ exchange rate and β is the coefficient on COMPR in the long-run equation for the import deflator[14]. As for the

13 F-test for this restriction F(1,89)= 0.00357 with Significance Level 0.95.

14 This adjustment only takes into account the long-run impact.

export equation, a unit elasticity of imports to demand is assumed in the long-run, in order to obtain a well-defined steady-state. The estimation results are reported below.

Box 2: Estimation results for total real imports

Long-run equation

$$\text{LOG}\,(MTR\,/\,WER) = -0.36 - 0.57 * \text{LOG}\,(MTDNO\,/\,YFD) + 0.0044 * T931P$$

$R^2 = 0.96$

Dynamic equation

$$\Delta\,\text{LOG}\,(MTR) = -0.10_{(-3.88)} * ECM_{-1} + 1.23_{(16.42)} * \Delta\,\text{LOG}\,(WER)$$
$$+\,0.18_{(2.46)} * \Delta\,\text{LOG}\,(WER)_{-1} + 0.25_{(3.52)} * \Delta\,\text{LOG}\,(WER)_{-3}$$

$R^2 = 0.81$ DW= 2.41 t-values in brackets

MTR: Total real imports
WER: Import demand indicator
MTDNO: Total import deflator, corrected for oil price impact
YFD: GDP at factor cost deflator
T931P: Trend variable from 1993q1 onwards.
ECM: Error correction term (residual from the long-run equation)

Because imports have grown at a markedly faster pace than domestic activity, a deterministic trend is required to establish a cointegrating long-run relationship. However, the inclusion of such a trend is only required from 1993 onwards. This trend explains deterministic import growth of about 1.8% per year. From a steady-state perspective, the import share in GDP cannot rise indefinitely, so that the creation of a steady-state baseline requires an explicit assumption on the end date of this trend. The impact of competitiveness is estimated to be -0.57. In the short-run, changes in imports were found to respond by more than one-to-one to changes in domestic demand. The adjustment coefficient to long-run equilibrium is relatively small, but the t-value of the error-correction-term is nevertheless significant.

The recursive estimation results shown in Appendix 3 give no indication for any instability in the estimated coefficient values.

5.1.3 Intra- and extra-area real import shares

It was already noted in Section 3 that the share of extra-area in total trade was rising from slightly below 40 % to slightly below 50 % over the last two and a half decades. The share between intra- and extra-area imports is accordingly declining. This is at first sight not intuitive, because one would expect that the process of integration of the EU and especially also the formation of monetary union would have led to a trade diversion effect towards intra-area trade. At the same time, however, strong growth in the rest of the world and globalisation effects have led to a strong increase in export supplies from outside the euro area. The above factors cannot be directly investigated within the intra- and extra-area import share model. However, a further aspect of globalisation works through the lower price levels prevailing in some emerging economies, which means that the import prices for imports from those countries would be lower. In the estimation of this equation it is therefore interesting to find out to what extent this decline in the intra-area import share can be attributed to changes in relative competitiveness. The graphs shown in Section 3 indicate that the two ratios are indeed moving in opposite directions. However, the rise in the deflator ratio is only a feature of the earlier part of the sample, whereas the ratio between intra- and extra-area imports continues to decline throughout the sample, albeit also at a higher rate in the earlier part of the sample.

Like in the case of the total import deflator, the extra-area import deflator is corrected for the impact of commodity prices as follows:

$$MXDNO = \frac{\log(MXD) - \beta \log(COMPR \times EXR)}{(1-\beta)}$$

The estimation results of the intra-/ extra-area import share equation are reported in the box below:

Box 3: Estimation results for intra-/ extra-area import shares

Long - run equation

$$\text{LOG}\ (MNR\ /\ MXR) = 2.96 - 0.66 * \text{LOG}\ (MND\ /\ MXDNO)$$
$$-\ 0.18\ \text{LOG}\ (WER) - 0.10 * D931P$$

$R^2 = 0.96$

Dynamic equation

$$\Delta\ \text{LOG}\ (MNR\ /\ MXR) = -0.36_{(-3.71)} * ECM_{-1} - 0.15_{(-1.74)} * \Delta\ \text{LOG}\ (MNR\ /\ MXR)_{-1}$$
$$-\ 0.57_{-6.94)} * \Delta\ \text{LOG}\ (MND\ /\ MXDNO) - 0.08_{(-3.39)}\ \text{D931}$$

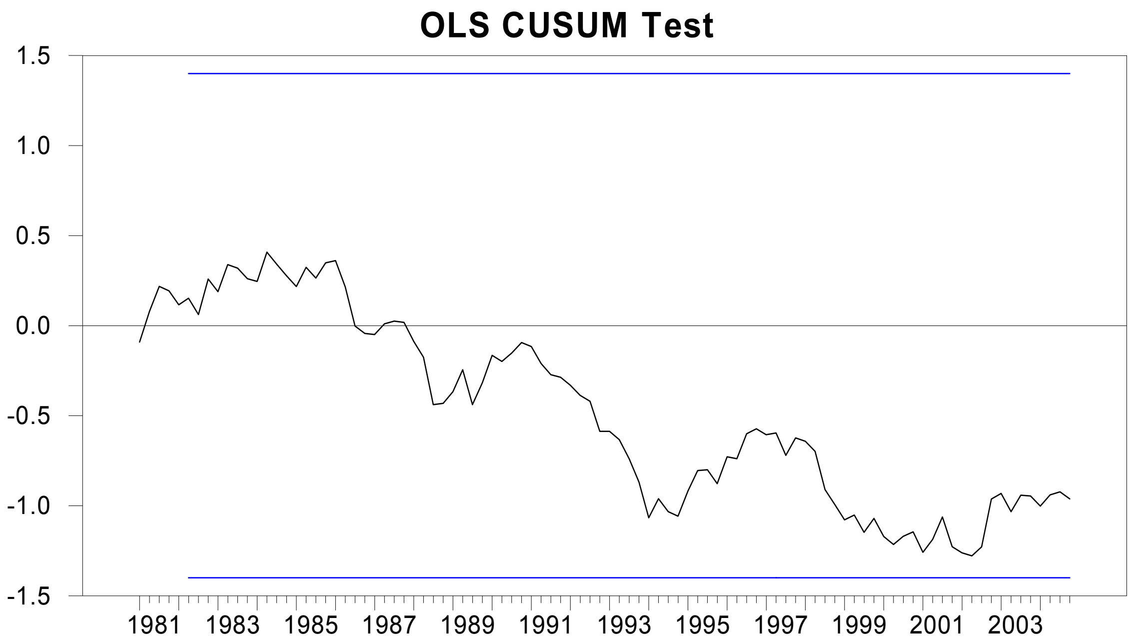
$R^2 = 0.40$ DW= 1.97 t-values in brackets

MNR: Intra-area real imports
MXR: Extra-area real imports
MND: Intra-area real import deflator
MXDNO: Extra-area real import deflator, corrected for oil price impact
D931P: Level dummy from 1993q1 onwards
D931: Step dummy for 1993q1
ECM: Error correction term (residual from the long-run equation).

The estimation results confirm that relative competitiveness played a significant role in explaining the ratio between intra- and extra-area imports. However, the long-run equation requires in addition a deterministic trend which attributes about 0.8 percentage point per year to the shift in the ratio between intra- and extra-area imports. Moreover, the long-run equation requires the inclusion of a step dummy from 1993 onwards which accounts for 6%. This step dummy is likely to be related to the data construction which required particular assumptions for pre-1993 data. The estimation results indicate overall that the decline in intra-area import shares is not only due to losses in competitiveness, but also due to factors which are not explicitly modelled. These factors are likely to be the increased trade integration with the rest of the world as well as the relatively fast growth observed in various emerging economies. The ECM coefficient in the short-run equation indicates a relatively fast adjustment to the long run. The coefficient on competitiveness in the short-run equation is not significantly different from that in the long-run equation.

Using this equation we can test to see if the introduction of the euro had an impact on intra-area imports. For this purpose, a step dummy from 1999 onwards was introduced to account for the formation of monetary union. The inclusion of this dummy turned out to be insignificant. To test for the stability of the equation more formally, a formal test for such structural breaks is conducted using the OLS-CUSUM test (Ploberger *et al.* (1992)). The graphical result of this test is shown below. It shows that there was no structural break in the parameters.

Figure 7: Test of stability of import shares equation



Finally, applying the same test for stability as for the other equations, the results from the recursive estimation suggest some volatility in the estimated coefficients. It appears that the elasticity with respect to relative competitiveness may have declined slightly over most of the sample, and has been particularly volatile towards the end of the sample. The latter may reflect a non-linearity in the elasticity in the light of strong exchange-rate movements observed in that period.

On the basis of the estimation results and the stability tests conducted, there is so far no evidence that the introduction of the euro would have had an impact on intra-area trade. It may be the case that the sample is still too short to find significant effects. The time span since formation of monetary union was also signified by sizeable swings in the exchange rate of the euro, which had strong effects on competitiveness of intra- versus extra-area imports. Some of the effects from the introduction of the euro work through the impact on intra- versus extra-area competitiveness, and these effects are implicitly captured by the model. Finally, it should be recalled that the data used may not be fully accurate, so that future improvements I the data may overwrite the results as they stand at this moment.

5.2 Trade deflators

5.2.1 Extra-area exports deflator

Box 4: Estimation results for extra-area exports deflator

Long - run equation

$$\mathrm{LOG}\,(XXD) = 0.43 + 0.25 * \mathrm{LOG}\,(CXD) + 0.75 * \mathrm{LOG}\,(YFD) + 0.02 * \mathrm{D971P} - 0.0020 * TIME$$

$R^2 = 0.99$

Dynamic equation

$$\Delta\,\mathrm{LOG}\,(XXD) = -0.53_{(-6.97)} * ECM_{-1} + 0.20_{(2.83)} * \Delta\,\mathrm{LOG}(XXD)_{-1} + 0.52_{(5.52)} * \Delta\,\mathrm{LOG}\,(YFD) + 0.15_{(6.78)} * \Delta\,\mathrm{LOG}\,(CXD)$$

$R^2 = 0.63$ DW=1.88 t-values in brackets.

XXD: Extra-area exports deflator
CXD: Competitor's export prices
YFD: GDP deflator at factor costs
D971P: Level dummy from 1997q1 onwards
TIME: Time trend
ECM: Error correction term (residual from the long-run equation).

The estimation results shown above suggest that extra-area export prices are mainly driven by domestic costs (YFD) rather than the competitors' prices. The long-run equation requires the inclusion of a trend variable that attributes -0.8% per year to the growth rate of the extra-area export deflator. Moreover, the inclusion of a step dummy from 1997 onwards is also required. The adjustment to the long run is relatively fast, as indicated by the ECM coefficient. The results from the recursive estimation indicate some instability in the trend and the constant.

5.2.2 Extra-area imports deflator

The estimation of the import deflator equation is particularly interesting as it provides information on the pass through of movements in foreign prices and the exchange rate, or, put in the opposite way, the pricing-to-market effect (PTM). With the estimation of the extra-area import deflator it is possible for the first time to derive such PTM for the euro consistently with national account data. The estimation results are reported in the box below.

Box 5: Estimation results for extra-area imports deflator

Long - run equation

$$LOG\ (MXD) = -0.12 + 0.55 * LOG\ (CMD) + 0.26 * LOG\ (YFD)$$
$$0.19 * LOG\ (COMPR * EXR) - 0.0025 * TIME$$

$R^2 = 0.99$

Dynamic equation

$$\Delta\ LOG\ (MXD) = -0.24_{(-4.56)} * ECM_{-1} + 0.37_{(7.37)} * \Delta\ LOG(MXD)_{-1} + 0.34_{(8.41)} * \Delta\ LOG\ (CMD)$$
$$+ 0.13_{(7.97)} * \Delta\ LOG\ (COMPR * EXR) - 0.04_{(-2.26)} * \Delta\ LOG\ (COMPR * EXR)_{-2}$$

$R^2 = 0.835$ DW=2.01 t-values in brackets

MXD: Extra-area imports deflator
CMD: Competitor's export prices (computed with import shares)
YFD: GDP deflator at factor costs
COMPR: Commodity prices
EXR: Bilateral euro-$ exchange rate
TIME: Time trend
ECM: Error correction term (residual from the long-run equation).

The estimation results shown above indicate that the PTM, as measured by the coefficient on domestic prices YFD, is about 0.26. A further interesting finding is the high coefficient of 0.19 on commodity prices. As shown in the recursive estimation results, the value of this coefficient has risen sharply in recent years due to substantial hikes in the oil price. The long-run equation requires the inclusion of a trend variable, which accounts for about 1% of the annual growth rate of the extra-area import deflator. The coefficient on the ECM term in the short-run equation is -0.24 with a significant t-value of -4.56.

As already noted, there is some instability in the parameter estimates, as shown in the recursive estimation results. The above mentioned rise in the coefficient on energy prices is broadly counterbalanced by a decline in the coefficient on competitors' prices, so that the pricing-to-market effect remains broadly stable. The estimated value of the PTM corresponds to the average value estimated for the largest five euro area countries in Warmedinger (2004), which is 0.27. This is on the one hand surprising, because the competitors' prices (CMD) for the individual countries include the intra-area component, which is expected to have a higher impact on import prices, because the limited exchange-rate pass-through is not relevant within a currency union. On the other hand, competition within a currency union may be expected to be higher, for instance because of a higher price transparency. It this is the case, exporters are more likely to be price takers, which means that the PTM would be higher. A possible interpretation of the results is that the two effects are balancing each other out.

5.2.3 Intra-area trade deflator (imports)

The approach taken for modelling the intra-area trade deflator is that it is a function of domestic prices and imported prices from outside the euro area. The estimation results are reported below.

Box 6: Estimation results for intra-area trade deflator (imports)

Long - run equation

$$\text{LOG}(\mathit{MND}) = 0.25 + 0.26 * \text{LOG}(\mathit{MXD}) + 0.74 * \text{LOG}(\mathit{YFD}) - 0.07 * \mathit{D931P}$$

$R^2 = 0.99$

Dynamic equation

$$\Delta \text{LOG}(\mathit{MND}) = -0.19_{(-2.87)} * \mathit{ECM}_{-1} + 0.58_{(5.81)} * \Delta \text{LOG}(\mathit{YFD}) + 0.14_{(3.64)} * \Delta \text{LOG}(\mathit{MXD})_{-1} - 0.04_{(-3.93)} * \mathit{D931}$$

$R^2 = 0.40$ DW=1.93 t- values in brackets

MND: Intra-area imports deflator
MXD: Extra-area imports deflator
YFD: GDP deflator at factor costs deflator
D931P: Level dummy from 1993q1 onwards
ECM: Error correction term (residual from the long-run equation)
D931: Step dummy for 1993q1.

The results show that the intra-area import deflator is mainly determined through domestic prices. The inclusion of a trend variable from 1993 onwards was also required.

6 Simulation analysis

The estimation results presented in the previous parts are based on a single equation analysis. In this part the emphasis is on the interdependencies between the individual equations. This is done by means of diagnostic simulations using the AWM. The simulations are conducted in the full AWM, but the emphasis in this part is on the properties of the trade block introduced in this paper. The full model is used mainly to derive the impact on domestic variables which have a second-round impact on trade variables, such as in particular domestic prices and domestic activity. The simulations comprise mainly the main external shocks that are transmitted to the euro area through the trade equations of the AWM. In addition, a domestic shock is simulated in order to illustrate the absorption properties of such a shock. The simulations in the AWM are conducted in backward-looking mode with no policy rules being activated. The simulations are described below, corresponding graphs are shown in Appendix 4, and more detailed simulation results are shown in the Tables in Appendix 5.

6.1 Appreciation of the nominal exchange rate by 10%

The simulation of a shock to the exchange rate is a prime example to illustrate the advantage of a disaggregated intra / extra analysis, because the exchange rate affects by definition only the extra-area competitiveness. The exchange rate has an impact mainly on the competitors' prices and commodity prices when expressed in euro. Both are key determinants of *extra-area import prices*, where consequently the largest impact is expected to occur. The pricing behaviour of exporters to the euro area, who partly set up their prices as a mark up to their costs, generally attenuates this impact due to pricing-to-market (PTM) effects. The PTM is in the estimated long-run equation determined by the coefficient on domestic prices (GDP deflator at factor prices, YFD). This coefficient is 0.26, such that the pass-through is 0.74 (1 minus 0.26). Overall, the extra-area import deflator drops by almost 8%, reflecting on the one hand the aforementioned incomplete pass-through of the exchange-rate shock, and on the other hand some second-round effects through an increase in domestic prices.

The impact on the *intra-area import deflator* is considerably smaller, because there is only an indirect effect on this variable. The overall impact within the first five years amounts to about 3%, which implies an effect to extra- versus intra-area import competitiveness by about 5%.

Taken together, the impact on the *total import deflator* is somewhat above 5% within the first five years. This is practically identical to the result found in Warmedinger (2004)[15], where the impact was derived from a simulation of the total import price equation in conjunction with a stylised bridge equation for domestic prices. The pass-through may be considered somewhat on the high side, because the energy prices are assumed to be fully determined in US Dollar, while it can be argued that the oil price expressed in euro may not move one-to-one with the exchange rate. The overall pass-through is also determined to some extent by the impact on domestic prices, as determined mainly in other parts of the AWM. However, the results are not particularly sensitive with regard to this domestic price effect because the coefficient on the domestic price variable in the import price equation is relatively small.

The impact on export prices is expected to be smaller, because they are determined as a mark-up to domestic prices, and competitors' prices outside the euro area are only considered as a factor to maintain international market shares. The latter effect is only a feature for the *extra-area export deflator*, where the corresponding coefficient on competitors' prices is 0.25 in the long-run equation. The simulated impact on the extra-area export deflator amounts after five years to almost 4%. The impact on the *intra-area export deflator* is by construction equal to the impact on the intra-area import deflator as reported above. The impacts on the extra-area, intra-area and *total export deflator* are quite similar.

Given the asymmetric impact of this shock on intra- versus extra-area import competitiveness, there should be a corresponding effect in terms of the intra- and extra-area import volumes. To recall the modelling strategy, for imports we chose a top-down approach which reflects the fact that the main determinant of imports, i.e. domestic activity, is not separable into its intra- and extra-area components. There is a positive effect on *total imports* expected from the decrease in total import prices, and a negative effect from a decrease in domestic activity, notably exports. As can be seen in the graphs and

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15 The exact impact of the exchange-rate shock on total import prices is in this paper -5.5% after 5 years, which is identical to Warmedinger (2004). However, the latter results entail a somewhat stronger impact in the shorter horizon, whereas the results in this paper indicate a gradually increasing impact.

tables in the Appendix, the effect on total imports is relatively small, and the negative impact prevails over the shorter horizon. This negative impact in the short run is partially driven by the relatively high import content in exports (see Section 4.1.2). The sign of the effect reverses only after about 2 years. Although GDP is then still below baseline, the gradual decrease in domestic prices restores to some extent the import competitiveness.

Turning to the novel feature presented in this paper, which is the explicit modelling of the substitution between intra- and extra-area imports, it can be seen that the impact on the two sub-components is indeed quite different. *Extra-area imports* start to increase immediately, reflecting the dominance of the competitiveness effects on the extra-area side. *Intra-area imports*, in contrast, remain below baseline for about five years. This reflects the substitution effect due to relative import price competitiveness and the negative impact from domestic activity. However, the different elasticities of the two sub-components with respect to domestic activity absorbs some of the shift towards intra-area imports.

The above effect on intra-area imports is by construction equal to the effect on *intra-area exports*. The impact on intra-area exports is within the first two years even larger than the impact on *extra-area exports*. This relative strength of the intra-area impact is – as noted above - due to two effects, i.e. the impact from lower domestic activity and the substitution effect away from intra-area imports due to relative price competitiveness. This elasticity is estimated to be relatively high (-0.66) in comparison with the estimated price elasticity of extra-area exports (-0.23), which outweighs also the relatively larger effect on extra-area price competitiveness[16]. The path of intra-area exports is then below that of extra-area exports after about two years. Overall, the impact on *total exports* is a decline of up to about 2% below baseline, with a gradual return closer to the baseline due to the profile of the intra-area exports.

In particular the impacts on imports and exports and their intra- and extra-area sub-components illustrates the additional insights gained by this type of analysis. It can be seen that there are various transmission channels at work with potentially asymmetric impacts on the two components. When looking only at the total aggregate it would not be possible to understand the individual transmission channels at work.

6.2 An increase in world demand by 1 %

This simulation entails a shock to world demand outside the euro area by 1%. The primary impact of this shock is on *extra-area exports*, where the impact roughly coincides with the size of the shock. The effect on *intra-area exports* is determined through imports, as discussed below. The rise in exports has a positive impact on euro area GDP, and even more on the import demand indicator due to the relatively high import content of exports. The impact on *total imports* is an increase by around half a percent. The impact on *extra-area imports* is slightly higher than that on *intra-area imports*. This is due to the relative import price competitiveness and the slightly higher elasticity of extra-area imports with respect to domestic activity.

[16] The price competitiveness on the extra-area export side is given by the difference between the extra-area export deflator (just under 4% after 5 years) and the competitors' export prices (10%). The relative intra-/extra-area import price competitiveness is given by the difference between the intra- and extra-area import deflator, which is after 5 years about 5%.

The price effects of this shock are generally relatively small. They are triggered by a small increase in domestic prices, as determined through the price mechanism in the AWM. The *extra-area import deflator* increases only marginally (about 0.5% after five years), because it is mainly determined by foreign competitors' prices, which remain unchanged. The *intra-area import deflator* increases somewhat more (about 0.2% after five years) due to the higher dependence on domestic prices. The impact on the *intra-area export deflator* is by construction equal to the intra-area import deflator, which is also approximately the path of the *extra-area export deflator*.

6.3 An increase in public consumption by 5 %

An increase in public consumption was simulated in order to assess the absorption of such a domestic shock. The 5% increase in public consumption temporarily increases euro area GDP by up to 1.5%. In terms of the trade variables, the primary impact of this shock is on *total imports*, which increase by up to about 2% by the end of the second year. *Intra-area imports* increase less than *extra-area imports* due to the slight loss in intra-area import price competitiveness, and the slightly higher elasticity of extra-area imports with respect to domestic activity. The impact on *intra-area exports* is again equal to that on intra-area imports, whereas *extra-area exports* decrease slightly due to the slight loss in export price competitiveness. The positive impact on intra-area exports is clearly dominating, such that the overall effect on *total exports* is also positive. The internal dynamics of the AWM imply a relatively large impact on domestic prices, which amounts to more than 2% after 5 years. The transmission to the *intra-area import deflator* is again larger than that to the *extra-area import deflator*, which is thus the reason for the above mentioned effect on the relative import price competitiveness. The impact *intra- and extra-area export deflators* are similar.

7 Summary and conclusions

This paper introduced a modelling approach for disaggregated intra- and extra-area trade data. Amongst the available options of either modelling *"top-down"*, i.e. starting from the aggregate figures and disaggregate afterwards, or to model *"bottom-up"*, i.e. starting with the disaggregated figures, the paper proposes a mixed approach. This choice of approach is mainly determined by the possibilities of disaggregating the explanatory variables of the equations.

Regarding the trade volume equations, we propose behavioural equations for extra-area exports, total imports and the share between intra- and extra-area imports. The latter was considered to be the best possible way to utilise all available information. It may also shed light on possible effects from monetary union on this share, reflecting trade creation effects within the euro area and trade diversion effects from extra- to intra-area trade. On the basis of the estimation results and stability tests of the estimated equation, it was not directly possible to identify such effects. However, to the extent that the introduction of the euro had an impact on intra- versus extra-area trade competitiveness, the impact may be captured through the competitiveness term in the equation.

Regarding the trade deflators, behavioural equations are proposed for the extra-area export and deflator deflators and the intra-trade deflator. The latter was specified on the basis of the data for the intra-area import due to a slightly better fit compared to the intra-area import deflator. A particularly interesting feature arises through the estimation of the extra-area import deflator. Before the intra- / extra-area disaggregation of trade data it was not possible to derive estimates for the pricing-to-market effect in the euro area which are consistent with national account data. The estimate in this paper suggests a pricing-to-market effect of 0.26.

The disaggregation of the data into their intra- and extra-area components required a series of assumptions, which may have negative implications for the quality of the data. The modelling approach, particularly the choice of *"top-down"* versus *"bottom-up"*, was in any event mainly based on theoretical considerations which are independent from the data. However, the estimation results turned out to be well-behaved in terms of signs and magnitudes of elasticities, so that any future improvements in data would probably not require a change in the modelling approach.

Using the adopted framework, within the AWM, various simulations were performed. These show the different responses of intra- and extra-area trade to different shocks to the economy. The simulations illustrated the various transmission channels, particularly in the case of an exchange rate shock to the euro area economy. These transmission channels can be quite different in magnitude and sign for the intra- and extra-area components. Through the disaggregated intra- / extra-area analysis it is thus possible to take explicit account of these channels, which leads ultimately to a richer understanding of the dynamics at work. This allows in particular to analyse the substitution between intra- and extra-area trade.

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Appendix 1: Construction of intra-/extra-area trade data

Intra-extra trade decomposition[17]

In order to create the decomposition, a number of different sources were required, in particular 3 different databases were used. Firstly, ESA95 National accounts which contains series for total trade in gross terms, i.e. an aggregate of goods and services without separating between intra and extra-area trade. The ESA95 database also contains series for goods and services (although also in gross terms). Secondly, Eurostat's External trade in goods statistics are used, which are compiled on a monthly basis using data collection systems based on both extra-EU and intra-EU (Intrastat) data.[18] Finally, Balance of Payments (BOP) statistics are used which distinguish between intra and extra-area trade in goods and services value, but do not include volumes.

In particular, the following series were taken:

- Nominal and real National Accounts series for total euro-area gross trade in goods and services, both imports and exports.
- Nominal and real National Accounts data for trade in goods and services at the national level, nominal and real.
- Seasonally adjusted monthly series for intra- and extra-area trade in goods, nominal and real back until 1993.
- Euro area balance of payments data for goods and services trade with the rest of the world, i.e. extra-area data. These series were only nominal.
- Historical data from 1970 to 2000 for nominal extra-area imports of goods and total nominal imports of goods. Taken from OECD Monthly Statistics of International Trade.

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[17] This section draws heavily on internal ECB work by Ricardo Mestre.

[18] For further information, refer to the User Guide of External Trade Statistics. Community Legislation applicable to the Statistics Relating to the Trading of Goods Between Member States and Statistics Relating to the Trading of Goods with Third Countries.

In order to proceed from these series to a breakdown of trade consistent with national accounts gross trade a number of calculations and assumptions were needed. The steps undertaken were:

1. Trade in goods, both real and nominal, were decomposed between intra and extra area trade using trade series from Eurostat database. This was broadly comparable with BOP data.

2. Extra-area trade in services, in nominal terms, was derived by taking the goods-to services ratio implicit in the BOP data, and applying it to the goods trade series derived in the previous step. As the resulting series started in 1997q1, data was back-extended by assuming that the goods-to-services ratio in extra-area trade evolved in parallel with the same ratio for gross trade.

3. The resulting nominal series for total nominal extra-area trade were derived by adding up extra-area series for goods, and services.

4. Figures for intra-area nominal trade were then derived by simple subtraction from total trade.

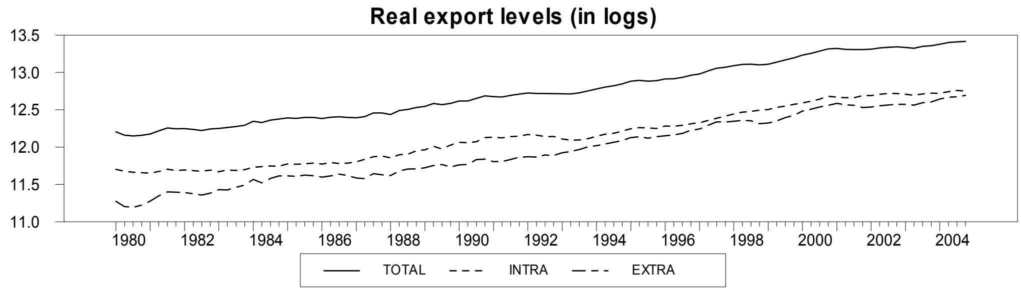
5. For the real series, the issue was slightly more problematic because of the lack of volumes in the BOP database. In this respect, it was assumed that the goods-to-services ratio in extra-area trade series evolved as the corresponding ratios in gross trade. Using these assumed ratios, and real extra-area trade data for goods, extra-area real trade for services was projected.

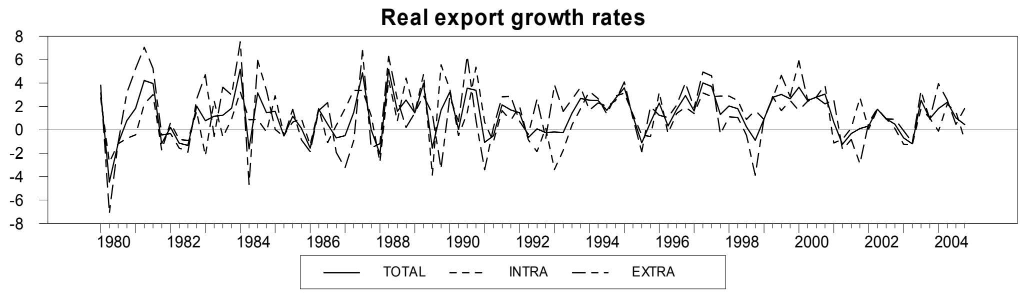
6. Unfortunately this data was only possible back to 1993 on a quarterly basis. Before 1993 the extra-to-total nominal imports goods ratio is used for both nominal extra imports and real extra exports. The exports are then derived assuming that intra exports grow at the same rate as intra imports[19].

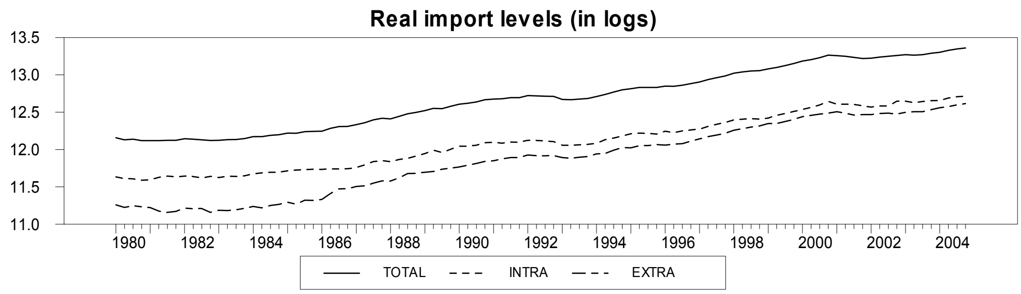
The end result is a breakdown of National accounts trade data into intra and extra euro area trade, both for real and nominal variables.

[19] As alternative methods could have been to use the extra-to-total nominal imports for both real and nominal extra-imports, or to have fixed import shares for both real and nominal. Both of these alternative methods, gave similar profiles to the above method.

Figure A1: Graphs Real intra/extra trade







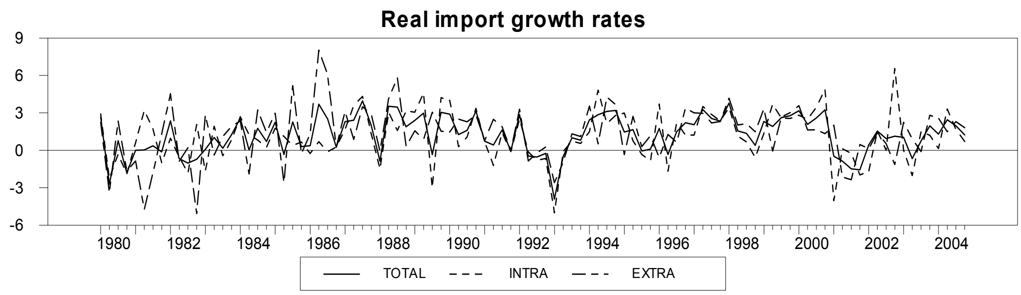


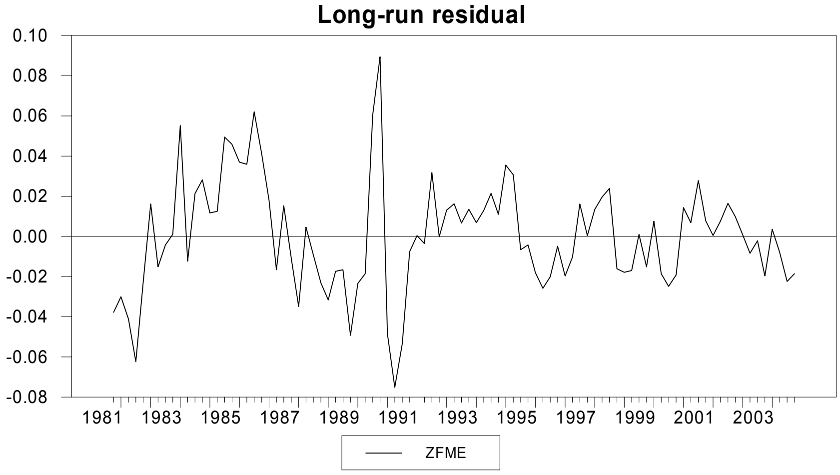
Table A1: Statistics for intra/extra trade variables

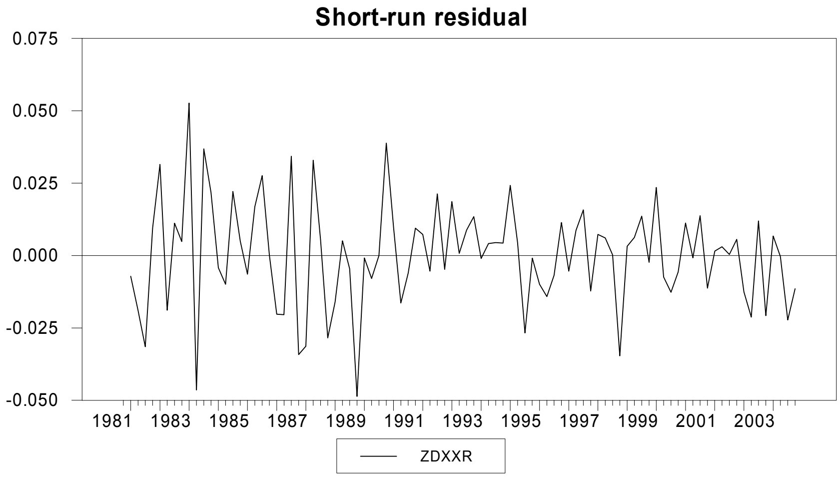
Variable	Sample Mean	Standard Error	Skewness	Excess Kurtosis
DMTR	1.23	1.53	-0.54	0.13
DMNR	1.11	2.02	-0.20	0.26
DMXR	1.38	2.16	-0.27	1.03
DXTR	1.24	1.77	-0.15	0.02
DXNR	1.07	1.91	-0.15	-0.28
DXXR	1.45	2.68	-0.24	0.32
DMTD	0.60	1.83	0.14	1.77
DMND	0.59	1.49	-0.20	-0.07
DMXD	0.57	3.18	-0.22	1.81
DXTD	0.71	1.08	0.81	0.62
DXND	0.65	1.81	0.62	4.14
DXXD	0.75	1.51	0.09	-0.11

The table above shows the sample means and standard errors for the log-differences of the trade volumes and deflators and their intra- and extra-area components. Except for the export deflators, it can be seen that the extra-area components are more volatile. The differences in the mean growth rates between the intra- and extra-area components are larger for the trade volumes, where extra-area trade has grown at a higher rate than intra-area trade.

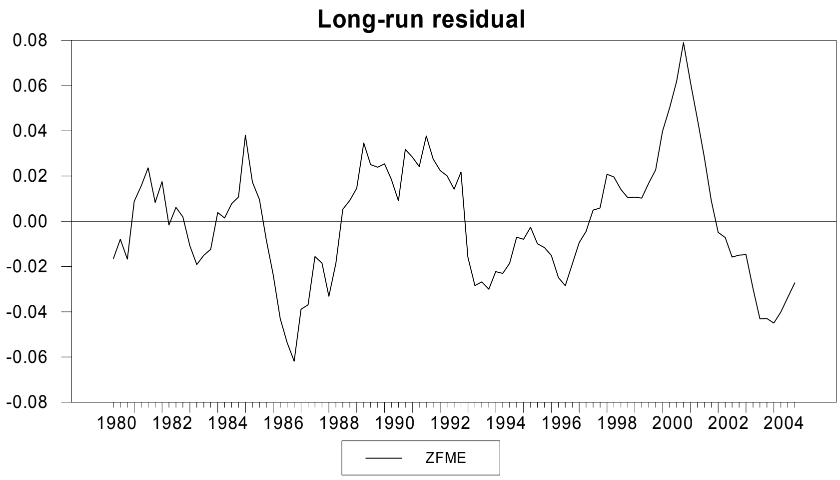
Appendix 2: Residuals from estimated equations

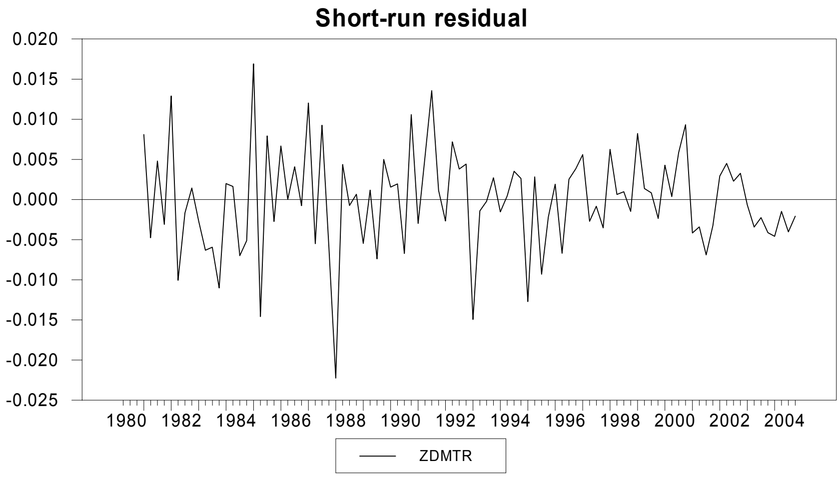
Extra-area exports (XXR):



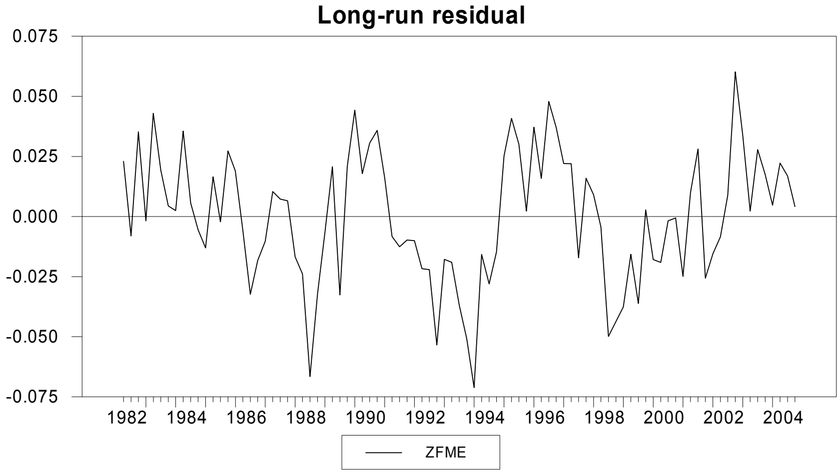


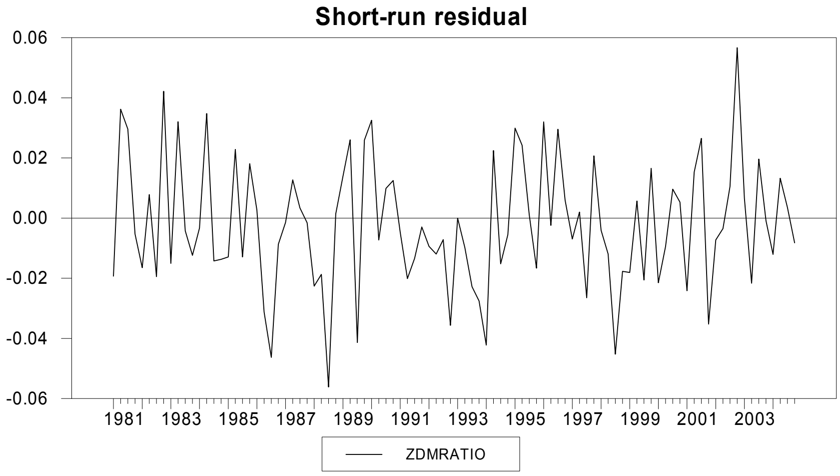
Total imports (MTR):



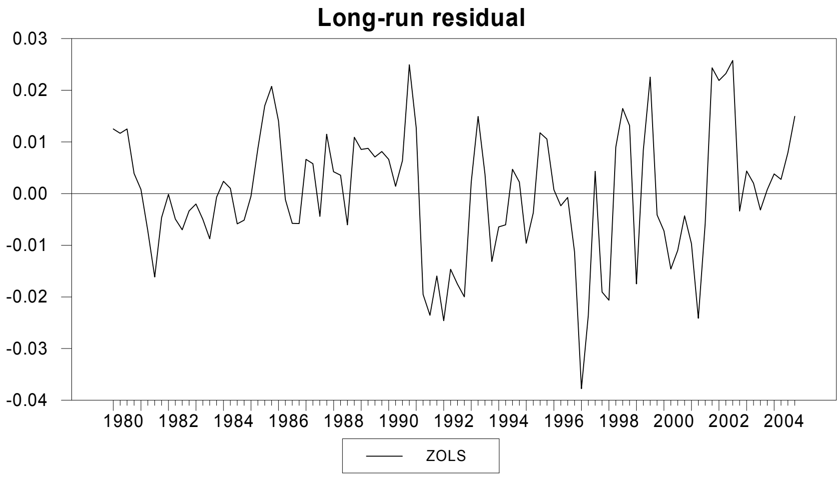


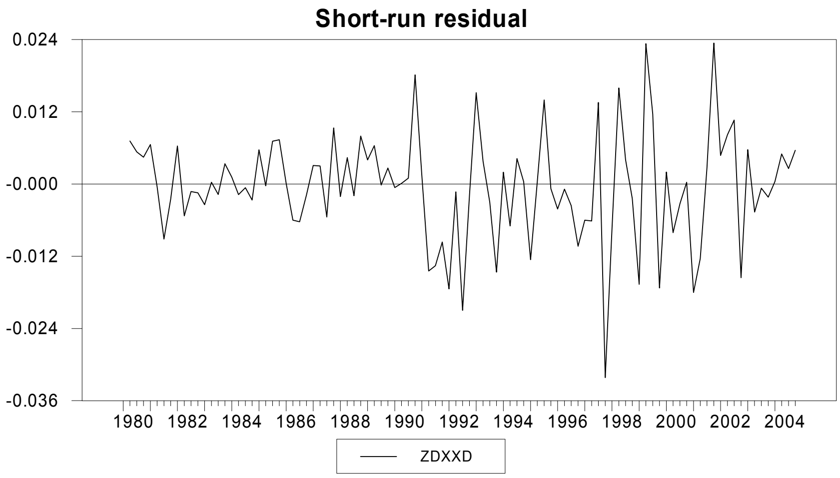
Intra-/ extra-area import shares (MNR / MXR):



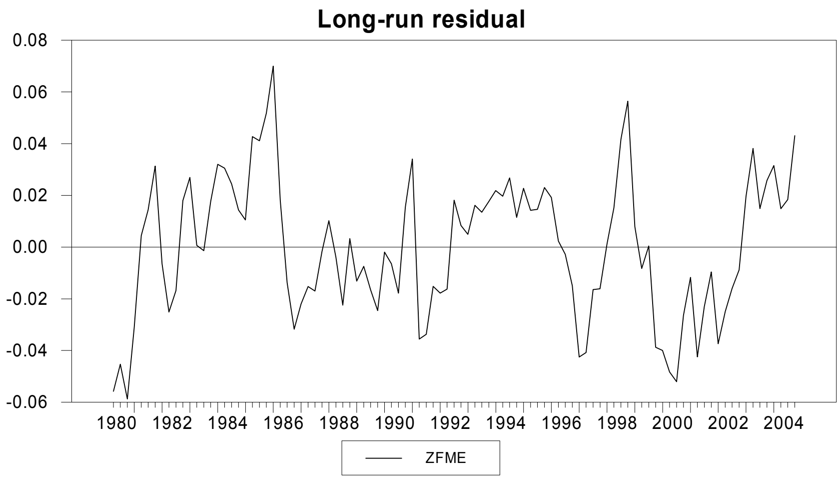


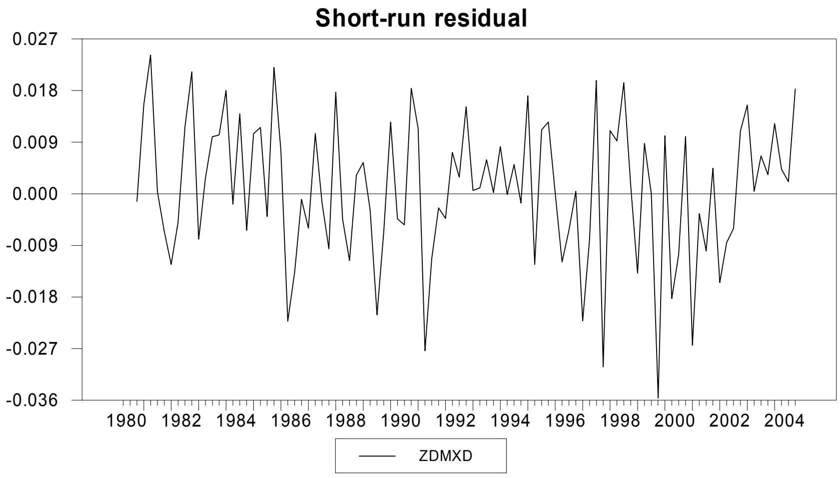
Extra-area export deflator (XXD):



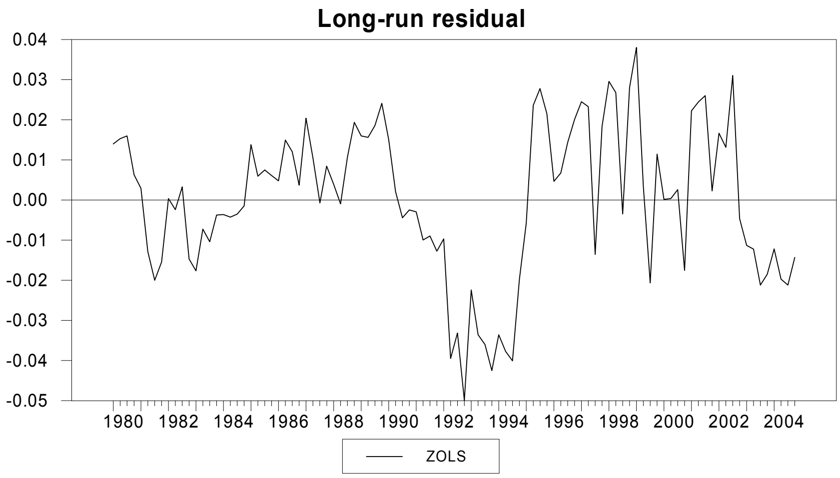


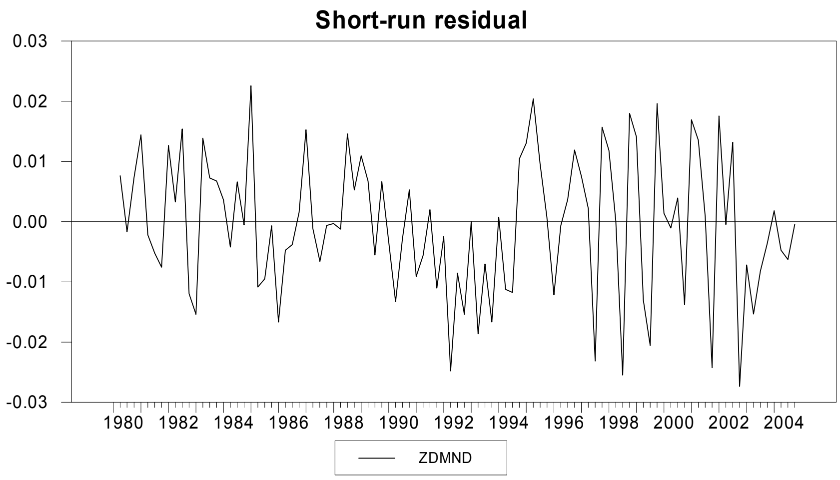
Extra-area import deflator (MXD):





Intra-area import deflator (MND):

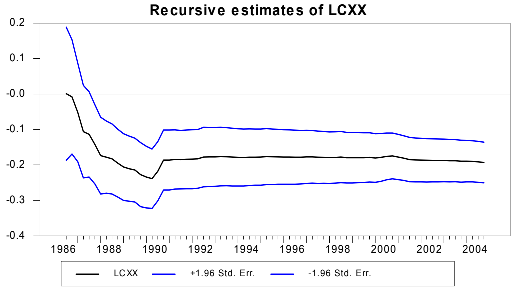


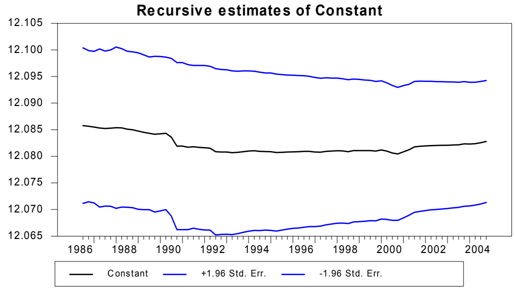


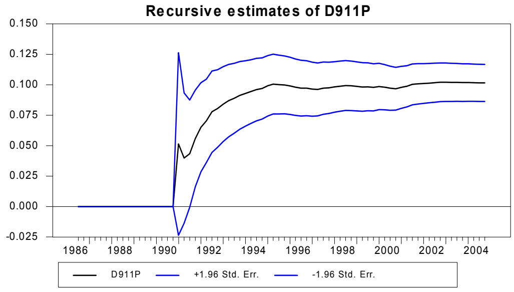
Appendix 3: Recursive estimation results

Extra-area exports (XXR)

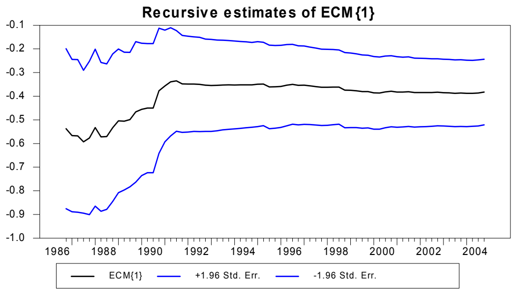
Long-run equation:

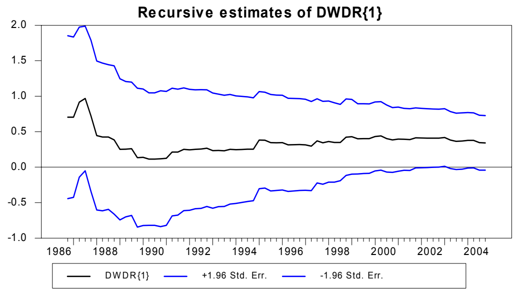


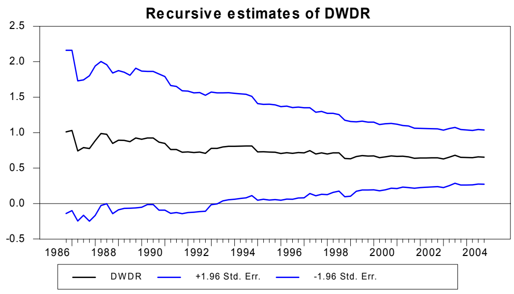


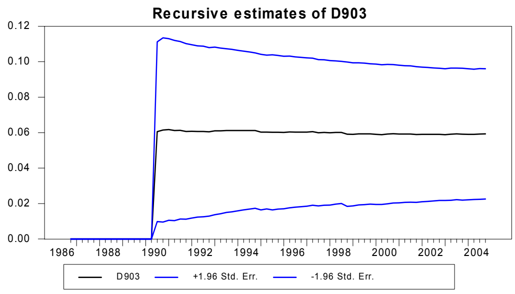


Short-run equation:



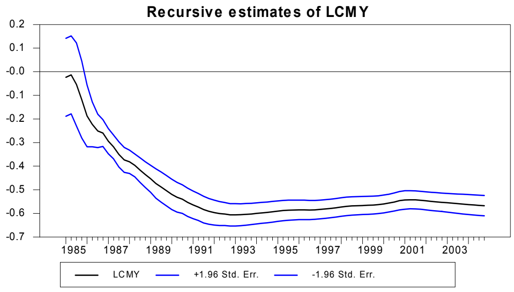


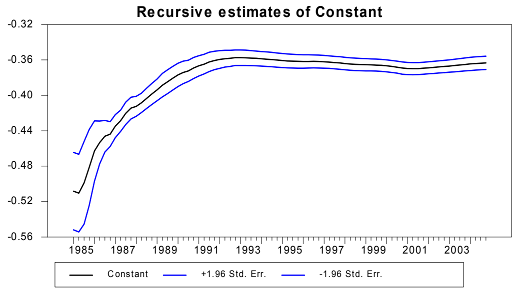


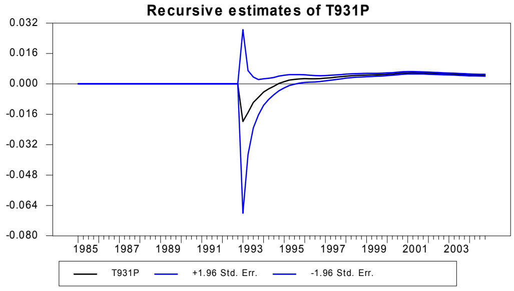


Total imports (MTR)

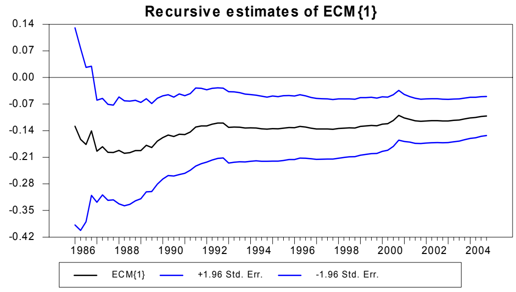
Long-run equation:

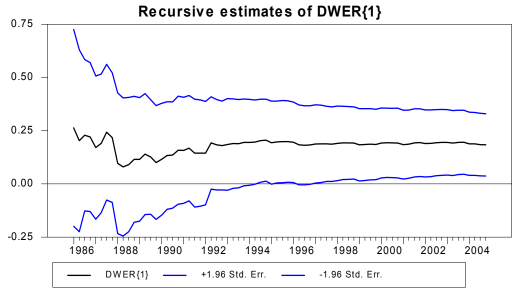


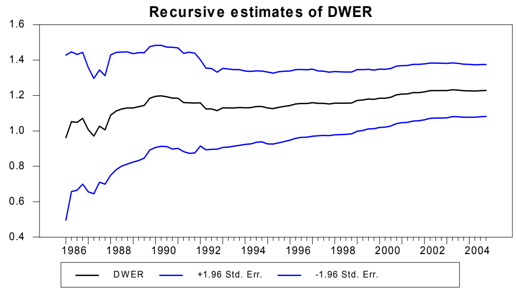


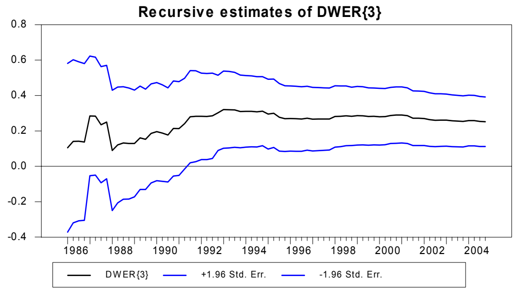


Short-run equation:



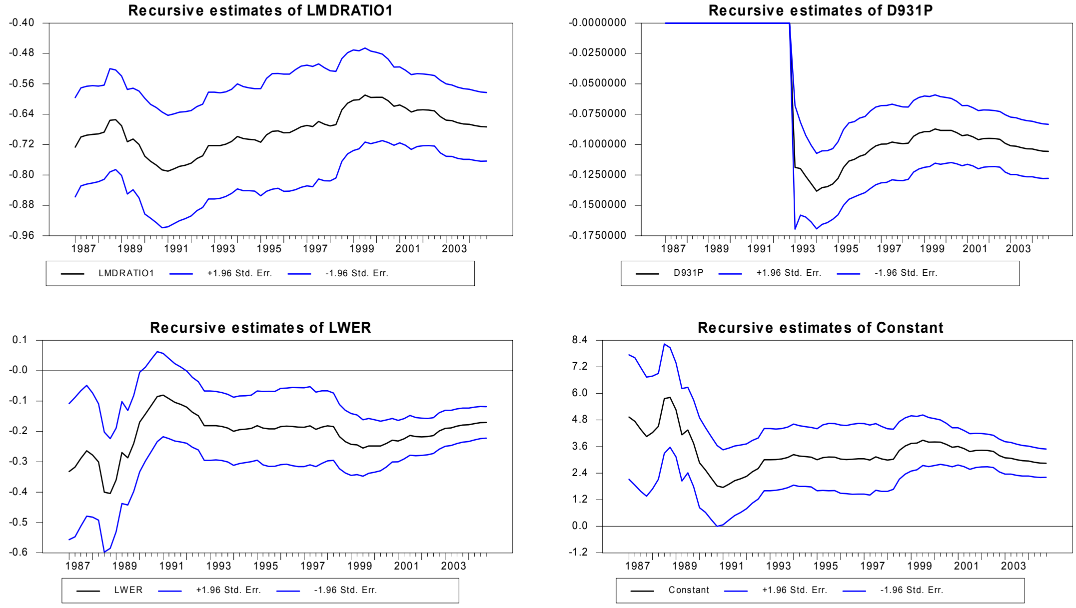




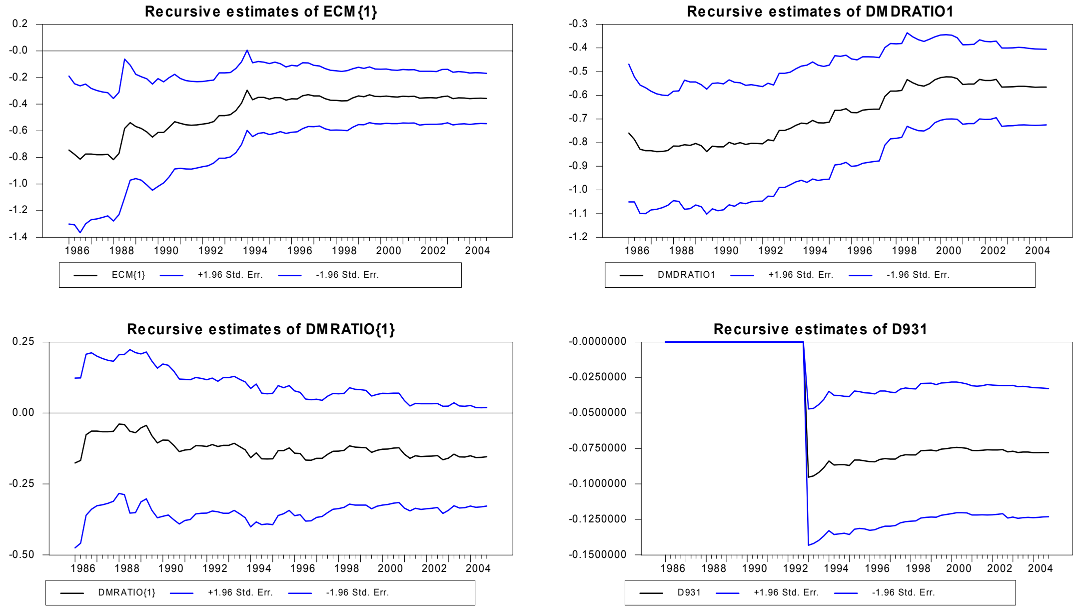


Intra-/ extra-area import shares (MNR / MXR)

Long-run equation:

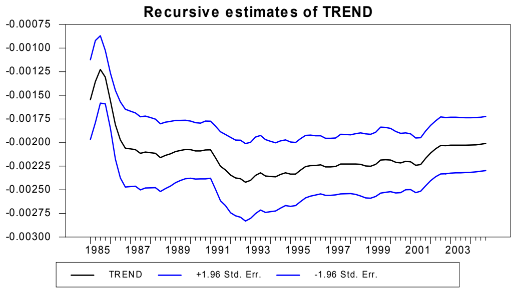


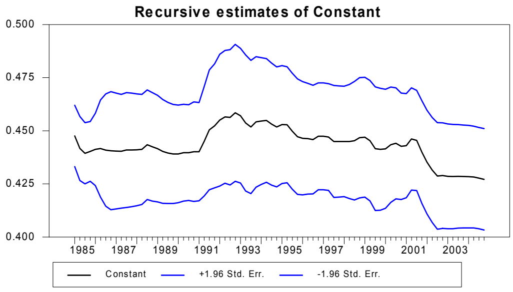
Short-run equation:

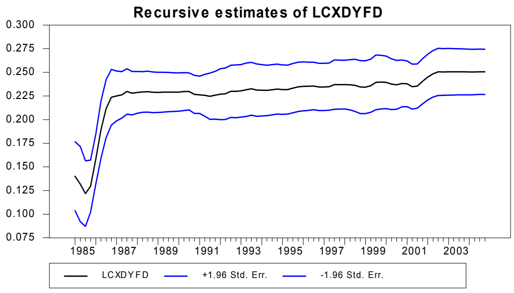


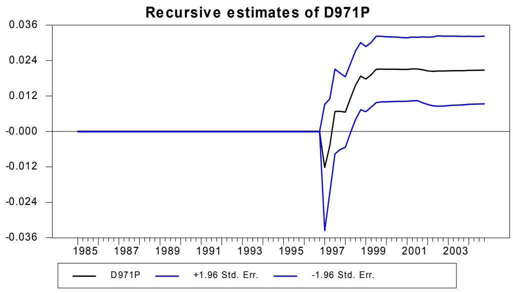
Extra-area export deflator (XXD)

Long-run equation:

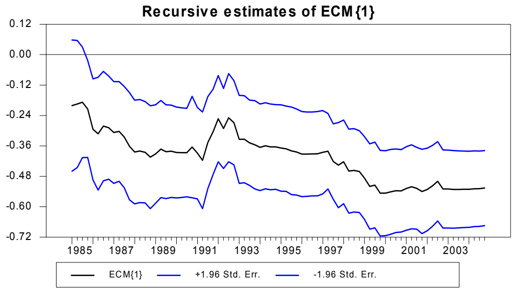


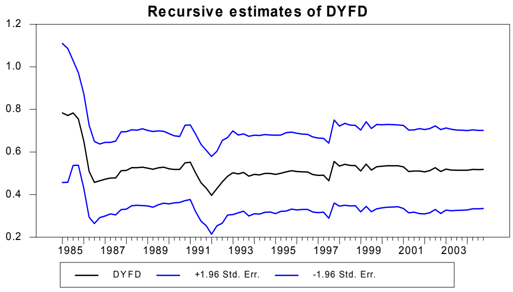


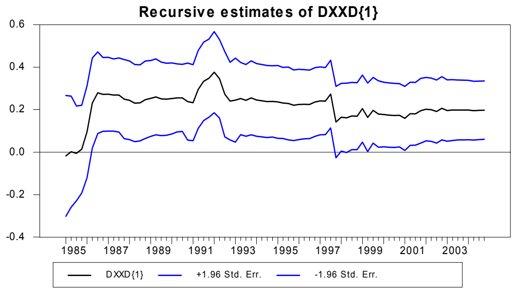


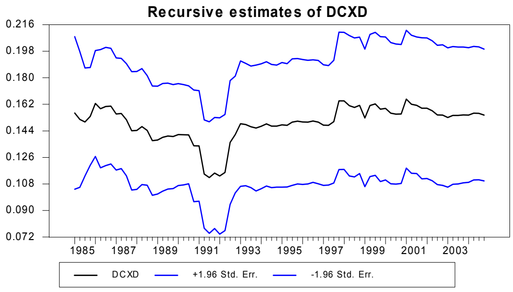


Short-run equation:



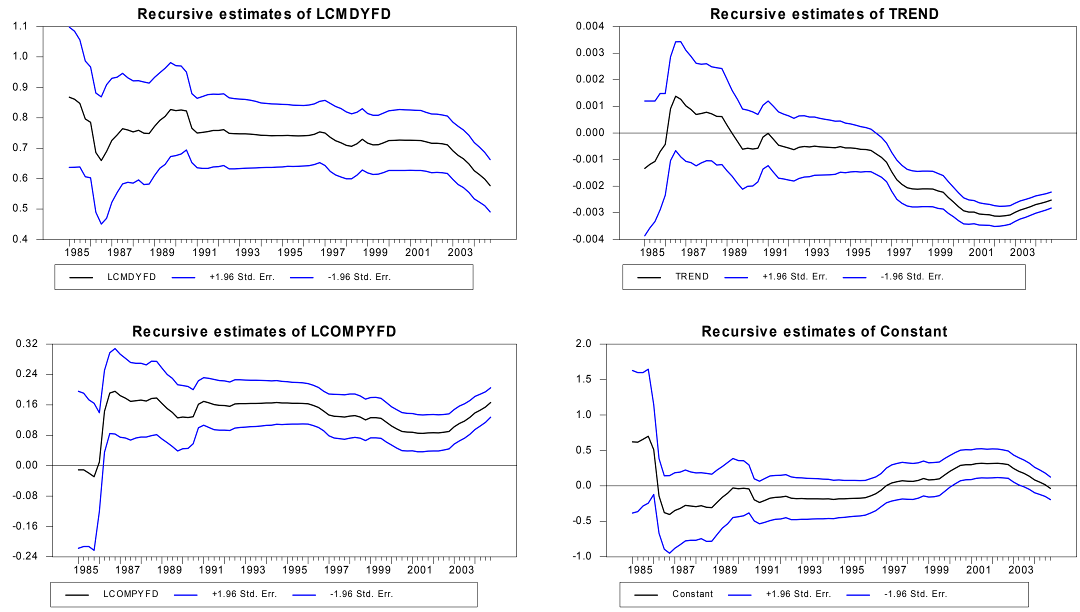




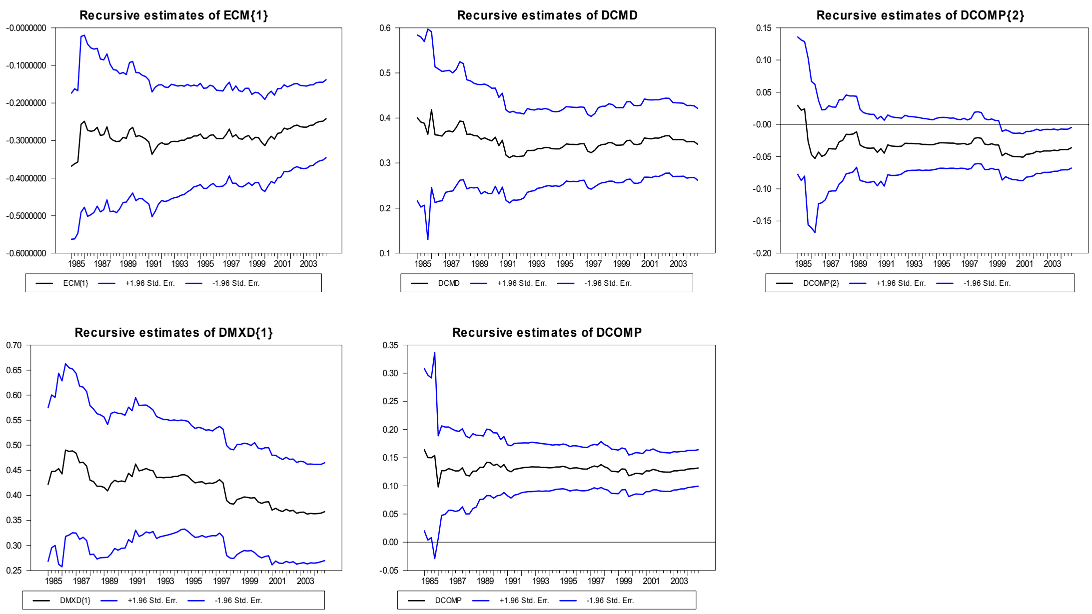


Extra-area import deflator (MXD)

Long-run equation:

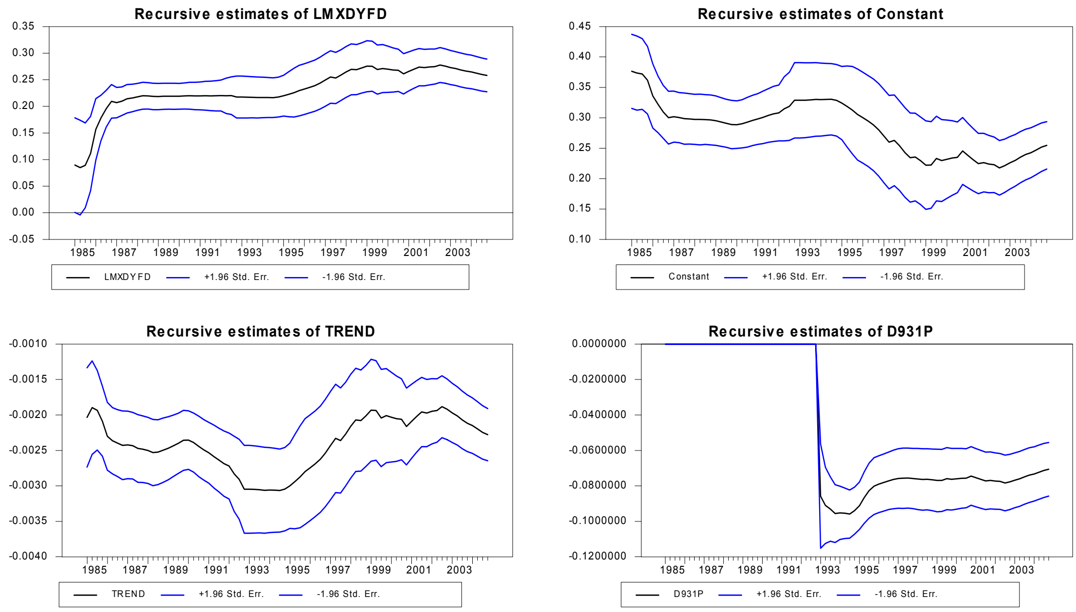


Short-run equation:

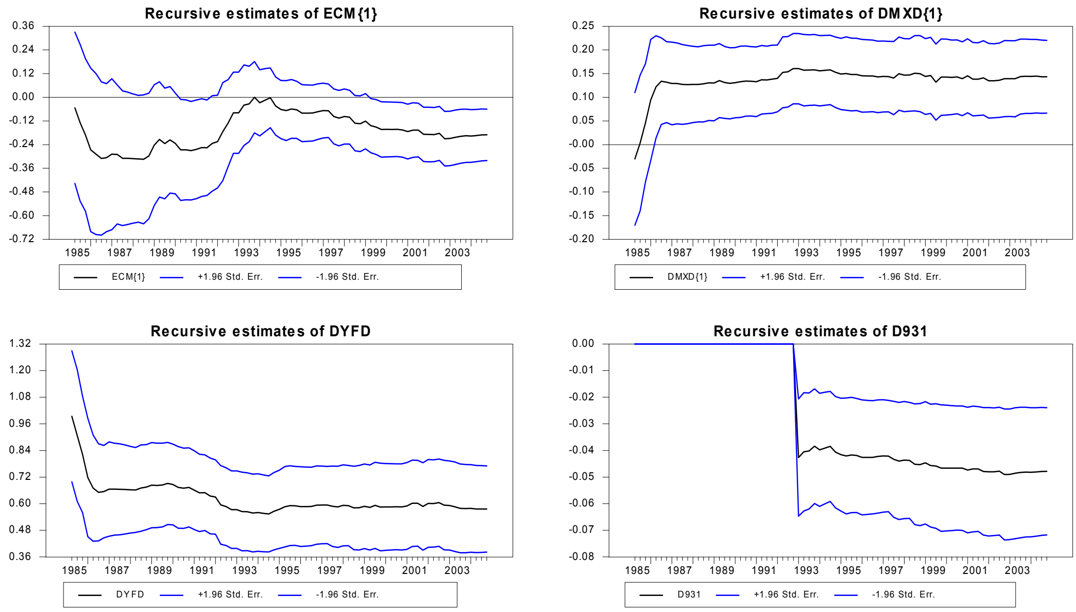


Intra-area import deflator (MND)

Long-run equation:



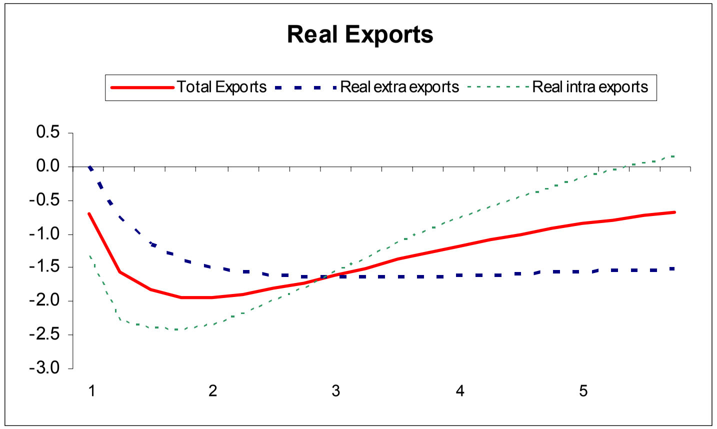
Short-run equation:

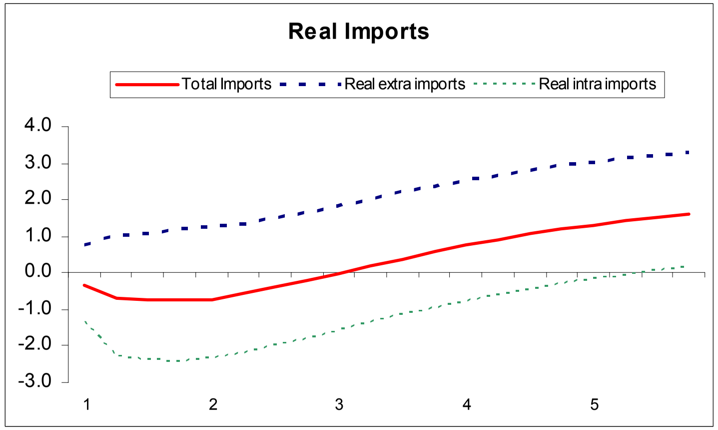


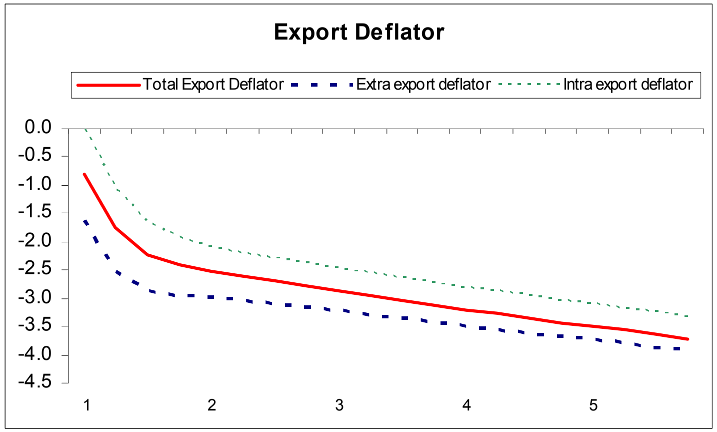
Appendix 4: Simulations results – Graphs

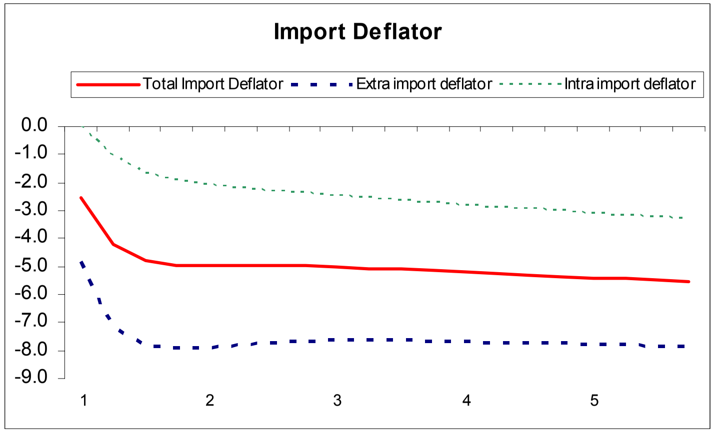
Impact of a 10% appreciation of the exchange rate

(Percent deviation from base in the first 5 years)



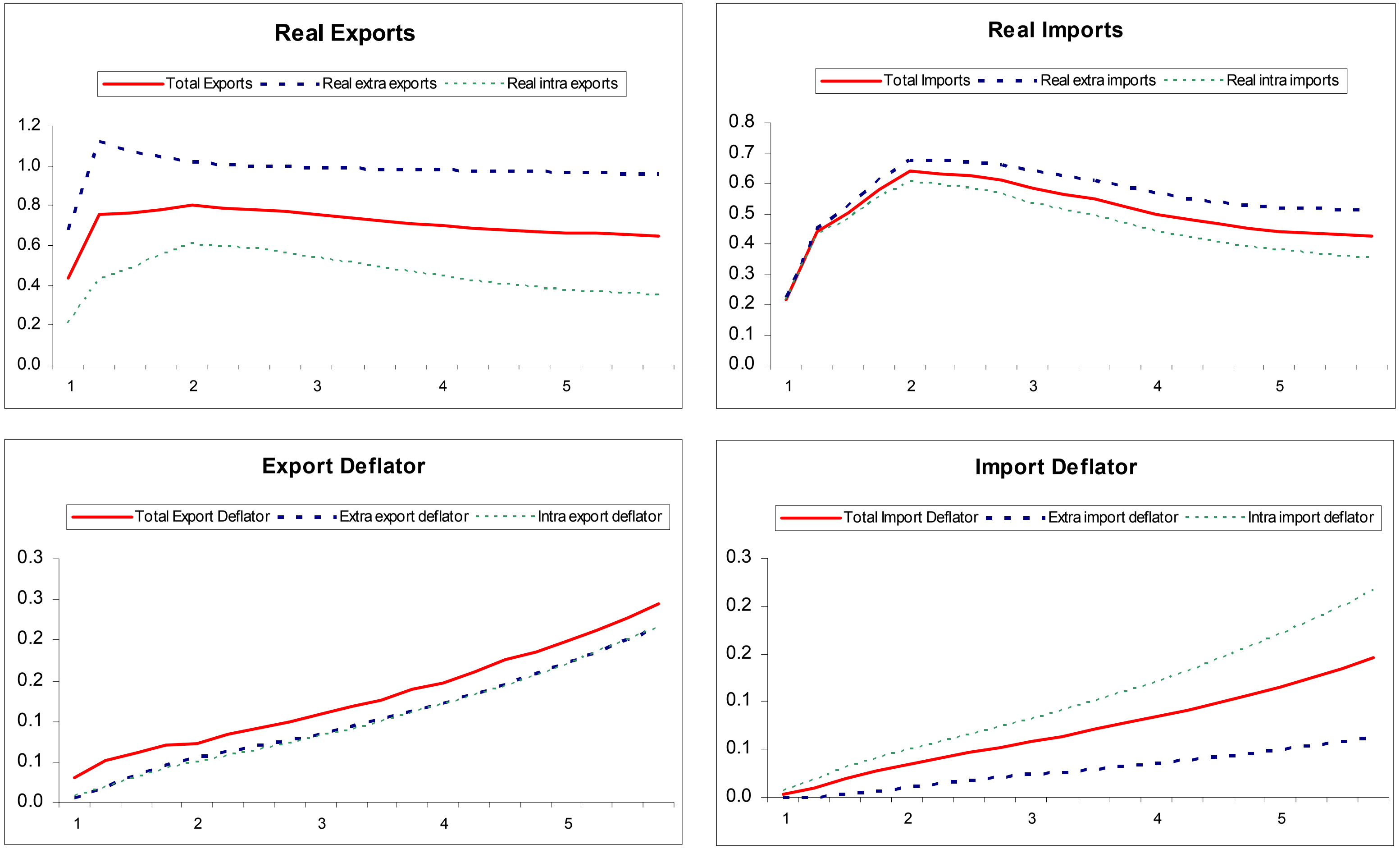






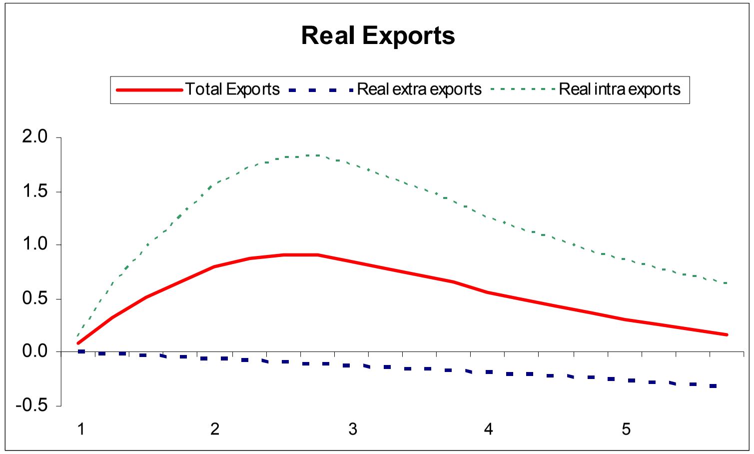
Impact of an increase in world demand by 1 %

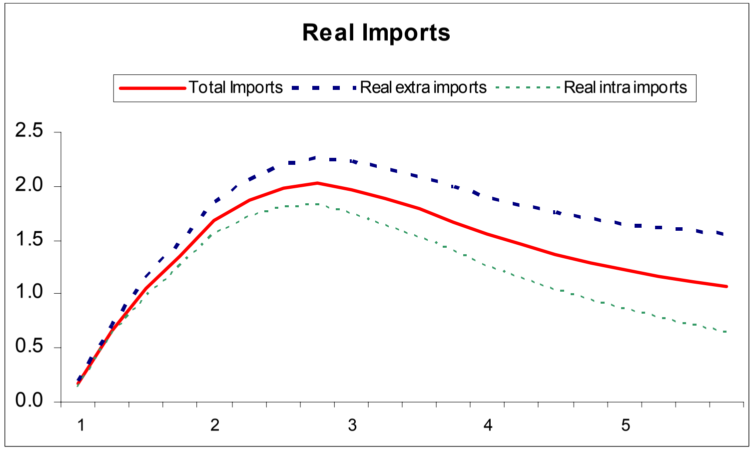
(Percent deviation from base in the first 5 years)

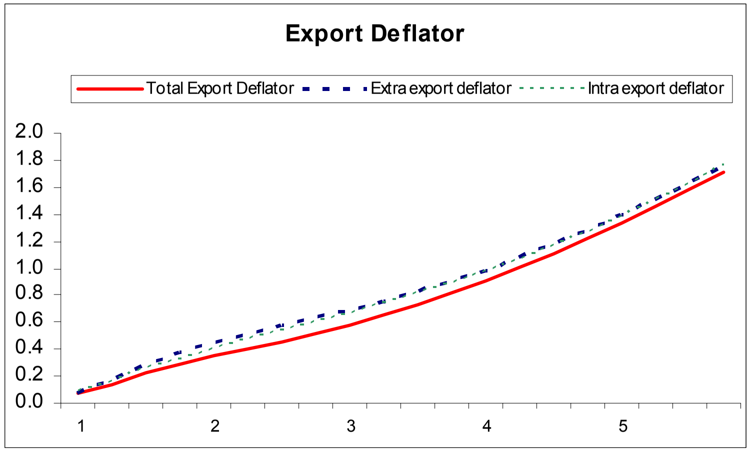


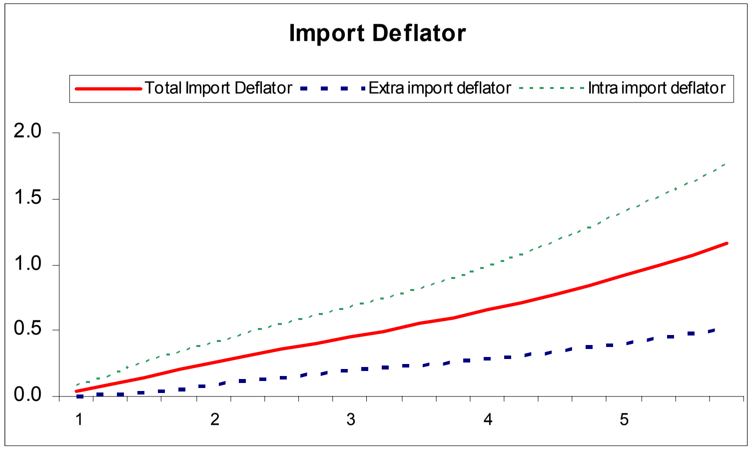
Impact of an increase in public consumption by 5 %

(Percent deviation from base in the first 5 years)









Appendix 5: Simulation results - Tables

Exchange rate appreciation 10%

Years

	1	2	3	4	5	6	7	8	9	10
Prices	Levels, percentage deviations from baseline									
HICP	-0.40	-1.04	-1.55	-1.94	-2.30	-2.67	-3.03	-3.40	-3.77	-4.17
GDP Deflator	-0.21	-0.63	-1.00	-1.35	-1.69	-2.06	-2.48	-2.92	-3.36	-3.84
Total Export Deflator	-1.83	-2.65	-3.00	-3.32	-3.61	-3.90	-4.12	-4.37	-4.68	-5.04
Extra export deflator	-2.53	-3.06	-3.32	-3.58	-3.83	-4.10	-4.40	-4.73	-5.05	-5.40
Intra export deflator	-1.19	-2.24	-2.60	-2.91	-3.21	-3.51	-3.84	-4.18	-4.53	-4.90
Total Import Deflator	-4.17	-4.97	-5.08	-5.29	-5.47	-5.70	-5.66	-5.80	-6.04	-6.31
Extra import deflator	-7.00	-7.77	-7.64	-7.72	-7.81	-7.90	-8.00	-8.10	-8.21	-8.33
Intra import deflator	-1.19	-2.24	-2.60	-2.91	-3.21	-3.51	-3.84	-4.18	-4.53	-4.90
GDP and Components	e deviations from baseline									
GDP	-0.39	-0.76	-0.89	-0.92	-0.92	-0.93	-0.95	-0.94	-0.85	-0.74
Total Exports	-1.52	-1.85	-1.44	-1.05	-0.76	-0.59	-0.25	-0.15	-0.19	-0.18
Real extra exports	-0.84	-1.58	-1.64	-1.59	-1.53	-1.47	-1.41	-1.34	-1.26	-1.18
Real intra exports	-2.12	-2.08	-1.25	-0.54	-0.01	0.28	0.68	0.72	0.61	0.57
Total Imports	-0.64	-0.48	0.29	0.98	1.46	1.73	1.93	1.88	1.71	1.61
Real extra imports	1.02	1.43	2.10	2.73	3.17	3.36	3.64	3.55	3.27	3.06
Real intra imports	-2.12	-2.09	-1.25	-0.54	-0.01	0.28	0.68	0.72	0.61	0.57
Contributions to Shock	solute deviations from baseline									
Domestic Demand	-0.11	-0.22	-0.17	-0.11	-0.05	-0.01	-0.01	-0.01	0.02	0.05
Trade Balance	-0.35	-0.54	-0.66	-0.76	-0.84	-0.91	-0.94	-0.92	-0.85	-0.78
Foreign Demand	e deviations from baseline									
World Demand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices	e deviations from baseline									
Effective Exchange Rate	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Foreign Prices (euro)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Commodity Prices (euro)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

Quarters

	1				2				3				4				5			
Prices	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HICP	-0.20	-0.33	-0.45	-0.64	-0.81	-0.97	-1.12	-1.26	-1.38	-1.50	-1.60	-1.71	-1.81	-1.90	-1.99	-2.08	-2.17	-2.26	-2.35	-2.44
GDP Deflator	-0.02	-0.15	-0.28	-0.39	-0.49	-0.58	-0.68	-0.77	-0.86	-0.95	-1.05	-1.13	-1.22	-1.31	-1.39	-1.47	-1.56	-1.64	-1.73	-1.82
Total Export Deflator	-0.79	-1.75	-2.23	-2.41	-2.52	-2.60	-2.69	-2.78	-2.88	-2.96	-3.04	-3.13	-3.20	-3.28	-3.36	-3.43	-3.50	-3.57	-3.64	-3.71
Extra export deflator	-1.63	-2.54	-2.87	-2.96	-2.99	-3.03	-3.08	-3.15	-3.22	-3.29	-3.35	-3.42	-3.48	-3.55	-3.61	-3.67	-3.73	-3.79	-3.86	-3.92
Intra export deflator	-0.01	-1.04	-1.66	-1.92	-2.09	-2.20	-2.30	-2.39	-2.47	-2.55	-2.64	-2.72	-2.80	-2.88	-2.95	-3.02	-3.10	-3.17	-3.24	-3.31
Total Import Deflator	-2.53	-4.23	-4.79	-4.95	-4.96	-4.98	-4.95	-4.98	-5.02	-5.09	-5.07	-5.14	-5.21	-5.26	-5.31	-5.36	-5.40	-5.45	-5.49	-5.55
Extra import deflator	-4.86	-7.21	-7.77	-7.92	-7.88	-7.79	-7.71	-7.66	-7.63	-7.63	-7.64	-7.66	-7.69	-7.71	-7.73	-7.76	-7.78	-7.80	-7.82	-7.84
Intra import deflator	-0.01	-1.04	-1.66	-1.92	-2.09	-2.20	-2.30	-2.39	-2.47	-2.55	-2.64	-2.72	-2.80	-2.88	-2.95	-3.02	-3.10	-3.17	-3.24	-3.31
GDP and Components																				
GDP	-0.12	-0.33	-0.49	-0.61	-0.68	-0.74	-0.79	-0.82	-0.85	-0.88	-0.90	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92
Total Exports	-0.70	-1.57	-1.81	-1.93	-1.95	-1.90	-1.81	-1.72	-1.61	-1.50	-1.37	-1.27	-1.18	-1.09	-1.00	-0.92	-0.85	-0.78	-0.72	-0.67
Real extra exports	0.00	-0.77	-1.16	-1.38	-1.50	-1.57	-1.61	-1.64	-1.64	-1.64	-1.63	-1.62	-1.61	-1.60	-1.58	-1.57	-1.56	-1.54	-1.53	-1.51
Real intra exports	-1.33	-2.28	-2.39	-2.42	-2.36	-2.19	-1.98	-1.80	-1.57	-1.38	-1.13	-0.95	-0.77	-0.61	-0.46	-0.31	-0.18	-0.06	0.05	0.14
Total Imports	-0.33	-0.71	-0.76	-0.76	-0.72	-0.57	-0.40	-0.22	-0.01	0.19	0.39	0.57	0.75	0.91	1.06	1.19	1.31	1.42	1.52	1.60
Real extra imports	0.76	1.03	1.08	1.19	1.23	1.35	1.50	1.64	1.82	1.99	2.21	2.37	2.52	2.66	2.80	2.92	3.04	3.14	3.22	3.28
Real intra imports	-1.33	-2.28	-2.39	-2.42	-2.36	-2.19	-1.98	-1.80	-1.57	-1.38	-1.13	-0.95	-0.77	-0.61	-0.46	-0.31	-0.18	-0.06	0.05	0.14
Contributions to Shock																				
Domestic Demand	-0.01	-0.07	-0.15	-0.20	-0.22	-0.22	-0.22	-0.21	-0.19	-0.18	-0.17	-0.16	-0.14	-0.12	-0.11	-0.09	-0.07	-0.06	-0.05	-0.03
Trade Balance	-0.14	-0.34	-0.42	-0.48	-0.50	-0.53	-0.56	-0.58	-0.61	-0.65	-0.68	-0.71	-0.73	-0.75	-0.77	-0.79	-0.81	-0.83	-0.85	-0.87
Foreign Demand																				
World Demand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices																				
Effective Exchange Rate	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Foreign Prices (euro)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00
Commodity Prices (euro)	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00

World demand shock

	Years									
	1	2	3	4	5	6	7	8	9	10
Prices	Levels, percentage deviations from baseline									
HICP	0.03	0.08	0.12	0.17	0.23	0.31	0.39	0.47	0.56	0.65
GDP Deflator	0.04	0.09	0.13	0.19	0.26	0.35	0.44	0.54	0.64	0.75
Total Export Deflator	0.06	0.09	0.12	0.17	0.22	0.29	0.34	0.39	0.46	0.55
Extra export deflator	0.03	0.07	0.10	0.14	0.19	0.26	0.33	0.40	0.47	0.56
Intra export deflator	0.03	0.06	0.10	0.14	0.19	0.26	0.33	0.41	0.49	0.57
Total Import Deflator	0.02	0.04	0.07	0.09	0.13	0.17	0.23	0.29	0.35	0.41
Extra import deflator	0.01	0.02	0.03	0.04	0.06	0.08	0.10	0.13	0.15	0.18
Intra import deflator	0.03	0.06	0.10	0.14	0.19	0.26	0.33	0.41	0.49	0.57
GDP and Components	e deviations from baseline									
GDP	0.15	0.17	0.19	0.19	0.20	0.19	0.18	0.16	0.15	0.14
Total Exports	0.69	0.78	0.73	0.68	0.66	0.64	0.60	0.57	0.55	0.54
Real extra exports	0.98	1.01	0.98	0.97	0.96	0.95	0.94	0.92	0.90	0.89
Real intra exports	0.42	0.59	0.50	0.41	0.36	0.34	0.33	0.31	0.29	0.29
Total Imports	0.44	0.63	0.55	0.47	0.43	0.42	0.41	0.40	0.40	0.41
Real extra imports	0.45	0.67	0.61	0.54	0.52	0.51	0.53	0.54	0.56	0.59
Real intra imports	0.43	0.59	0.50	0.41	0.36	0.34	0.33	0.31	0.29	0.29
Contributions to Shock	solute deviations from baseline									
Domestic Demand	0.07	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.07
Trade Balance	0.10	0.08	0.09	0.09	0.10	0.10	0.10	0.09	0.08	0.07
Foreign Demand	e deviations from baseline									
World Demand	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Foreign Prices	e deviations from baseline									
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Quarters																			
	1				2				3				4				5			
Prices	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HICP	0.01	0.03	0.04	0.06	0.07	0.08	0.09	0.09	0.10	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.22	0.24	0.26
GDP Deflator	0.01	0.03	0.05	0.07	0.08	0.09	0.10	0.10	0.12	0.13	0.14	0.15	0.17	0.18	0.20	0.21	0.23	0.25	0.27	0.29
Total Export Deflator	0.03	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.20	0.21	0.23	0.24
Extra export deflator	0.01	0.02	0.03	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.17	0.19	0.20	0.22
Intra export deflator	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.20	0.22
Total Import Deflator	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15
Extra import deflator	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06
Intra import deflator	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.20	0.22
GDP and Components																				
GDP	0.09	0.17	0.18	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.20	0.20
Total Exports	0.43	0.76	0.76	0.78	0.80	0.79	0.78	0.77	0.75	0.74	0.73	0.71	0.70	0.69	0.68	0.67	0.67	0.66	0.66	0.65
Real extra exports	0.68	1.12	1.07	1.04	1.02	1.01	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.96	0.96
Real intra exports	0.21	0.43	0.48	0.55	0.61	0.59	0.58	0.56	0.54	0.51	0.49	0.47	0.44	0.42	0.40	0.39	0.38	0.37	0.36	0.35
Total Imports	0.22	0.44	0.50	0.58	0.64	0.63	0.62	0.61	0.58	0.56	0.55	0.52	0.50	0.48	0.47	0.45	0.44	0.44	0.43	0.43
Real extra imports	0.22	0.45	0.52	0.61	0.68	0.68	0.67	0.66	0.64	0.62	0.61	0.59	0.57	0.55	0.54	0.53	0.52	0.52	0.51	0.51
Real intra imports	0.21	0.43	0.48	0.55	0.61	0.59	0.58	0.56	0.54	0.51	0.49	0.47	0.44	0.42	0.40	0.39	0.38	0.37	0.36	0.35
Contributions to Shock																				
Domestic Demand	0.03	0.07	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Trade Balance	0.08	0.13	0.11	0.09	0.08	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Foreign Demand																				
World Demand	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Foreign Prices																				
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Public consumption shock

	Years									
	1	2	3	4	5	6	7	8	9	10
Prices	Levels, percentage deviations from baseline									
HICP	0.19	0.56	0.88	1.27	1.78	2.37	2.99	3.62	4.28	4.96
GDP Deflator	0.35	0.75	1.09	1.54	2.14	2.82	3.55	4.30	5.04	5.82
Total Export Deflator	0.19	0.43	0.69	1.06	1.52	2.04	2.64	3.24	3.83	4.45
Extra export deflator	0.24	0.55	0.80	1.13	1.57	2.08	2.62	3.17	3.72	4.30
Intra export deflator	0.22	0.50	0.78	1.12	1.57	2.09	2.68	3.25	3.84	4.46
Total Import Deflator	0.13	0.33	0.52	0.75	1.04	1.37	1.87	2.33	2.76	3.19
Extra import deflator	0.04	0.13	0.23	0.33	0.46	0.62	0.81	1.00	1.19	1.38
Intra import deflator	0.22	0.50	0.78	1.12	1.57	2.09	2.68	3.25	3.84	4.46
GDP and Components	e deviations from baseline									
GDP	1.32	1.51	1.50	1.46	1.38	1.26	1.11	0.99	0.90	0.81
Total Exports	0.40	0.87	0.75	0.47	0.24	0.06	0.02	0.00	-0.04	-0.09
Real extra exports	-0.02	-0.08	-0.14	-0.21	-0.29	-0.39	-0.51	-0.63	-0.75	-0.87
Real intra exports	0.77	1.72	1.58	1.10	0.74	0.50	0.45	0.46	0.48	0.51
Total Imports	0.83	1.89	1.83	1.42	1.14	0.99	0.98	1.08	1.20	1.35
Real extra imports	0.89	2.09	2.12	1.79	1.60	1.55	1.71	1.96	2.23	2.52
Real intra imports	0.77	1.72	1.58	1.10	0.74	0.50	0.45	0.46	0.48	0.51
Contributions to Shock	solute deviations from baseline									
Domestic Demand	1.62	1.77	1.75	1.73	1.68	1.61	1.53	1.49	1.47	1.45
Trade Balance	-0.15	-0.36	-0.37	-0.33	-0.33	-0.36	-0.41	-0.49	-0.56	-0.62
Foreign Demand	e deviations from baseline									
World Demand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices	e deviations from baseline									
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Quarters																			
	1				2				3				4				5			
Prices	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HICP	0.03	0.13	0.25	0.35	0.44	0.52	0.60	0.67	0.75	0.83	0.92	1.01	1.10	1.21	1.32	1.44	1.57	1.71	1.85	1.99
GDP Deflator	0.15	0.27	0.43	0.53	0.62	0.71	0.79	0.86	0.95	1.03	1.13	1.23	1.35	1.47	1.61	1.75	1.90	2.05	2.22	2.38
Total Export Deflator	0.07	0.14	0.23	0.29	0.35	0.40	0.45	0.51	0.57	0.65	0.73	0.81	0.91	1.01	1.10	1.22	1.34	1.46	1.58	1.71
Extra export deflator	0.08	0.17	0.29	0.38	0.45	0.52	0.58	0.64	0.70	0.76	0.83	0.90	0.99	1.08	1.18	1.28	1.39	1.51	1.63	1.75
Intra export deflator	0.08	0.16	0.26	0.33	0.40	0.47	0.54	0.60	0.67	0.74	0.81	0.89	0.98	1.07	1.17	1.28	1.39	1.51	1.63	1.76
Total Import Deflator	0.04	0.08	0.15	0.20	0.26	0.31	0.36	0.40	0.45	0.50	0.55	0.60	0.65	0.71	0.78	0.84	0.92	1.00	1.08	1.16
Extra import deflator	0.00	0.01	0.03	0.06	0.09	0.12	0.14	0.17	0.19	0.22	0.24	0.26	0.28	0.31	0.34	0.37	0.40	0.44	0.48	0.52
Intra import deflator	0.08	0.16	0.26	0.33	0.40	0.47	0.54	0.60	0.67	0.74	0.81	0.89	0.98	1.07	1.17	1.28	1.39	1.51	1.63	1.76
GDP and Components																				
GDP	1.08	1.32	1.41	1.45	1.48	1.50	1.52	1.53	1.52	1.50	1.49	1.48	1.48	1.47	1.46	1.44	1.43	1.40	1.37	1.34
Total Exports	0.08	0.33	0.51	0.65	0.79	0.88	0.92	0.90	0.85	0.78	0.72	0.65	0.57	0.50	0.44	0.37	0.31	0.26	0.21	0.16
Real extra exports	0.00	-0.01	-0.02	-0.04	-0.06	-0.07	-0.09	-0.11	-0.12	-0.13	-0.15	-0.16	-0.18	-0.20	-0.21	-0.23	-0.26	-0.28	-0.30	-0.33
Real intra exports	0.15	0.62	0.98	1.25	1.55	1.72	1.81	1.82	1.75	1.64	1.53	1.40	1.26	1.15	1.04	0.94	0.86	0.78	0.70	0.64
Total Imports	0.17	0.66	1.06	1.36	1.68	1.87	1.99	2.02	1.97	1.88	1.79	1.67	1.56	1.46	1.37	1.29	1.23	1.17	1.11	1.07
Real extra imports	0.20	0.71	1.14	1.48	1.83	2.06	2.20	2.26	2.24	2.17	2.10	2.00	1.90	1.83	1.76	1.69	1.65	1.61	1.58	1.56
Real intra imports	0.15	0.62	0.98	1.25	1.55	1.72	1.81	1.82	1.75	1.64	1.53	1.40	1.26	1.15	1.04	0.94	0.86	0.78	0.70	0.64
Contributions to Shock																				
Domestic Demand	1.39	1.64	1.71	1.74	1.76	1.78	1.78	1.78	1.77	1.75	1.73	1.73	1.73	1.73	1.72	1.71	1.71	1.69	1.67	1.65
Trade Balance	-0.03	-0.12	-0.19	-0.26	-0.32	-0.35	-0.37	-0.38	-0.38	-0.37	-0.36	-0.35	-0.34	-0.34	-0.32	-0.32	-0.32	-0.32	-0.33	-0.33
Foreign Demand																				
World Demand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices																				
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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