ESTIMATION OF ARMINGTON ELASTICITIES IN AN ENERGY CGE MODEL FOR EUROPE

Gabriella Németh, László Szabó and Juan Carlos Ciscar (*)

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ABSTRACT

The main purpose of the present article is to econometrically estimate the Armington elasticities of the computable general equilibrium model called GEM-E3 and, in particular, the energy-related sectors. In the estimation we follow the model's staged budget optimisation procedure of the consumer by first optimising between domestically produced and imported goods, and then by country of origin. We estimate the Armington elasticities in a panel data econometric framework with dynamic adjustment to capture both the long and short term elasticities for five aggregated sectors of Europe. The estimated long-term elasticities are in line with the literature, but higher than those used in the GEM-E3 model. The results suggest that in general consumer choice appear to be more price sensitive between the domestic and the composite imported goods and amongst the importers than assumed in the model.

I. INTRODUCTION

Computable general equilibrium (CGE) models are used to assess the economic consequences of shocks or policies, such as trade and environmental policies. CGE models have a solid data basis since they are calibrated to reproduce National

Accounts information. Those models also heavily rely on microeconomic theory, which justifies the use of CGE models for policy support.

In the context of climate policies, particularly after the 1997 Kyoto Protocol on climate policy, CGE models have been extensively used to evaluate the costs of mitigation policies (e.g. Weyant and Hill, 1999). Russ et al. (2007) explore the mitigation costs of global climate policies consistent with the 2 degrees target of the EU, which recently committed to a 20% reduction in greenhouse gas emissions in 2020 compared to the 1990 levels.

Concerning the calibration of CGE models, some key parameters need to be specified using exogenous information beyond that of the National Accounts statistics, in particular, the values of the elasticity parameters in the production and trade parts of the model. Those elasticities can play a major role in the overall results as they determine the degree to which agents respond to price changes.

Most of the CGE models apply the Armington assumption (Armington, 1969) in order to represent the differentiation of domestically produced and imported products and the differentiation of imported goods by country of origin. The value of the Armington elasticities is crucial for the determination of trade effects in the CGE framework as the effects of trade, and environmental policies on prices and quantities of domestic and imported goods can vary significantly.

There are two ways to calibrate those elasticities: statistical analysis or taking values from similar studies in the literature. Due to data problems, most CGE models take the elasticities from the existing literature. Hence, the lack of statistical validation of these parameters is one of the major critiques to CGE models.

There is a small number of econometric estimations on the Armington elasticities, in spite of its relatively wide-spread use in CGE models. As these elasticities are region, time and sector specific, there is even more limited number of models where these estimations are adjusted to the model specifications. There are three studies that we have taken as references for the elaboration of our estimation structure. Gallaway et al. (2003) estimate the elasticities of the upper level nest for the US using monthly data from 309 manufacturing industries. They employ co-integration analysis and conclude that on average long term elasticities are around twice the values of the short term elasticities.

Welsch (2006) also uses co-integration techniques to estimate the upper level Armington elasticities, using annual data for France. He concludes that the elasticities are time dependant and finds an average elasticity of around 0.2 for the end of the sample analysed, a value much lower than those usually employed in CGE models. Saito (2004) makes an empirical analysis of the Armington elasticities for 14 OECD countries comparing the estimated elasticities coming from multilateral trade data with those coming from bilateral trade data. He notes that as there is an increasing tendency in trading intermediate inputs, and this is not well captured in multilateral data, one should pay attention to estimates coming from multilateral trade.

The main purpose of the present article is to econometrically estimate the Armington elasticities for Europe of the CGE GEM-E3 model and, in particular, the energy-related sectors. In the GEM-E3 model the consumers have a three-stage budget optimisation procedure. First, they decide how much to spend on each product, then consumers optimise between domestically produced and imported goods (this we call NEST1 or upper nest with elasticity σ_1); and finally the imported goods are differentiated according to their country of origin (NEST2 or lower nest with elasticity σ_2). This nesting structure reflects the application of the Armington assumption of differentiated goods by origin in the GEM-E3 model.

Estimates for the Armington elasticities for NEST1 and NEST2 are based on recent bilateral trade data for the European version of the GEM-E3 model. It was decided to estimate the elasticities of the European model, rather than those of the world model, because, first, there exists data for the European countries from EUROSTAT (COMEXT) and, secondly, they are rather harmonised with the model's data structure (SAM and sectoral breakdown). In particular, the structure of the database replicates the structure of the GEM-E3 model. The import quantity and price variables are proxied by index numbers through the application of sectoral value added deflators.

The two nests of the GEM-E3 model are estimated separately in a panel data analysis econometric framework where both short and long-term elasticities are estimated by using dynamic adjustments. The linkage between the two nests is the common database for imported goods. The sample covers yearly data for the 1995-2005 period.

The relationship between the two different levels of elasticities in GEM-E3, as in the majority of the CGE models, is set so that σ_2 is higher than σ_1. This goes in line with the findings of Shiells and Reinert (1993). These authors have demonstrated that in a two-level nested structure the higher σ_1 with respect to σ_2, the higher the terms-of-trade-effects of the Armington elasticities.

The article is divided into six sections, including this introduction. Section 2 presents in detail the implementation of the Armington scheme in the GEM-E3 model. Section 3 discusses the specification of the empirical model to be estimated. Section 4 explains the specific data sources. Section 5 analyses the main results obtained so far. Finally, Section 6 presents the concluding remarks.

II. ARMINGTON ELASTICITIES IN GEM-E3

The Armington elasticities are represented in the model in a two-level structure mimicking the two last steps of the optimisation in the budgeting procedure. The CES functional forms for the simulation of the consumption of the composite goods are the following at the different nests:

NEST 1. [1]

(1) Max $Y^{i,t} = \left[\left(\delta_1^i \cdot XXD^{i,t} \right)^{\frac{\sigma_1^i - 1}{\sigma_1^i}} + \left(1 - \delta_1^i \cdot IMP^{i,t} \right)^{\frac{\sigma_1 - 1}{\sigma_1}} \right]^{\frac{\sigma_1^i}{\sigma_1^i - 1}}$;

(2) s.t. $PY^{i,t} \cdot Y^{i,t} = PXD^{i,t} \cdot XXD^{i,t} + PIMP^{i,t} \cdot IMP^{i,t}$;

(3) 1st order condition:

$$\frac{IMP^{i,t}}{XXD^{i,t}} = \left(\frac{1 - \delta_1^i}{\delta_1^i} \right)^{\sigma_1^i} \cdot \left(\frac{PXD^{i,t}}{PIMP^{i,t}} \right)^{\sigma_1^i};$$

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[1] Notation:

- Indices: ´*i*´ for sector, ´*t*´ for time, ´*j*´ for country of import destination (reporting country), ´*k*´ and ´*l*´ countries of import origin (partner countries)
- XXD and PXD stand for the quantity and price of domestically produced and consumed goods
- IMP and PIMP are quantities and prices of imports
- δ is a distribution parameter
- σ_1 is the Armington substitution elasticity between domestically produced and imported goods (NEST1).
- σ_2 is the Armington substitution elasticity between the imported goods differentiated by country of origin (NEST2).

NEST 2.

(4) Max $$IMP_j^{i,t} = \sum_{j \neq k} \delta_{2\,jk}^{i} \cdot \left(IMP_{j,k}^{i,t}\right)^{\frac{\sigma_2^i - 1}{\sigma_2^i}};$$

(5) s.t. $$PIMP_j^{i,t} \cdot IMP_j^{i,t} = \sum_{j \neq k} PIMP_{j,k}^{i,t} \cdot IMP_{j,k}^{i,t};$$

(6) 1st order condition:

$$\frac{IMP_{j,k}^{i,t}}{IMP_{j,l}^{i,t}} = \left(\frac{\delta_{2\,j,l}^{i}}{\delta_{2\,j,l}^{i}}\right)^{\sigma_2} \cdot \left(\frac{PIMP_{j,l}^{i,t}}{PIMP_{j,k}^{i,t}}\right)^{\sigma_2};$$

In the GEM-E3 model the Armington elasticities are applied for the total demand of each sector in line with the assumption that the buyer's decision is uniform throughout the economy. It also means that the applied elasticities are the same within each sector for all countries; however, they differ among sectors.

According to theory, the Armington elasticity applies to tradable and competitive goods. It is important to highlight that the GEM-E3 model distinguishes, on the one hand, between tradable and non-tradable goods, and on the other hand, between competitive and non-competitive goods. For non-tradable goods only price elasticities are taken, and they have a general share below 5%. On the other hand, the presence of non-competitive goods in the economy are much higher and in GEM-E3 they represent as much as the competitive goods. The database used in this exercise includes all imports due to the lack of data availability on non-tradable, non-competitive or intermediate goods

The values for the Armington elasticities applied in the GEM-E3 model (see last columns of Table 4 and 5 for NEST1 and for NEST2) fall in the interval of 0,4-1,7 for NEST1 (σ_1) and between 0,8-2,4 for NEST2 (σ_2). In the highly competitive sectors such as energy intensive or consumer goods the values are normally higher than unity, while in the case of energy sectors like oil or gas, where the products are more homogeneous, the values tend to be around unity.

III. METHODOLOGY

III.1. Functional relationships among variables

For representing the functional relationship among variables in the estimation of the Armington elasticities we have opted for a pure theoretical approach and have estimated the logarithm of the first order conditions of the CES functions presented in equations (3) and (6). Thus, for mimicking the choice between the imported and domestically produced for NEST1 we obtain the following equation:

(7) $\ln\left(\frac{IMP_j^{i,t}}{XXD_j^{i,t}}\right) = \sigma_1^i \cdot \ln\left(\frac{1-\delta_{1i}}{\delta_{1i}}\right) + \sigma_1^i \cdot \ln\left(\frac{PXD_j^{i,t}}{PIMP_j^{i,t}}\right)$ that leads to

(8) $\ln\left(\frac{IMP_j^{i,t}}{XXD_j^{i,t}}\right) = a_1 + \sigma_1^i \cdot \ln\left(\frac{PXD_j^{i,t}}{PIMP_j^{i,t}}\right) + \varepsilon..$, where $a_1 = \sigma_1 \cdot \ln\left(\frac{1-\delta_{1i}}{\delta_{1i}}\right)$.

In order to mimic long run adjustments in the consumption of the composite goods, we introduce a dynamic effect in our estimation and put the lagged explained variable on the right hand side of the equation.

(9) $\ln\left(\frac{IMP_j^{i,t}}{XXD_j^{i,t}}\right) = a_1^i + \beta_1^i \cdot \ln\left(\frac{IMP_j^{i,(t-1)}}{XXD_j^{i,(t-1)}}\right) + \sigma_1^i \cdot \ln\left(\frac{PXD_j^{i,t}}{PIMP_j^{i,t}}\right) + \varepsilon..$

So, equation (9) permits for the calculation of long run elasticity[2], σ_1^L, from the directly obtained short run elasticity σ_1^i as $\sigma_1^{L,i} = \frac{\sigma_1^i}{1-\beta_1^i}$.

For NEST2 we aim at reproducing the choice between the imports from different partner countries in the following way and also apply a pure theoretical method:

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[2] Demonstration of the calculation of the long run elasticity: C stands for consumption, Y for income and P for prices. Short run elasticity: $C_t = a + b \cdot Y_t + c \cdot P_t$

Calculating the long run elasticity: $C_t = \gamma \cdot C_{t-1} + a + b \cdot Y_t + c \cdot P_t$

Assuming steady growth on the long run implies that consumption does not vary significantly from year to year, so that on the long run $C_t \approx C_{t-1}$.

$$C_t \cdot (1-\gamma) = a + b \cdot Y_t + c \cdot P_t$$

$$C_t = \frac{a}{(1-\gamma)} + \frac{b}{(1-\gamma)} \cdot Y_t + \frac{c}{(1-\gamma)} \cdot P_t$$

(10) $\ln\left(\frac{IMP_{j,k}^{i,t}}{IMP_{j,l}^{i,t}}\right)=\sigma_2^i\cdot\ln\left(\frac{\delta_{2j,l}^i}{\delta_{2j,k}^i}\right)+\sigma_2^i\cdot\ln\left(\frac{PIMP_{j,l}^{i,t}}{PIMP_{j,k}^{i,t}}\right);$

(11) $\ln\left(\frac{IMP_{j,k}^{i,t}}{IMP_{j,l}^{i,t}}\right)=a_2+\sigma_2^i\cdot\ln\left(\frac{PIMP_{j,l}^{i,t}}{PIMP_{j,k}^{i,t}}\right)+\varepsilon..$, where $a_2=\sigma_2^i\cdot\ln\left(\frac{\delta_{2j,l}^i}{\delta_{2j,k}^i}\right)$

By introducing the dynamic effect we obtain:

(12) $\ln\left(\frac{IMP_{j,k}^{i,t}}{IMP_{j,l}^{i,t}}\right)=a_2^i+\beta_2^i\ln\left(\frac{IMP_{j,k}^{i,(t-1)}}{IMP_{j,l}^{i,(t-1)}}\right)+\sigma_2^i\cdot\ln\left(\frac{PIMP_{j,l}^{i,t}}{PIMP_{j,k}^{i,t}}\right)+\varepsilon..$, where the long term elasticity is obtained in the following way: $\sigma_2^{L,i}=\frac{\sigma_2^i}{1-\beta_2^i}$.

Moreover, in order to catch possibly different consumption and substitution patterns among the EU15 countries and the new EU member states, we distinguish these two groups with dummy variables in the estimations.

III.2. Econometric considerations

We estimate the Armington elasticities in a panel data econometric framework, where the two nests of the GEM-E3 model are estimated separately. The linkage between these two nests is created by the common database for imported goods. This means that the data used at NEST2, where we have information on the country of origin of imports, is aggregated for NEST1 where the choice between the imported and domestic goods is replicated.

The main reason of opting for panel data analysis was to account for individual heterogeneity among countries and control for possibly biased results originating from this fact. Moreover, with the panel data analysis we can also avoid biases that might result from aggregation over countries. Furthermore, by having cross section information on domestic production and trade for the EU25 countries over the period of 1995-2005 it helps to overcome multicollinearity problems that could have been present by applying a simple time series dataset. This also means that by having more informative data we obtain more variability, higher degrees of freedom and more efficiency.

On of the main objectives of our estimations is to capture dynamic adjustment effects. Therefore, we have applied the mentioned lagged dependent variable in the regression. By doing so, however, we should be aware of some theoretical problems that might arise from the weakly exogenous regressor (in our case $\ln\left(\frac{IMP_j^{i,(t-1)}}{XXD_j^{i,(t-1)}}\right)$ in NEST1 and $\ln\left(\frac{IMP_{j,k}^{i,(t-1)}}{IMP_{j,l}^{i,(t-1)}}\right)$ in NEST2) with fixed effect estimation. The problem is that the ortogonality conditions are not fulfilled anymore and the constant term of the dynamic equation does not account for the unobserved heterogeneity. In these cases the estimates will be biased and / or inconsistent.

In order to circumvent this problem we have applied instrumental variables (IV) and have found that the second lag of the explanatory variables are the best instruments. Thus, we have used the IV estimation the regressors of $\ln\left(\frac{IMP_j^{i,(t-2)}}{XXD_j^{i,(t-2)}}\right)$ in NEST1 and $\ln\left(\frac{IMP_{j,k}^{i,(t-2)}}{IMP_{j,l}^{i,(t-2)}}\right)$ in NEST2.

Moreover, random effect and fixed effect models were contrasted for the IV regressions, a common approach to estimate unobservable effects in a panel model. Before proceeding with the grouping of the sectors and carrying out the estimations group by group, it is decided through a correlation contrast procedure whether the NEST1 and NEST2 observations follow a fixed or a random effect model. This procedure focuses on determining the significance of the country effects at the different nests. The results of these pre-estimations show that for the NEST1 dataset a fixed effect model is preferred, while at NEST2 the country effect is not significant, thus indicating the application of a random effects model.

IV. DATA

Empirical studies with estimation on both nests of the Armington CES functions' elasticities based on the same database are very few in the literature. The majority of the relatively low number of estimations is carried out on NEST1. One of the main reasons of this circumstance is the serious limitations for obtaining reliable databases on which the estimations can be done.

For our estimations we have obtained data on production and trade at country level from Eurostat. In the case of domestic production data is at NACE 31 aggregation, while for trade data we have used the COMEXT database at CN8 level. Firstly, we have reproduced the sectoral breakdown of the tradable sectors of GEM-E3; therefore, the sectoral aggregation was the following: 1) agriculture, 2) coal, 3) oil, 4) gas, 5) electricity, 6) ferrous and non-ferrous metals, 7) chemical products, 8) other energy intensive products, 9) transport equipment, 10) other equipment and 11) consumer goods.

Secondly, in order to obtain more robust results in the estimations, the above mentioned 11 tradable sectors were aggregated into 5 main groups as follows:

- Group1: "agriculture" (data only from agriculture sector)
- Group2: "manufacturing" (all manufacturing sectors: ferrous and non-ferrous metals, chemical products, other energy intensive products, electronic equipments, transport equipments, other equipments), it has also been split into
    - "energy intensive manufacturing" (ferrous and non-ferrous metals, chemical products, other energy intensive products) and
    - "other manufacturing" (electronic equipments, transport equipments, other equipments)
- Group3: "consumption goods" (all consumer goods)
- Group4: " electricity"
- Group5: "energy" including the sectors of coal, oil and gas.
    - Additional energy sector "ALL_Energy" including electricity, coal, oil and gas.

The database covers the EU25 countries; however, Ireland, Malta and Cyprus are excluded since we could not adjust the domestic production to the corresponding trade data for the lack of information on the value added deflator in the same sectoral breakdown. An important aspect of the database is that data is limited to Europe on both on the origin and destination side of trade. It means that in sectors with higher extra EU import, the analysis covers only limited part of trade. However, as the next table illustrates, in most of the manufacturing and consumption goods (and sectors) the intra EU-trade is dominant with 60 to 75 %. These are the sectors like machinery, transport equipment, chemical and related sectors, consumption goods (food, drinks and tobacco). Similar pattern is traceable at the products level as well. But the raw material sector have different characteristics: almost half of sectoral trade is accomplished with extra-EU partner. Nevertheless, in the last years an increasing tendency of intra-EU commerce can be observed. The third category of sectors is formed by the mineral fuels, lubricants and related materials sector, in which Europe is dependent on exports from other regions.

Additionally the table also shows that these import shares were also rather constant over the given period.

Table 1: Value Shares in Total Import %

Sectors	**Trade-type**	**1999**	**2001**	**2003**	**2005**	**2007**
Mineral fuels, lubricants and related materials	Intra EU-27 trade	32.4	31.4	32.4	32.9	32.3
	Extra EU-27 trade	67.6	68.6	67.6	67.1	67.7
Raw materials	Intra EU-27 trade	54.4	53.2	56.8	57.1	57.1
	Extra EU-27 trade	45.6	46.8	43.2	42.9	42.9
Chemicals and related products, n.e.s.	Intra EU-27 trade	76.1	75.7	77	77.4	76.9
	Extra EU-27 trade	23.9	24.3	23	22.6	23.1
Machinery and transport equipment	Intra EU-27 trade	67.6	67.6	68.9	68.2	70.2
	Extra EU-27 trade	32.4	32.4	31.1	31.8	29.8
Food, drinks and tobacco	Intra EU-27 trade	72.7	72.5	74	74.5	74.3
	Extra EU-27 trade	27.3	27.5	26	25.5	25.7
Other manufactured products	Intra EU-27 trade	67.2	65.8	67.6	66.3	64.7
	Extra EU-27 trade	32.8	34.2	32.4	33.7	35.3
Total - All products	Intra EU-27 trade	66.2	64.6	66.1	64.5	64.3
	Extra EU-27 trade	33.8	35.4	33.9	35.5	35.7

Source: EUROSTAT 2008

The constructed database represents an unbalanced panel. On the one hand, not all countries are necessarily producing and /or trading with all commodities, and on the other hand, for the new member states we have data only for the period of 1999-2005, whereas for the EU15 data covers the period of 11 years, 1995-2005.

The estimation of the Armington elasticities requires data, on the one hand, on domestic production, exports and imports by sectors and countries for NEST1, and on the other hand, more detailed import data is needed for NEST2 that informs about the country of origin of imports. It should be noted that Eurostat reports both exports and imports at free on board prices, which enable us to convert export data into import by inverting the trade values reported by reporting and partner countries. The advantages of using this indirect import data is that the export information is more reliable compared to the import data.

The import quantity and price variables are proxied by index numbers through the application of sectoral value added deflators. The construction of the four proxies of the variables was done in the following way where the approach proposed by Welsch (2006) was taken as reference:

1) XXD stands for the domestic consumption of domestically produced goods. This means to take the difference of the gross output in constant terms (1995 prices) minus the sectoral aggregation of exports in constant terms. In both cases the sectoral value added deflator of the producing country (here the reporting country) was used for converting the directly obtained values in current terms to constant ones. It is used in NEST1.

2) PXD is for the price of domestically produced and consumed goods, which is proxied by the sectoral value added deflator of the reporting country. It is used in NEST1.

3) IMP stands for the value of imported goods from different EU countries to the reporting country in constant terms (1995), where also the producers' value added deflator was applied which in this case meant the partner country's deflator. In NEST1 the import values were aggregated by sector and reporting country, while at NEST2 the information on the country of origin was maintained in order to create the pair-wise binomial combinations present as the explained variable in equation (13).

4) PIMP is the variable for import prices proxied by the value added deflator of the partner country as it is the producer of the imported goods. At both nests the value added deflator is adjusted in order to adequate it to the structure and aggregation level of the variable IMP.

The following tables give a summary on the obtained dataset for both NEST1 and NEST2.

Table 2. Descriptive statistics of the groups for NEST1

		Obs	Mean	Std.Dev.	Min	Max
NEST 1	**AGRICULTURE**					
	IMP/XXD	220	1.136029	10.46321	0.018987	154.4908
	PXD/PIMP	220	1.074984	0.202713	0.553402	2.03978
	MANUFACTURING					
	IMP/XXD	1103	4.676174	54.58574	0.058603	1626.366
	PXD/PIMP	1103	1.080796	0.253768	0.236885	3.120694
	Energy intensive manufacturing					
	IMP/XXD	597	1.421361	6.587102	0.058603	124.8076
	PXD/PIMP	597	1.080408	0.198307	0.70198	2.046747
	Other manufacturing					
	IMP/XXD	506	8.516339	80.14685	0.225262	1626.366
	PXD/PIMP	506	1.081254	0.306783	0.236885	3.120694
	CONSUMPTION GOODS					
	IMP/XXD	193	2.077349	9.672436	0.15404	125.0441
	PXD/PIMP	193	1.069397	0.203223	0.689281	1.649841
	ELECTRICITY					
	IMP/XXD	201	0.022198	0.03386	1.86E-07	0.227512
	PXD/PIMP	201	1.205103	0.37675	0.530925	2.481216
	ENERGY					
	IMP/XXD	193	0.525298	1.097214	0.019639	12.75658
	PXD/PIMP	193	1.149219	0.641648	0.306761	5.037728
	All_energy					
	IMP/XXD	394	0.26864	0.807558	1.86E-07	12.75658
	PXD/PIMP	394	1.177728	0.523601	0.306761	5.037728

Table 3. Descriptive statistics of the groups for NEST2

	Obs	Mean	Std.Dev.	Min	Max
AGRICULTURE					
IMP	4937	196.4918	502.9595	1.54E-06	5424.858
PIMP	4937	1.046093	0.206973	0.48437	1.94599
IMP_RATIO	41034	15022.48	522746.2	2.48E-08	8.09e
PIMP_RATIO	41034	1.074679	0.319472	0.406591	4.017566
MANUFACTURING					
IMP	28409	643.2614	2428.986	0.000033	57163.37
PIMP	28409	1.062267	0.223571	0.185196	2.192141
IMP_RATIO	223450	1182.948	73058.93	3.97E-07	2.09e
PIMP_RATIO	223450	1.025577	0.336047	0.095176	5.082006
Energy intensive manufacturing					
IMP_k_A	14229	496.786	1778.262	5.07E-05	44796.41
PIMP_A	14229	1.075286	0.199543	0.624816	2.192141
Q	112115	569.5018	55086.45	3.97E-07	1.18e
P	112115	1.026587	0.254602	0.320184	2.929145
Other manufacturing					
IMP	14180	790.243	2933.338	0.000033	57163.37
PIMP	14180	1.049204	0.24464	0.185196	2.178571
IMP_RATIO	111335	1800.692	87499.25	4.05E-07	2.09e
PIMP_RATIO	111335	1.024559	0.401708	0.095176	5.082006
CONSUMPTION GOODS					
IMP	4748	1125.61	3275.258	0.001482	45840.05
PIMP	4748	1.129847	0.217087	0.778676	1.828365
IMP_RATIO	37454	79.23033	3966.311	1.55E-05	592781.5
PIMP_RATIO	37454	1.082225	0.278262	0.487246	2.348044
ELECTRICITY					
IMP	881	91.81583	249.9945	3.39E-05	3272.067
PIMP	881	1.18541	0.527314	0.662744	3.588889
IMP_RATIO	1505	13997.38	350379.8	1.42E-07	1.32e
PIMP_RATIO	1505	1.381889	0.67795	0.280006	4.663821
ENERGY					
IMP	9177	61.20547	284.1366	4.69E-07	5045.839
PIMP	9177	1.533632	0.740963	0.5695	5.533808
IMP_RATIO	48648	50464.54	1490742	1.29E-09	1.48e
PIMP_RATIO	48648	1.044675	0.651494	0.173831	6.846373
All_energy					
IMP	10058	63.8867	281.4334	4.69E-07	5045.839
PIMP	10058	1.503131	0.731405	0.5695	5.533808
IMP_RATIO	50153	49370.23	1469470	1.29E-09	1.48e
PIMP_RATIO	50153	1.054794	0.654829	0.173831	6.846373

V. RESULTS

The following tables summarize the results that were obtained both for NEST1 and NEST2. For a better comparison the last column in each table reports the values that are currently applied in the GEM-E3 model. The following main conclusions can be drawn from the obtained results:

First, according to the application of the Armington elasticities in different trade and general equilibrium models, the elasticity of substitution between domestically produced and consumed final goods and imported final goods is usually lower than the elasticities between the final goods imported from different countries, $\sigma_1 < \sigma_2$. Moreover, the lower the value of Armington the less substitution elasticity it indicates between the domestic or imported final goods or between the imported goods. Thus, demand tends to be less flexible to price changes at NEST1 than at NEST2. This relationship implies that once the decision on the import of a product is taken, there is more flexibility from where to do it increases with respect to that of NEST1.

The results show that except for the "energy sector", both the short and long run elasticities, are lower for NEST1 than for NEST2. The exception is the "energy sector", where in the short run $\sigma_1 > \sigma_2$. This elasticity refers to an aggregated energy sector where the individual coal, oil and gas sectors are all included implying a great heterogeneity. In the overwhelming majority of the EU25 countries oil and gas products are rather imported from extra-EU countries and national production has no or a very reduced proportion of supply (see Table 1 for details). The fact that our database does not cover the extra-EU trade and the aggregation of sectors can explain the low level of the NEST2 short run elasticities which seem to be even more rigid in the EU14 countries than in the new EU member states.

Second, microeconomic theory sais that for normal goods substitution and price elasticities tend to be more rigid in the short run, while in the longer term demand can adjust to price changes so that the substitution between the different products (here differentiated by the country of origin) is more elastic, $\sigma_{short} < \sigma_{long}$.

In the present analysis long term adjustment to price changes is stronger than short term adjustments in all but the NEST2 elasticities of "agriculture sector". Dividing the sample of the "agriculture sector" in EU14 and NEU shows that this result is obtained due to the behaviour of the EU14 in the long run where the elasticities seem to be almost half of the short term values. This can be explained by the high level of subsidies in this sector.

Third, with respect to the GEM-E3 values the present results show a mixed picture. In the majority of the cases the GEM-E3 values are under both the obtained short and long run elasticities: in "agriculture", "energy intensive manufacturing" and "electricity" at both nests, in "energy2 at NEST1 and in "manufacturing" at NEST2).

In some cases, like in “manufacturing” at NEST1 or in “other manufacturing”, “energy” and “ALL_energy” the originally applied elasticities lay between the obtained short and long run values. The present results are lower than the GEM-E3 ones in “consumption goods” at both NESTS and in “other manufacturing” at NEST1.

The differences of the recently obtained results with the formerly estimated ones might be due, on the one hand, to the broader coverage of countries, and, on the other hand, to changes in demand patterns. “Agriculture”, “energy intensive manufacturing” and “electricity” became more sensitive to price changes (that might also imply stronger competition in these sectors). On the other hand “consumption goods” and “other manufacturing” have evolved in the opposite direction becoming more rigid in their price responses.

In recent years specialisation has increased in the industrial sectors, which in principle would imply a more rigid demand response to price changes. According to the results this could have been the case in the sectors of “consumption goods” and “other manufacturing”.

Fourth, with regard to the sectoral comparison we would expect that Armington elasticities are higher for machinery and other investment goods than for primary products, ores, chemicals and consumption goods. The results partly correspond to this presumption. The sector of “manufacturing” is one of the sectors with the highest values at both levels and both short and long run, where after separating the “energy intensive manufacturing” from “other manufacturing” (mostly equipments), it is shown that the former one, with higher capital intensity, obtains higher values. At the other end, the lowest values are obtained in the “energy sector”.

The results of the “agriculture sector” is surprisingly high at all levels. Moreover, we would have expected lower ranking also for “consumption goods” among the sectors.

And fifth, the differentiation of the EU14 and NEU in all sectors and nests was motivated by the a priori expectation of obtaining more sensitivity to price changes in the new MS, where the market and restructuring of production in several sectors is not consolidated yet. On the other hand, more stable and consolidated market behaviour was expected for the EU14 countries where quality considerations could equal or even overweight price responses. All together, in general we were expecting to obtain higher values for NEU than for EU14.

The results show that at NEST1 the separation of the dataset into EU14 and NEU did not lead to robust outcomes due to the relatively reduced number of observations. However, it seems indeed that the new MS are more sensitive to price changes both in the short and the long run. One exception is the "energy sector".

At NEST2 the differentiation of the two groups led to meaningful but not necessarily to the expected results. In the short run the majority of the sectors seem to be more flexible to price changes in the EU14 countries, concretely "agriculture", "manufacturing" (both energy intensive and other manufacturing) and "conumption goods". It should be noted that all these sectors have experienced an increasing trade with extra-EU25 countries which could have had a bias effect on the results. In the long term the new member states are more flexible in the "agriculture", "other manufacturing". and the "energy" sectors. Again the very high value for agriculture (5.21) is surprising, which might be explained by the increased trade of these countries with the former EU member in the last decade. It should be noted that sector of "energy intensive manufacturing" in the EU14 seem to be very sensitive to price changes in the long run (5.2).

Table 4: Nest 1 Armington elasticities

NEST1 ARMINGTON ELASTICITIES									
SECTORS	# obs (# groups)	σ_1-short (t)	σ_1-short EU14 (t)	σ_1-short NEU (t)	# obs (# groups)	σ_1-long	σ_1-long EU14	σ_1-long NEU	σ_1-GEM-E3
AGRICULTURE	220 22	**2** 7.3	**-** -	**3.19** 9.44	176 21	**3.60**	**3.07**	**4.47**	**1.2**
MANUFACTURING	1103 20	**1.17** 5.86	**0.92** 3.45	**1.5** 0.04	877 20	**2.29**	**-**	**-**	**1.5**
ENERGY INT. MANUF.	597 20	**0.57** 8.01	**1.68** 3.27	**3.13** 7.67	477 20	**-**	**-**	**-**	**1.5**
OTHER MANUF.	506 19	**0.98** 5.21	**0.85** 3.57	**1.2** 3.9	400 18	**0.85**	**-**	**0.88*** **	**1.5**
CONSUMER GOODS	193 19	**1.55** 3.51	**-** -	**2.54** 4.42	155 19	**-**	**-**	**-0.63**	**1.7**
ELECTRICITY	201 22	**1.66** 2.88	**-** -	**2.73** 3.69	157 22	**1.85**	**-**	**4.23**	**0.6**
ENERGY (COAL, OIL, GAS)	193 19	**0.72** 5.01	**0.73** 4.4	**0.68** 2.37	155 19	**1.09**	**0.85**	**0.92**	**0.6**
ALL ENERGY	394 22	**-** -	**-** -	**-** -	312 22	**1.27**	-	-	**0.6**

Note: 1) in the case of the long term elasticities the "t-values" are not calculated directly. However, the components of the long term elasticities give the indication for the leel of significance.
2) *** acceptable at the 90% significance level

Table 5: Nest 2 Armington elasticities

NEST2 ARMINGTON ELASTICITIES									
SECTORS	# obs (# groups)	σ_2-short (z)	σ_2-short EU14 (z)	σ_2-short NEU (z)	# obs (# groups)	σ_2-long	σ_2-long EU14	σ_2-long NEU	σ_2-GEM-E3
AGRICULTURE	41034 25	**5.24** 80	**6.5** 79	**3.55** 36	30605 25	**4.21**	**3.36**	**5.21**	**1.6**
MANUACTURING	223450 25	**2.81** 145	**3.44** 131	**2.07** 72	171010 25	**3.00**	**3.00**	**2.75**	**2.4**
ENERGY INT MANUF.	112115 25	**3.99** 125.13	**5.19** 121	**2.51** 53	85895 25	**4.43**	**5.20**	**3.33**	**2.4**
OTHER MANUF.	111335 25	**2.34** 98.28	**2.68** 79	**1.92** 52	85115 25	**2.42**	**2.00**	**2.57**	**2.4**
CONSUMER GOODS	37454 25	**1.94** 40.4	**2.2** 34	**1.61** 22	28714 25	**2.33**	**2.50**	**1.83**	**2.8**
ELECTRICITY	1505 23	**1.73** 7.53	**2.11** 8.35	**-** -	767 17	**2.06**	**2.46**	**0.08**	**0.8**
ENERGY (COAL, OIL, GAS)	48648 25	**0.23** 5.42	**0.15** 2.91	**0.37** 5.22	34242 25	**2.18**	**2.00**	**2.47**	**0.8**
ALL ENERGY	50153 25	**0.26** 6.4	**0.21** 4.25	**0.35** 5.06	35009 25	**2.00**	**1.89**	**2.47**	**0.8**

VI. CONCLUSIONS

The main purpose of this article has been to estimate the Armington elasticities of the GEM-E3 European model. The elasticities of the two nestings (substitution between domestically produced goods and imported goods, NEST1: upper level; substitution between imported goods according to the country of origin NEST2: lower level) have been estimated for most of the European countries, using the COMEXT database and National Accounts from Eurostat. This has the advantage of using a harmonised database for the estimation of the parameters of the two nestings.

The preliminary analysis of the econometric results for the "agriculture", "electricity", "other equipment" and "energy" sectors confirms that the elasticities of NEST1 are lower than those of NEST2. The estimated long-run elasticities are also higher than the short-term elasticities, in conformity with theory. Moreover, the preliminary results show in general that the estimates of the Armington parameters are in line with those reported in the literature. This is hold for both the first and second nests of the Armington specification. These results are more in line with the findings of some more recent studies (eg. Welsch 2006, and Saito 2004) based on longer period trade data. The results appear to be closer to the numbers of the Welsh study, in which the time dependence of these elasticities are also analysed, and a certain downward trend in these parameters are reported.

The results suggest that, in general, consumer choice appear to be more price sensitive between the domestic and the composite imported goods and amongst the importers than assumed in the model.

The estimated NEST1 long-term elasticities are higher than those used in the GEM-E3 model, with the exception of the "other manufacturing sector" (for "energy intensive manufacturing" and "consumer goods" there are no long-term estimates in this study at this level). In particular, the "electricity" and "energy" sectors estimated elasticities are more than twice their assumed values in the model. This could be due to the fact that the GEM-E3 model elasticities were estimated with data from an earlier period. The further integration of the EU single market could have led to more substitution possibilities between domestically produced and imported goods within Europe.

Concerning the energy sector long-term elasticities in NEST2, in general they are higher than the assumed parameters in the GEM-E3 model. The "agriculture" and "manufacturing" sectors´ long-term elasticities are also higher than in GEM-E3, with a large difference in the agriculture case.

The differences in the Armington elasticities used in the GEM-E3 model and found in the literature on the energy sector highlight four directions that deserve further investigation. First, the scope of the data could be enlarged to include other geographical regions in the analysis. Second, the dataset only covers the intra-EU trade. While in most of the manufacturing sectors the coverage is relatively large because the extra-EU trade is relatively low, while in the energy sector it is rather high, which could bias the results. Third, the time dimension could be further explored, making the elasticities time-dependant. The differences of our results with those in the literature could be explained by the time dimension of our dataset. And fourth, availability of data on intermediate goods could improve our dataset permitting to carry out the analysis only on final goods.

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ANNEX 1.

VA data: Eurostat - NACE 31	Sectoral breakdown for estimation												
	20 - Agriculture	21 - Coal	22 - Gas	23 - Oil	24 - Electricity	25 - Ferrous and non-ferrous metal	26 - Chemical products	27 - Other energy intensive products	28 - Electronic equipments	29 - Transport equipments	30 - Other equipments	31 - Consumer goods industries	32 - Energy (coal + gas + oil)
Agriculture, hunting and forestry	X												
Fishing	X												
Mining and quarrying													
Mining and quarrying of energy producing materials													X
Mining and quarrying except energy producing materials								X					
Manufacturing													
Manufacture of food products; beverages and tobacco												X	
Manufacture of textiles and textile products												X	
Manufacture of leather and leather products												X	
Manufacture of wood and wood products												X	
Manufacture of pulp, paper and paper products; publishing and printing								X					
Manufacture of coke, refined petroleum products and nuclear fuel													X
Manufacture of chemicals, chemical products and man-made fibres							X						
Manufacture of rubber and plastic products							X						
Manufacture of other non-metallic mineral products								X					
Manufacture of basic metals and fabricated metal products						X							
Manufacture of machinery and equipment n.e.c.											X		
Manufacture of electrical and optical equipment									X				
Manufacture of transport equipment										X			
Manufacturing n.e.c.												X	
Electricity, gas and water supply					X								

Note: There was no data on coal, gas and oil VA, but for the combination of the three, which is included in category energy . There was VA data for electricity, but in this case there was no data on import quantities and prices.

ANNEX 2.

CODING FOR OUR SECTORAL BREAKDOWN	PRODUCTs in the COMEXT database (CN8 level)
20	00 LIVE ANIMALS OTHER THAN ANIMALS OF DIVISION 03
20	011 MEAT OF BOVINE ANIMALS, FRESH, CHILLED OR FROZEN
20	012 OTHER MEAT AND EDIBLE MEAT OFFAL, FRESH, CHILLED OR FROZEN (EXCEPT MEAT AND MEAT OFFAL UNFIT OR UNSUITABLE FOR HUMAN CONSUMPTION)
31	016 MEAT AND EDIBLE MEAT OFFAL, SALTED, IN BRINE, DRIED OR SMOKED
31	017 MEAT AND EDIBLE MEAT OFFAL, PREPARED OR PRESERVED, N.E.S.
31	02 DAIRY PRODUCTS AND BIRD'S EGGS
20	03 FISH, CRUSTACEANS AND MOLLUSCS AND PREPARATIONS THEREOF
20	04 CEREALS AND CEREAL PREPARATIONS
20	05 VEGETABLES AND FRUIT
31	06 SUGARS, SUGAR PREPARATIONS AND HONEY
31	07 COFFEE, TEA, COCOA, SPICES, AND MANUFACTURES THEREOF
31	08 FEEDING STUFF FOR ANIMALS (NOT INCLUDING UNMILLED CEREALS)
31	09 MISCELLANEOUS EDIBLE PRODUCTS AND PREPARATIONS
31	1 BEVERAGES AND TOBACCO
31	21 HIDES, SKINS AND FURSKINS, RAW
31	22 OIL SEEDS AND OLEAGINOUS FRUITS
26	23 CRUDE RUBBER (INCLUDING SYNTHETIC AND RECLAIMED)
31	24 CORK AND WOOD
27	25 PULP AND WASTE PAPER
31	26 TEXTILE FIBRES (OTHER THAN WOOL TOPS), WASTES
27	27 CRUDE FERTILIZERS + MINERALS (EXCL. COAL, PETROL, PRECIOUS STONES)
25	28 METALLIFEROUS ORES AND METAL SCRAP
31	29 CRUDE ANIMAL AND VEGETABLE MATERIALS, N.E.S.
21	32 COAL, COKE AND BRIQUETTES
22	33 PETROLEUM, PETROLEUM PRODUCTS AND RELATED MATERIALS
23	34 GAS, NATURAL AND MANUFACTURED
24	35 ELECTRIC CURRENT
20	4 ANIMAL,VEGETABLE OIL,FAT
26	5 CHEMICALS
30	60 COMPLETE INDUSTRIAL PLANT APPROPRIATE TO SECTION 6
31	61 LEATHER, LEATHER MANUFACTURES, N.E.S. AND DRESSED FURSKINS
26	62 RUBBER MANUFACTURES, N.E.S.
31	63 CORK AND WOOD MANUFACTURES (EXCLUDING FURNITURE)
27	64 PAPER, PAPERBOARD + ART. OF PAPER PULP, OF PAPER OR OF PAPERBOARD
31	65 TEXTILE YARN, FABRICS, MADE-UP ARTICLES, N.E.S., + RELATED PRODUCTS
27	66 NON-METALLIC MINERAL MANUFACTURES, N.E.S.
25	67 IRON AND STEEL
25	68 NON-FERROUS METALS
25	69 MANUFACTURES OF METALS, N.E.S.
30	70 COMPLETE INDUSTRIAL PLANT APPROPRIATE TO SECTION 7
30	71 POWER GENERATING MACHINERY AND EQUIPMENT
30	72 MACHINERY SPECIALIZED FOR PARTICULAR INDUSTRIES
30	73 METAL WORKING MACHINERY
30	74 GENERAL INDUSTR. MACH. + EQUIPMENT, N.E.S., MACHINE PARTS, N.E.S.
28	75 OFFICE MACHINES AND AUTOMATIC DATA-PROCESSING MACHINES
28	76 TELECOMMUNIC. + SOUND RECORDING + REPROD. APPARATUS + EQUIPMENT
28	77 ELECTR. MACH., APP. + APPLIANCES, N.E.S. + ELECTR. PARTS THEREOF
29	78 ROAD VEHICLES (INCLUDING AIR-CUSHION VEHICLES)
29	79 OTHER TRANSPORT EQUIPMENT
31	8 MISC MANUFACTURED GOODS
31	9 GOODS NOT CLASSED BY KIND

Note: Sector 32 (energy) is the sum of the sectors coal, oil, gas.