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An estimation of Armington elasticities at the EU-28 level

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Abstract

The Armington substitution elasticity is a key parameter for trade-policy analysis. The purpose of this study then is no other than to re-estimate NEST 1[1] Armington elasticities making use of the upgraded versions of WIOD databases. Short-run as well as long-run elasticities Armington elasticities at the EU-28 level for 2 different industry classifications will be estimated, providing this way to energy and policy modellers an updated numerical value of the former ones. The estimation will be performed for the temporal period departing from 2000 up to 2014. Our analysis is going to be oriented towards an estimation of the Armington elasticities for intermediate goods (intermediate demand) and final goods (final demand).

[1] The literature refers NEST 1 as the level of analysis attending the degree of substatibility among domestically produced and consumed products and imports.

Introduction

The estimation of Armington elasticities have formed part, in the past one or two decades, of one of the key drivers to different results in the numerical study implemented in the CGE models applied to the energy and climate modelling. These estimations, indeed, have contributed to assess in many orders the impact on the macroeconomic and sectoral structures of a particular country that unilaterally decides to reduce carbon emissions. The degree of substitutability by imports of the affected goods will determine at a certain degree the extension of those impacts. The major part of the CGE models used in climate and energy modelling employ the approach conducted by Armington (Armington, 1969). A further analysis of the Armington model for composite goods demand is going to be carried out in the second section.

The implementation of the numerical values of Armington elasticities does not lack a certain degree of uncertainty. The vast majority of the values applied in the CGE models are extracted from the literature, even when the correspondent CGE models are not fully compatible in terms of disaggregation, temporal specification or functional form (Feenstra et al., 2017). Additionally, an estimation of Armington elasticities for the European countries are rare to find.

Several have been the studies that made efforts in the estimation of these Armington elasticities. One of the first studies in addressing Armington elasticities estimation was the one made by Stern, Francis and Schumacher in 1976 for 28 industries of the US economy. They found rubber products, wearing apparel, metal products and transport equipment to be import elastic, finding considerable high values of the Armington elasticities for the cited sectors.

Shiells, Stern and Deardoff (1986) made use of a stock-adjustment model with annual data for the temporal range departing from the year 1962-1978 for 163 activity sectors (Daniel and Balistreri, 2003). They obtained significant results for 122 out of the 163 industry classifications. Their results were relatively consistent with the findings of Stern et al (1976).

Gallaway, MacDaniel and Rivera (2000) included the long-run specification that we are going also to take into account in our analysis. They estimated Armington elasticities for 309 industries at the 4-digit ISIC classification for the period going from 1989 to 1995. They found two times larger estimates on average for long-run Armington elasticities in comparison with short-estimates.

The conducted estimation of the elasticities for each one of the industry classifications has led to an import inelastic estimation in the short-run (Armington elasticities below unity) for the first sector (other non-metallic mineral products) and a relatively high value of the short-run Armington elasticity in the same temporal horizon for the motor vehicles sector, under both demand classifications. Additionally, we have obtained greater values of the elasticities in the long-run for both sectors, something that goes in line with the obtained results in the main literature on the topic.

The study is going to be organised as follows: In the first section a short revision is going to be made on the model and its implications while the main literature available in the field is going to be reviewed. In section 2, the study will cover the specifications of the data sources and the variables introduced in the estimation. In section 3, the study will define the selected methodology in both the data processing and estimation procedure. In the next section 4 the descriptive analysis of the variables included in the model will be approached, presenting this way an introductory guideline for the understanding of the temporal evolution of the imports and domestic consumption at the European level for the years 2000-2014. Following this descriptive work, the estimation results for the correspondent industry classifications are going to be presented (section 5) followed by the comments derived from the formers. Lastly, at section 6, the final conclusion of the study will be set, where efforts are going to be made on the identification of the main ideas and results of the analysis at the same time that future research lines are proposed with the intention of exploring deeper approaches to the estimation of NEST 2[2].

The model

Before going through the Armington´s model it would be helpful to introduce the main idea under this central concept. In a broad sense, the Armington elasticity of substitution determines the degree of substitutability between a given type of good between the imports and the domestic production. In this sense, it is assumed a potential substitution of imports of a given product in a given country by domestically produced product. In the same way, the elasticity of substitution among imported goods, calibrates the degree of substitutability between imported goods from different exporting countries.

A high value of the elasticity of substitution between imports and domestic production in a particular good indicates that consumers are price sensitive and that domestic production and imports of that particular good are close to be perfect substitutes. The underlying assumption of the Armington model sets the idea that goods produced domestically and foreign products are not perfect substitutes while the elasticity of substitution remains constant.

Under the aim of constructing a model for the demand of tradable goods, Armington departs from the identification of the characteristics that determine International trade flows. According to this, a tradable good is specified then by the kind of merchandise involved, the country or region of the seller and the country of the buyer.(Armington, 1969)

[2] NEST 2 methodology analyses the consumption and substitution patterns among different countries of origin, excluding in this way the domestic-imported framework set by NEST 1.

In the classical theory of demand for tradable goods it is assumed that a merchandise of a given type supplied by particulars sellers in one particular country is a perfect substitute for another merchandise of the same type supplied by any other country. This means that consumers do not differentiate products of the same kind by the country of origin of the supplier. This leads to assuming infinite elasticity of substitution and constant price ratios among the pair of products of the same kind.

In his seminal paper, nonetheless, Armington presents a general theory of demand where products are distinguished by their kind and also by their place of production. As an example he considers that chemicals produced in France are a differentiated good from Japanese chemicals. Moreover, if there exist 10 products and 20 supplying areas under the assumption of differentiated goods, the number of products distinguished in the model would be 200.

Departing from the general Hicksian model, Armington's model runs through several restrictions that lead to a characterization of the product demand functions. In this context, the fundamental modification of the Hicksian model is the assumption of independence. In this context, the assumption of independence states that buyer´s preferences for different products of any given kind (chemicals for instance) are independent of their purchases of products of any other kind. Additionally, a second assumption is set that states that each country´s market share is unaffected by changes in the size of the market. This implies that the market size is a function of the money income and the general prices of the various goods.

An important additional approach to simplify the product demand functions that Armington´s mentioned is to present the following assumptions on the elasticities:

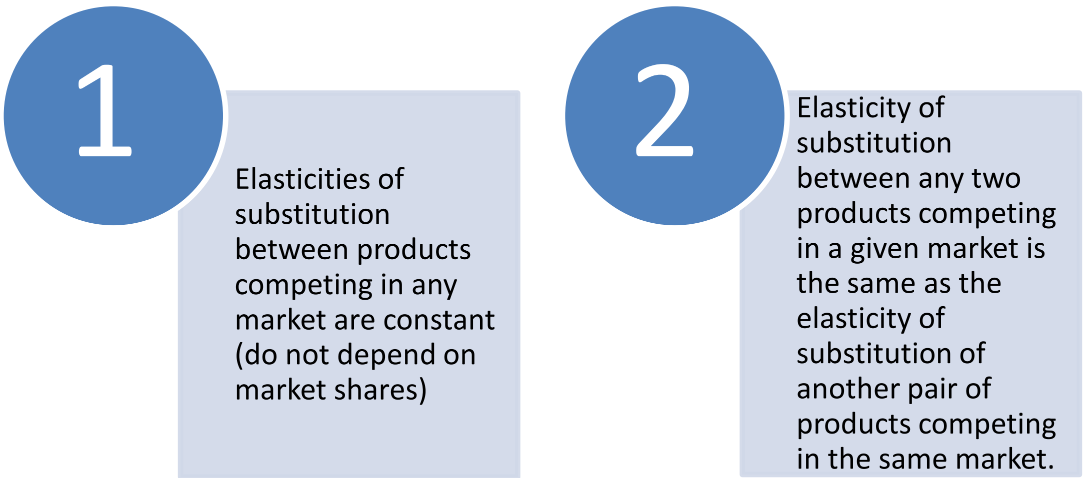


Figure 1: Assumptions on the elasticities in the Armington model (own elaboration)

These two assumptions will be useful in order to specify a particular functional form the quantity index function that we are going to present next.

Armington presents a vector of countries $C = (C_{1,} C_2, \dots, C_m)$ and a vector of goods determined by $X = (X_{1,} X_{2,}, \dots, X_n)$. This way, there are *m* countries and n goods represented in the model and X_i characterize a particular group of products commonly produced by each of the m countries: $X_i = (X_{i1,} X_{i2,}, \dots, X_{im,})$. Therefore, X_{ij} is consider as a imperfect substitute of X_{ik} being *k* different from *j*.

That way,

$$X = (X_{11,} X_{12,}, \dots, X_{1m,} X_{21,} X_{22,} \dots, X_{nm,})$$

Which is equivalent to:

$$(X_{1,} X_{2,}, \dots, X_n),$$

where

$$X_i = (X_{i1,} X_{i2,}, \dots, X_{im,}) \quad \text{for } i = 1,2, \dots., n$$

represents the production of a given type of good *i* of a certain country. Each country, then, will have *mn* demands functions where the demand of the good *i* of the country *j* depend on the general income *D* and the prices of the rest of the goods:

$$X_{ij} = X_{ij}\left(D, P_{11,} \dots, P_{1m,} P_{21,} \dots, P_{nm}\right) \quad \text{for every } i \text{ and } j.$$

Through the previously explained assumption of independence we can run from a general utility function that the consumer seeks to maximize:

$$U_i = U(X_{11,} X_{12,} X_{1m,}, X_{21,} \dots, X_{nm,})$$

to,

$$X_i = \emptyset_i(X_{i1,} X_{i2,}, \dots, X_{im,}) \text{ for } i = 1,2, \dots., n$$

Where $\emptyset_i$ represents the quantity index functions (which defines the specific trade flow of the good *i*) among countries that assigned the production of the good *i* to each of the countries.

The resulting demand functions are then represented by

$$X_i = X_i\left(D, P_{1,} P_{2,} \dots, P_n\right)$$

$$X_{ij} = X_{ij}\left(X_i, \frac{P_{ij}}{P_{i1}}, \frac{P_{ij}}{P_{i2}}, \dots, \frac{P_{ij}}{P_{im}}\right),$$

where X_i represents any good *i* and X_{ij} is a particular good, (chemicals produced in France for instance).

That way, the demand of good *i* by the country *j* depends on the total demand for the good *i* and the relative prices among the country *j* and the prices for that particular good in the rest of the *m-1* countries.

Introducing the two assumptions of the elasticity of substitution that have been presented before, we can convert the quantity index function into a CES function (constant elasticity function) of the form:

$$X_i = \left(b_{i1}X_{i1}^{-p_i} + b_{i2}X_{i2}^{-p_i} + \cdots + b_{in}X_{in}^{-p_i}\right)^{\frac{-1}{p_i}} \quad (1)$$

Where p_i stands for the participation parameter and b_{in} is a constant term. From (1) it is derived that the demand for a given product X_{ij} can be expressed as:

$$X_{ij} = b_{ij}^{\sigma_i} X_i \left(\frac{P_{ij}}{P_i}\right)^{-\sigma_i} \quad (2)$$

Being σ_i the elasticity of substitution in the *i*-th market and b_{ij} a constant term associated with good-*i* and country *j*.

In the same way, the market share for the product X_{ij} is expressed as

$$\frac{X_{ij}}{X_i} = b_{ij}^{\sigma_i} X_i \left(\frac{P_{ij}}{P_i}\right)^{-\sigma_i} \quad (3)$$

Where $\frac{X_{ij}}{X_i}$ account for the country *j*´s market share of the product X_{ij} in the *i*-th market.

That way, the Armington's model specifies a particular relationship among the demand of a particular product and the elasticity of substitution of the good in the market.

At the same time, the Armington model explains the demand for a composite good *i* that is domestically produced (XXD) and imported (M) as:

$$X_i = A_i\left[\delta_i XXD_i^{-p} + (1-\delta_i)M_i^{-p}\right]^{\frac{-1}{p}} \quad (4)$$

Where A_i refers the efficiency factor, δ_i refers to the participation parameter of domestic and import consumption of the good *i* and *p* is the substitution parameter (Hernandez, 1998). From the optimal conditions derived from the maximization of the composite good function subject to the budget restriction it is achieved that the Marginal Rate of substitution is equal to the ratio of prices for the good *i*:

$$\frac{\delta_i XXD_i^{(-1+p)}}{(1-\delta_i)M_i^{(-1+p)}} = \frac{PXXD_i}{PM_i} \quad (5)$$

Solving for $\frac{M}{XXD}$, and linearizing the system we get the expression to estimate where the log of the ratio of imports and domestic products depends on the ratio of domestic prices and imports as:

$$log\left(\frac{M_i}{XXD_i}\right) = \delta_i log\left(\frac{(1-\delta_i)}{\delta_i}\right) + \sigma log\left(\frac{PXXD_i}{PM_i}\right) \qquad (6)$$ [3]

Where σ_i and δ_i are the structural parameters of the model representing respectively the Armington elasticity of substitution and the participation parameter for the good (industry classification) *i.*

Data

In this section a brief description of the databases used in the analysis is going to be developed, as well as the description of the variables employed in the estimation procedure. Lastly, it will inform about the industry classification that is going to be included, taking into account the particular disaggregation level available in the World Input Output database (WIOD).

This study uses data from two following main databases:

1-USE tables of the World Input Output Database (WIOD) has provided for the sectoral information for the domestic and imported consumptions (expressed in millions of current dollars).

2-Socio Economic Accounts (also provided under the WIOD database) has enabled the creation of the price variables. Indeed, this last database has provided for the following variables:

Table 1: Socio Economic accounts variables (WIOD)

Socio Economic variables	Notation
Gross domestic output deflator	GO_PI
Value Added deflator	VA_PI

The gross domestic output deflator (GO_PI) and the value added deflator (VA_PI) are indexes that are computed having fixed the year of reference at 2010 ($\mathrm{GO\_PI}_{2010} = 100, \mathrm{VA\_PI}_{2010} = 100$).

[3] The constant term can also be expressed as: α_i

Regarding the structure of the USE tables, this database supplies information for 43 countries of the world for each one of the sectors included in the corresponding industry classification (ISIC 4) offered by the WIOD database. The USE tables assign a number (in millions of current dollars) referring to the value of the total trade volume among the reporting country (REP) and the partner country (PAR) for each one of the industry classifications included in the WIOD database. This way, each country will report its trade volume information not only with the rest of the 42 countries but with itself as well (domestically produced consumption). The former information has been used for the computation of the domestically produced and consumed variable for the given sector of activity *i* (XXD_i).

As it has been commented in the introductory section, the estimation of the Armington elasticities of substitution is going to be performed for the following categories of goods classification according the demand[4]:

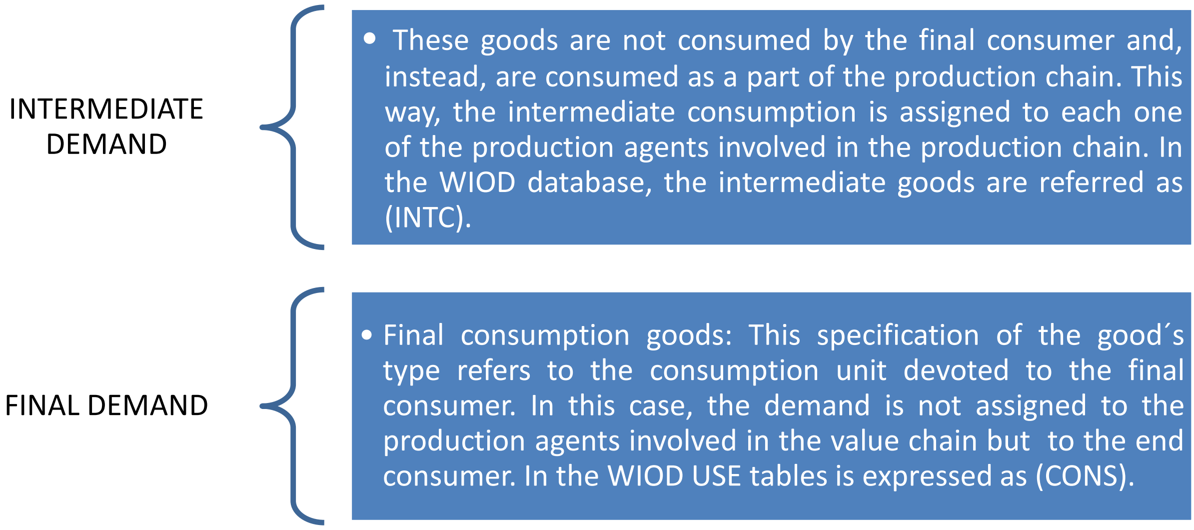


Figure 2:Demand classification (own elaboration)

Before going through the particular selection of the industry classification, it is crucial to point out the existing trade-off regarding the selection of the particular level of disaggregation. Indeed, high-degree of disaggregation implies a higher chance for non-observed values (more detailed information derives in greater difficulty of data collection) while a lower disaggregation level implies a potential loss of information within sectors. In our particular case the level of disaggregation corresponds to the level set by the WIOD databases (see pag.10). What regards the

[4] This demand classification is harmonized with the demand classification defined in the FIDELIO CGE-macroeconomic model where the demand for each one of the sectors in the model is split into the consumption made along the value chain by the producers of the good and the final consumer.

industries classification (or sectors) that have been elected to introduce in the estimation, the following sectoral breakdown has been chosen.

Table 2:Selected industry classification[5]

Code	Description
C-23	Manufacture of other non-metallic mineral products
C29	Motor vehicles and transport equipment

In this sectoral disaggregation, we have focused the selection in the manufacturing activity. By choosing this classification, we exclude some other sectors (as the energy and electricity sector) which could present a more complicated interpretation of the elasticities as primary sectors are highly subjected to structural restrictions explained by the availability of the specific natural resources. Nevertheless, other authors have included specific primary sectors (Gustavo hernández, 1998). In the same way, electricity and energy-related sectors have been widely included for the CGE-Environmental-Energy- models[6] This way, by introducing the cited sectors, we restrict our analysis to the manufacturing-related activities.

We will describe now the definition of the four basic variables of the model (6). The definition of the domestic and import consumption is straightforward. Both the intermediate and the final consumptions for the imported and domestic variables by sector of activity are extracted from the WIOD database, computing as a domestically produced and consumed value whenever the partner country matches the reporting country. For the imports variable, it is directly computed as the sum of all the values by sector of activity, whenever the reporting country is different from the partner country. The construction of these variables, then, does not require any special adjustment except from the deflation process[7].

This way, we would have four different variables regarding imports and domestic consumption, which are going to be defined and denoted as:

[5] The particular code defining the name of each one of the sectors follows the 4-digit ISIC industry classification which is applied in the construction of the WIOD databases.
[6] An example of these models is the GME-E3 model for Europe.
[7] All the original data in the WIOD USE tables is expressed in current millions of dollars. Through the deflation process, the flow variables are going to be expressed in euros (in millions) of 2010´s prices and exchange rates.

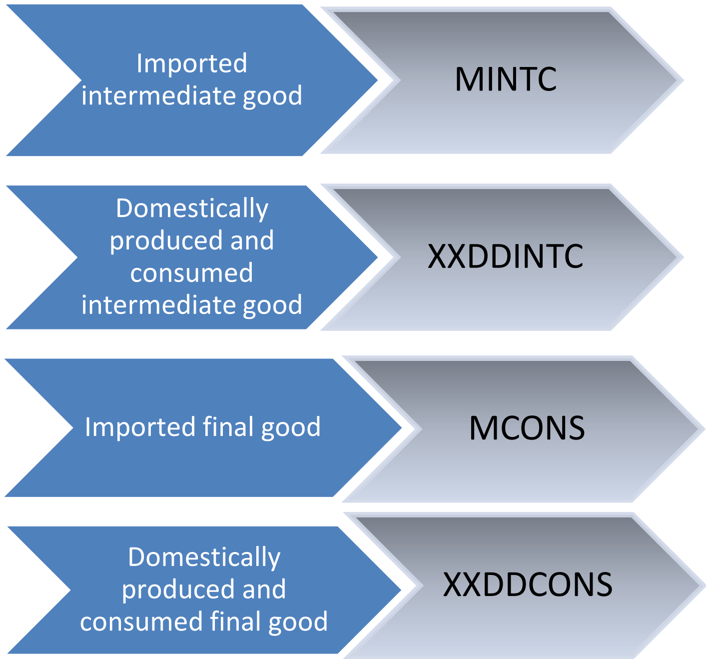


Figure 3: Specific notation for import and domestic consumption by demand classification (own elaboration)

Consequently, $\mathrm{MINTC}^{i,t}$ is going to express the value of the imports, in millions of current dollars, of the intermediate good in country *i*, in the year *t* for any given sector of activity . The remaining variables are defined correspondingly.

The process of generating the price variables has required a more complex approach. It is important to highlight that the creation of the price related variables have to be considered as proxies for the prices, and not as original variables. These variables provide rough information about the price levels in a given country (*i*) at a certain moment in time (*t*). Thus, we can differentiate two price related variables associated to each one of the countries introduced in the analysis as well as to the particular year (see eq.5)

Table 3: Price variables and notation

Price variables	Notation
Domestic price	PXXD
Import price	PM

This way, PXXD_i^t will assign the proxy to the domestic prices for the reporting country *i* at the year *t*, while PM_i^t will express the proxy to imports prices for the reporting country *i* at the year *t* for any given sector of activity.

Methodology

This section presents the particular methodology applied in this analysis. Firstly, the process of construction of the proxies for the price variables is going to be detailed. Secondly, the methodological approach to the deflating process of the flow variables is going to be displayed and lastly, the estimation process is going to be properly analysed.

Regarding the methodology in the price variables formation, two different approaches have been taken into consideration. The existing literature shows some degree of heterogeneity in their methodological approach to selection of data regarding the construction of prices proxies. While some authors have employed the added value deflator (VA) as the proxy for the domestic and import prices (Németh et al., 2011),others have made use of the gross-output deflator as an approximation for the cited variables (Welsch, 2008). There is no a clear methodological path in the election of one type of data or another, depending, in a major way, the final election on the availability and quality of data. In our case, and as it has been previously explained, WIOD databases provide a wide range of price level indexes which will be used in a comparative estimation scenario.

All the mentioned approaches are explained below.

Gross-output deflator approach

In order to obtain the proxy variable for the domestic price, we depart from the following approximation for the ratio of prices, which is defined as follows:

$$\frac{PXXD_r^{i,t}}{PM_r^{i,t}} \cong \frac{GO_{D_r}^{i,t}}{GO_{M_r}^{i,t}},$$

where

$$GO\_D_r^{i,t} = GO\_P_r^{i,t} \times (PEUR_r^t / PEUR_r^{2010}), \tag{7}$$

being $GO\_P_r^{i,t}$ the Gross Output deflator for the reporting country *r*, the sector of activity *i* and the year t. At the same time, $PEUR_r^t$ refers an index with takes value 100 at the year 2010 for the exchange rate eur/local currency for the reporting country *r* and the year *t*. The gross-output deflator is defined as the ratio between the nominal output for a particular year and the real output for that particular country.

In the case of the gross-output approach for the import price we have that the former one is defined as the weighted sum of the correspondent deflators for each one of the partner countries *s* exporting to the reporting country *r*, where the weights are the share of imports of each partner country s to the domestic country *r*. This way, the Gross output deflator for the imports is defined as:

$$GO\_M_r^{i,t} = \sum_{s\neq r} m_{rs}^{i,t} GO\_P_s^{i,t} \times (PEUR_s^t / PEUR_s^{2010}), \tag{8}$$

where $m_{rs}^{i,t}$ is the correspondent share of the imports that the country s exports to the domestic country *r*, for the sector *i* and the year t and $GO\_P_s^{i,t}$ is the gross output deflator for the partner country *s* , the sector of activity *i* and the year *t*. This way, the share of the imports *is* defined as:

$$m_{r,s}^{i,t} = \frac{M_{r,s}^{i,t}}{\sum_s M_{r,s}^{i,t}}, \tag{9}$$

where $M_{r,s}^{i,t}$ are the imports for the domestic country *r* of the country of origin (or exporting country) *s* and $\sum_s M_{r,s}^{i,t}$ is the aggregated imports of the domestic country *r* for the year *t* and the sector of activity *i* coming from all the exporting countries *s*. As the weights are going to be computed employing data for both final and intermediate demand, these values will be different for the demand classifications. Therefore, for each price approach, there will be two different import prices values: Import price for intermediate demand, and import price for final demand. Consequently, and using the notation presented in section 3, weights will be more specifically defined as:

$$mcons_{r,s}^{i,t} = \frac{MCONS_{r,s}^{i,t}}{\sum_s MCONS_{r,s}^{i,t}}, \tag{10}$$

for the final demand and:

$$mintc_{r,s}^{i,t} = \frac{MINTC_{r,s}^{i,t}}{\sum_s MINTC_{r,s}^{i,t}} \tag{11}$$

referring intermediate demand. The rest of the components of the equation (PEUR) refers to the same specifications that were discussed for the domestic price.

VALUE-ADDED DEFLATOR APPROACH

The approach for the value-added deflator is identical to the method used for the Gross-output deflator but instead of employing the latest one, the value-added deflator is used. This approach is followed by authors as Welsch in the estimation of Armington elasticities for a CGE model for Europe (Welsch, 2008).

Consequently, the approximation of this variable to the price variables (expressed in price ratio among domestic price and import price) will be expressed by:

$$\frac{PXXD_r^{i,t}}{PM_r^{i,t}} \cong \frac{VA_{D_r}^{i,t}}{VA_{M_r}^{i,t}}.$$

As it has been commented before this value-added deflator is extracted from the Socio-Economic Accounts, as well as the Gross output deflator. This way, the formal definition of the proxies for the domestic and the import prices respectively will be as follows:

$$VA\_D_r^{i,t} = VA\_PI_r^{i,t} \times (PEUR_r^t / PEUR_r^{2010}), \tag{12}$$

where $VA\_PI_r^{i,t}$ alludes to the value-added deflator for the domestic country *r*, the sector of activity *i* and the year *t* and is expressed in euros of the year 2010.
And for the import price:

$$VA\_M_r^{i,t} = \sum_{s \neq r} m_{rs}^{i,t} VA\_P_s^{i,t} \times (PEUR_s^t / PEUR_s^{2010}), \tag{13}$$

where $m_{rs}^{i,t}$ are the same weights defined previously (see eq.9) in the gross-output approach and $VA\_P_s^{i,t}$ accounts for the Value added deflator of the country of origin *s* for the activity sector *i*.

ESTIMATED EQUATIONS

Departing from eq.6 we have that, for the NEST1 estimation, the Armington elasticity assigned to a particular sector of activity is expressed as the coefficient associated to the ratio of domestic and import prices where the dependent variable is the ratio of imported and domestically produced and consumed products expressed in constant euros at 2010 prices and exchange rates. That way, the equation to be estimated will lead to:

$$log\left(\frac{M^{i,t}}{XXD^{i,t}}\right) = \beta_0 + \delta w' + \sigma^s og\left(\frac{PXXD^{i,t}}{PM^{i,t}}\right) + u_{i,t} \tag{14}$$

$$t = 2001, \dots, 2014$$

Where σ^s will defined the short-run Armington elasticity, $M^{i,t}$ is the imports of country *i* at year *t*, $XXD^{i,t}$ refers to the domestic consumption of country *i* at year *t* while $PXXD^{i,t}$ and $PM^{i,t}$ refer to the domestic and import price of the country *i* at year *t* respectively. Additionally, w' is defined as the vector of exogenous variables (years) where the first year is excluded from the equation In our case, as demand of products are going to be differentiated by intermediate and final demand, two separate equations are going to be estimated for each one of the demand classifications:

1) Intermediate demand:

$$log\left(\frac{MINTC_{i,t}}{XXDINTC_{i,t}}\right) = \beta_0 + \delta w' + \sigma_{INTC} log\left(\frac{PXXD_{i,t}}{PMINTC_{i,t}}\right) + u_{i,t} \tag{15}$$

$$t = 2001, \dots, 2014$$

2) Final demand:

$$log\left(\frac{MCONS_{i,t}}{XXDCONS_{i,t},}\right) = \beta_0 + \delta w' + \sigma_{CONS} log\left(\frac{PXXD_{i,t}}{PMCONS_{i,t}}\right) + u_{i,t} \tag{16}$$

$$t = 2001, \dots, 2014$$

Being σ_{INTC} and σ_{CONS} the Armington elasticity for the intermediate demand and final demand respectively.

This way, for each sector of activity and each demand classification one different value of the Armington elasticity will be reported, resulting in two elasticities by sector of activity.

Additionally, an additional explanatory variable can be added into the previous equations in order to try to capture the long-run dynamics of the domestic and imported consumptions (Németh et al., 2011). This last explanatory variable will be determined by the lagged dependent variable: $\frac{M_{i,t-1}}{XXD_{i,t-1}}$. This additional dynamic variable is incorporated to equations (19) and (20) as:

1.1) Intermediate demand:

$$log\left(\frac{MINTC_{i,t}}{XXDINTC_{i,t}}\right) = \alpha_0 + \delta w' + \beta log\left(\frac{MINTC_{i,t-1}}{XXD_{i,t-1}}\right) + \sigma_{INTC}^{s} log\left(\frac{PXXD_{i,t}}{PMINTC_{i,t}}\right) + u_{i,t} \tag{17}$$

In an analogous way,

2.1) Final demand:

$$log\left(\frac{MCONS_{i,t}}{XXDCONS_{i,t}}\right) = \alpha_0 + \delta w' + \beta log\left(\frac{MCONS_{i,t-1}}{XXDCONS_{i,t-1}}\right) + \sigma_{CONS}^{s} log\left(\frac{PXXD_{i,t}}{PMCONS_{i,t}}\right) + u_{i,t} \tag{18}$$

Where σ_{INTC}^{s} and σ_{CONS}^{s} represent the short-run Armington elasticity for intermediate and final demand respectively.

Therefore, the value of the elasticity containing this long-run dynamics will be expressed by the long-term Armington elasticity, which will be defined as (Németh et al., 2011):

$$\sigma_{INTC}^{l} = \frac{\sigma_{INTC}^{s}}{1-\beta}$$

For the intermediate demand and,

$$\sigma^{l}_{CONS} = \frac{\sigma^{s}_{CONS}}{1-\beta}$$

For the final demand respectively

Where σ^{s}_{INTC} and σ^{s}_{CONS} represent the long-run Armington elasticity for the intermediate demand and final demand respectively which are expressed by the coefficient associated to the ratio of domestic and imports prices (eq.21 & eq.22) while β is the coefficient associated to the lagged dependent variable.

Estimation methodology: Econometric considerations

Once that the formation of the variables and his correspondent treatment has already been detailed, the next step will cover the estimation methodology including the complete procedure that has led to the proper econometric estimation. As the data structure contains 28 individual groups (one for each country) and a temporal variation of the variables for each one of the groups, the resulting data was conformed in a panel data framework where an identification code was assigned to each country. That way, our panel data will contain 15 observations per country (one per year)[8], resulting in 420 observations for the entire panel. A different panel will be created for each one of the sectors included in the analysis. Within the available data for our variables, the corresponding panel results in a balanced panel as all the countries present information for each one of the time periods[9].

As any longitudinal data, the former is affected by unobserved effects that may be determining the particular temporal evolution of the variable (unobserved heterogeneity). Therefore, we cannot assume an independent distribution of the observations across time as an unobserved factor may be affecting the temporal evolution of the particular variable (William H. Greene, 2012)

At the same time, the inclusion of the lagged dependent variable $\left(\frac{M_{i,t-1}}{XXD_{i,t-1}}\right)$ in our estimated equations introduces an additional issue.:

Let´s suppose a dynamic equation where,

[8] The characterization of the panel resulting in 28 groups with a temporal horizon of 15 years, can be considered as a short panel with few individuals, which will determine the election of the applied panel estimator.

$$y_{i,t} = \beta x'_{i,t} + \delta y_{i,t-1} + c_i + \varepsilon_{i,t}\,. \qquad (19)$$

Where $x'_{i,t}$ refers to a vector of strictly exogenous variables, c_i is the time invariant effect affecting each one of the t periods, $y_{i,t-1}$ is our lagged dependent variable (ratio of imports and domestically produced and consumed products in our case) and $\varepsilon_{i,t}$ is the associated error term. The compound disturbance of the model will be then defined as $c_i + \varepsilon_{i,t}$,where $\varepsilon_{i,t}\ is\ iid \sim(0, \sigma_\varepsilon^2)$

In that way, the covariance among the lagged dependent variable and the error term will be different from 0 as,

$$Cov\big[\big(y_{i,t-1}, (c_i + \varepsilon_{i,t})\big)\big] \neq 0 = \sigma_c^2 + \delta\ Cov\big[\big(y_{i,t-2}, (c_i + \varepsilon_{i,t})\big)\big]$$

Moreover, under fixed effects estimation this problem does not disappears. In that way, OLS and GLS estimators lead to an inconsistent estimation of the dynamic model (William H. Greene, 2012).

In that context, Anderson and Hsiao (1981,1982) proposed an alternative approach based on first differences and instrumental variables, rather than differences in group means (Bond, 2002).

Under this first differences approach,

$$y_{i,t} - y_{i,t-1} = \beta(x_{i,t} - x_{i,t-1})' + \delta(y_{i,t-1} - y_{i,t-2}) + \varepsilon_{i,t} - \varepsilon_{i,t-1}. \qquad (20)$$

For a purpose of illustration let´s rewrite it from the first full observation as,

$$y_{i,3} - y_{i,2} = \beta(x_{i,3} - x_{i,2})' + \delta(y_{i,2} - y_{i,1}) + \varepsilon_{i,3} - \varepsilon_{i,2} \qquad (21)$$

Where the instrumental variable proposed for $(y_{i,2} - y_{i,1})$ by Anderson and Hsiao would be $z_{i(3)} = (y_{1,1}, y_{2,1}, y_{3,1}, y_{4,1}, \dots, y_{n,1})$ for the *n* observations. In that way, a choice is made among differences and levels (no differenced variables). In the Anderson and Hsiao proposal ,then, a large number of candidates for the instruments are specified[10].

Expressed in increments terms, the equation to be estimated will be expressed as,

$$\Delta y_{i,t} = \beta(\Delta x'_{i,t}) + \delta(\Delta y_{i,t-1}) + \Delta\varepsilon_{i,t} \qquad (22)$$

The matrix for the instruments for the first full observation will be then defined as,

$$Z_{(3)} = \begin{pmatrix} y_{1,1} & x'_{1,1} & \cdots & x'_{1,T} \\ & \vdots & \ddots & \vdots \\ y_{n,1} & x'_{n,1} & \cdots & x'_{n,T} \end{pmatrix}$$

[10] For each variable, a different instrument is proposed for each of the temporal units (years) for both the first-differenced and level variables(William H. Greene, 2012).

and the covariates matrix of the equation (20) is formed by

$$X_{(3)} = \begin{pmatrix} x'_{1,3} - x'_{1,2} & \cdots & y_{1,4} - y_{1,3} \\ \vdots & \ddots & \vdots \\ x'_{n,3} - x'_{n,2} & \cdots & y_{n,4} - y_{n,3} \end{pmatrix},$$

while the dependent variable vector $Y_{(3)}$ results in

$$Y_{(3)} = \begin{pmatrix} y_{1,3} - y_{1,2} \\ y_{2,3} - y_{2,2} \\ \vdots \\ y_{n,3} - y_{n,2} \end{pmatrix}$$

The same matrix structure is set for the next $T - 3$ observations. Following Anderson and Hsiao dynamic linear model estimation, a different estimator will be set for each observation:

$$\theta_{IV} = (\theta_{(3)}, \theta_{(4)}, \theta_{(5)}, \dots, \theta_{(T-2)})$$

That way, there is a need to reconcile the T-2 estimators of θ . Under Arellano and Bond approach, we will collect the full set of estimators in a counterpart. Firstly, we will combine the sets of instruments in a single matrix, Z, where for each individual, we obtain the (T − 2) × L matrix Z_i (William H. Greene, 2012)

In this case, we consider as instruments the first T-1 observations of the predetermined variables x_i. For the case of only exogenous variables the corresponding instruments consider the T observation of x_i. (Baltagi,2005) presents some alternative configurations of Z_i that allow for mixtures of strictly exogenous and predetermined variables.

Now, under Arellano and Bond approach we can use the two stage least square estimator using the proper definitions of X_i, Y_i and the instrument matrix Z_i where the subscript i is referring to any particular associated with a specific individual (William H. Greene, 2012, p. 404).

Descriptive analysis

In this subsequent section, the goal is going to be no other than setting some general and preliminaries ideas about the evolution of imports and domestically produced domestic consumption for the three sectors included in the estimation (textiles, other-non-metallic mineral products and motor vehicles). The goal is to represent simultaneously the temporal evolution of the ratio among total imports and total domestically produced consumption (aggregating intermediate and final consumption) at the EU-28 level and the distribution of total imports as well as domestic consumption. Lastly, a brief summary statistics analysis will be deployed for each one of the three cited sectors as a previous step to the final results presentation.

OTHER NON-METALLIC MINERAL PRODUCTS

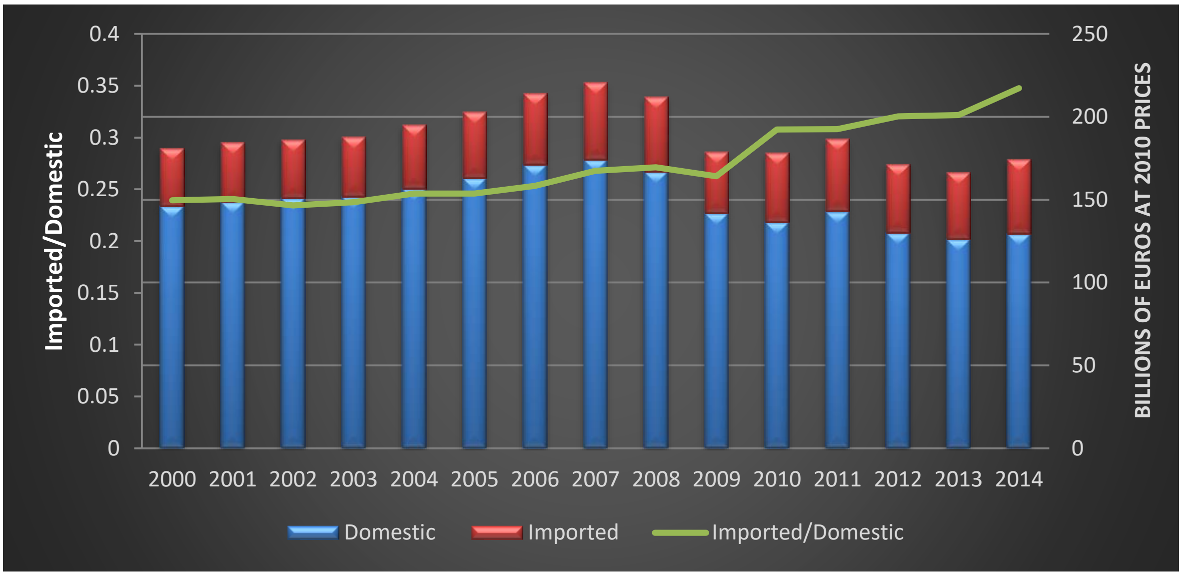


Figure 4: Temporal evolution of imported and domestically produced and consumed ratio for other non-metallic mineral products at the EU-28 level

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rates)

Regarding the temporal evolution of imports and domestic ratio in this first sector, we can see a clear predominance of domestic consumption over the total EU-28 consumption level for all the sample periods. This last aspect of the analysis could be explained by the features of the products that are included in this particular sector, which involves products not easy to transport due to the instable nature. This way, the same difficulties or instabilities in the transport constitutes a fundamental barrier in the imports flows. At the same time, we observe a positive trend in the ratio of imported-domestic consumption, something that is also seen for the other sector included in the analysis and which indicates a progressive evolution in transportation systems.

What concerns the evolution of total consumption at the EU-28 level, data clearly shows a relevant decline caused by the crisis period (around the year 2007) that has not recovered the pre-crisis levels. Given the particular nature of the sector, where intermediate demand has a relatively higher importance than final demand, the evolution of the consumption is very linked to the productive and consumption structures of manufacturing industry and construction sector. Indeed, the decline that this last sector suffered during the recession, could be one of the key factors that have contributed to the final depressive trend. (construction rates have not recovered yet pre-crisis period levels).

MOTOR VEHICLES AND OTHER TRANSPORT EQUIPMENT

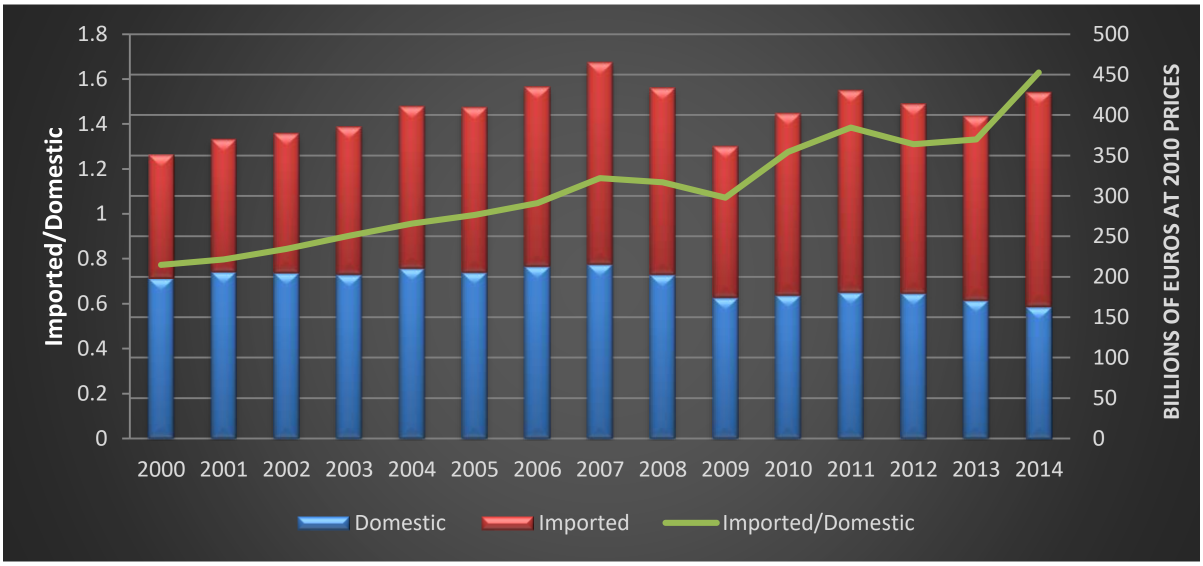


Figure 5: Temporal evolution of imported and domestically produced and consumed ratio for motor vehicles and other transport equipment at the EU-28 level

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rates)

For this second sector, the evolution of import-domestic consumption ratio shows as well as the other sectors, a positive trend. In this case, the sample started with a higher proportion of domestically produced consumption over the total, up to the year 2003 where this ratio appeared to be very close to 1. From that year on, the ratio of imported and domestic consumption has remained above the unity until the last year of the sample indicating a constant increase in the relative predominance of imports in the domestic demand for motor vehicles.

In absolute terms, the European demand for vehicles reached his peak in the year 2007 and as we all could anticipate, it falls dramatically over the following two years, registering in the year 2014 a total demand of almost 430 billion of euros. Since this setback in the total demand of motor vehicles at the EU-28 level registered in the crisis period, it seems in the year 2011 to start recovering levels close to the pre-crisis periods. However, the following years will not overpass the maximum point reached in the year 2007 (450 billion of euros).

SUMMARY STATISTICS

After having provided some descriptive insights on the evolution of domestic and imported consumption within the EU-28, and as a preliminary overview before the results, we will move into analysing briefly some descriptive statistics for our panel data framework. In this case, the mentioned descriptive statistics will be presented for each one of the two industry classifications that have been estimated. Moreover, for the prices variables, both approaches are going to be included, resulting in this way in six different price variables for each sector of activity.

Table 4: Panel statistics. Other non-metallic mineral products

VARIABLES	(1) N	(2) mean	(3) st. dev.	(4) min	(5) max
Year	420	2,007	4.326	2,000	2,014
Intermediate imports	420	1,319	1,673	10.19	8,961
Intermediate domestic	420	4,923	7,758	21.74	33,428
Final imports	420	125.0	169.8	2.711	760.1
Final domestic	420	401.6	669.1	0.497	3,053
Domestic price (Gross-output deflator)	420	95.99	15.47	42.36	166.8
Final Import Price (Gross-output deflator)	420	95.52	7.851	68.38	126.3
Intermediate Import Price (Gross-output deflator)	420	95.76	7.950	59.48	124.6
Domestic price (Value-added deflator)	420	99.12	16.09	42.36	166.8
Final Import Price (Value-added deflator)	420	98.07	5.222	75.21	127.6
Intermediate Import Price (Value-added deflator)	420	99.88	5.152	68.11	129.4

In the previous table we can observe some basic summary statistics of the data panel variables for the other non-metallic mineral products sector. For each one of the variables, four are the basic summary statistics that are going to be presented: mean, standard deviation, minimum and maximum value of the sample.

This way, we observe a higher average consumption at the intermediate classification than at the final consumption level. This fact could be partly explained by the features of the products that constitute the sector, which in his majority is formed by goods devoted to non-final consumption. That is the case of construction goods, which constitute an important part of the sector. At the same time, under both demand classifications, the average domestic consumption results higher in comparison with imported consumption. Regarding the average domestic price and imported price we have to recall that two different import prices have been approximated for each one the demand classifications. Consequently, we have reported the average import price for at the EU-28 level for both demand classifications. What we see is a very low discrepancy among the average import and domestic prices being the former slightly higher than the first two[11]. This may be partly explained by the methodology applied to the construction of import prices. While the domestic prices only take into consideration the price levels for the EU-28 countries, within import prices we have included the prices for all the 43 world regions available at WIOD databases. Therefore, as the European countries present (in average) higher price levels than non-EU countries, this explains the commented discrepancy among domestic and import prices at the EU-28 level. Lastly, but not least, we observe higher average values for price variables under the value-added approach than under the gross-output deflator approach.

Table 5: Panel statistics. Motor vehicles and other transport equipment

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Year	420	2,007	4.326	2,000	2,014
Intermediate imports	420	4,097	6,510	3.550	42,081
Intermediate domestic	420	3,793	12,590	0	82,419
Final imports	420	3,448	5,558	27.94	25,886
Final domestic	420	3,112	7,874	0	41,528
Domestic price (Gross-output deflator)	420	98.59	18.43	40.07	226.9
Final Import Price (Gross-output deflator)	420	97.78	5.313	67.59	111.7
Intermediate Import Price (Gross-output deflator)	420	97.72	4.253	79.75	109.6
Domestic price (Value-added deflator)	420	99.88	22.64	21.33	226.9
Final Import Price (Value-added deflator)	420	99.20	4.848	75.28	112.9
Intermediate Import Price (Value-added deflator)	420	99.53	5.226	85.43	133.9

In the case of motor vehicles and other transport equipment, we observe a similar pattern for the average consumption levels differentiated by demand classification. As it was the case for the previous sector, the average intermediate imports are higher than the average final imports. The same can be applied for the domestic consumption. Regarding the average values for the domestic and import prices, the reading is very similar than in the other non-metallic mineral products sector. In this case, the average value of the domestic price at the communitarian level is higher, although marginally, than prices for imports (under both demand classifications).

[11] Except in the case of average intermediate import price under the value-added approach, which is greater than the average domestic price level.

Another point that arises from the reading of the summary statistics for this particular sector is the existence of "zeros" in the sample for the domestically produced and consumed motor vehicles. This fact, is caused by the inclusion in the sample of several small countries that do not produce any product in this particular sector related to the automotive[12]. Despite the existence of "zeros" in the sample, our panel is still balanced as we do not register any missing-value from the disposable data.

Results

In the next lines the final results of the estimation are going to be detailed. The Armington elasticities values will be presented for both temporal horizons (short and long-run) and will be differentiated by the particular demand classification (intermediate and final) as well as by the selected approach for the price proxy (gross-output and value-added deflators).

Table 6: Short-run Armington elasticities by sector of activity and demand classification

SHORT-RUN ELASTICITIES				
	Gross-output deflator		Value-added deflator	
	Intermediate	Final	Intermediate	Final
Other non-metallic mineral products	0.608***	0.402	0.427***	0.563*
	(0.135)	(0.337)	(0.129)	(0.318)
Motor vehicles and other transport equipment	1.696	2.118***	3.698	1.174***
	(3.069)	(0.299)	(2.847)	(0.252)

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

For intermediate Armington elasticities, significant results have been estimated for the non-metallic mineral products and for textiles under the two different price approaches. In both sectors, Armington elasticity values are below unity, resulting in a value around 0.61 for the first sector (under Gross-output approach). In the case of the value-added approach for intermediate demand classification, the Armington elasticity is significant (at a 1% confidence level) and smaller than unity for other non-metallic mineral products.

[12] Within those countries we can find countries such as Cyprus and Malt, among others.

Regarding final demand, significant values were obtained for other non-metallic mineral products under the second approach (although we find weak significance) and for motor vehicles under two price approaches.

All the estimated short-run Armington elasticities appear to match consistently the values obtained in previous studies which go from the range of 0.14 up to 3.89 (Reinert and Roland-Holst, 1992). However, in the case of other non-metallic mineral products, the estimated elasticities under two approaches seem to be slightly lower, although not disproportionate, than the values commonly referred in the existing literature. In any case, values below unity in this particular sector are not rare to find.

Finally, regarding the economic interpretation, this could be expressed in the following way: A 1% increase in the ratio of domestic and import prices[13] lead in the case of the final demand for motor vehicles (the same reading can be applied for the other cases) to an increase in the domestic and imported consumption ratio of more than 1%. We could express then that final demand for motor vehicles, at the EU-28 level, is elastic. For values below unity the opposite reading could be performed, resulting in an inelastic demand for the particular sector of activity. In our case, we can classify as inelastic the demand for the other non-metallic mineral products.

Table 7: Long-run Armington elasticities by sector of activity and demand classification

LONG-RUN ELASTICITIES				
	Gross-output deflator		Value-added deflator	
	Intermediate	Final	Intermediate	Final
Other non-metallic mineral products	1.2039***	0.7944	0.9531***	1.0071*
Motor vehicles and other transport equipment	1.6981	2.7084***	3.5839	1.5386***

**** p<0.01, ** p<0.05, * p<0.1*[14]

In the case of long-run elasticities, the estimated values are overall consistent with the theoretical foundation that predicts higher values in the long-run than in the short-run temporal horizon (Daniel and Balistreri, 2003).

[13] That is, a relative increased of the domestic price.

[14] Delta method has been applied in order to assess the significance of the long-run elasticities. It must be recalled that long-run Armington elasticities are transformations, and not estimations. For a properly detailed explanation on how long-run elasticities are obtained, see pag.15.

In this case, the estimated long-run elasticities appear to match consistently the values obtained in previous studies which go from the range of 0.52 up to 4.83 (Gallaway et al., 2000)

For intermediate demand, we get values above unity and close to unity for the two different approaches. Regarding final demand estimated values, we find again bare significance in the first sector, and strong significance for motor vehicles under two approaches (gross-output and value-added deflator approach). In this case, all the values are above unity, especially in the case of motor vehicles, which present a relatively high value for the estimated parameter (2.7084).

Regarding the economic meaning of the long-run elasticities, this last one could be explained under a similar interpretation than in the short-run. In this case, the elastic or inelastic nature of the demand is referring long-run consumption dynamics which are, at the same time, more linked to structural changes in consumption and production schemes. This way, and as eq.22 specifies, a great persistence in the ratio of domestic and imported consumption (represented by a beta coefficient close to 1) derives this high persistence into the long-run Armington elasticity. That way, the highest the value of the correlation coefficient (beta) is, the higher the long-run Armington elasticity will be, ceteris paribus.

Conclusions and further research

The estimation of Armington elasticities have an important role to play in the Computable General Equilibrium models framework. The inclusion of these parameters in these models has seemed to follow an “arbitrary” election where estimation efforts have been limited. In this analysis we have profited from the last update of the WIOD databases in order to estimate short as well as long-run Armington elasticities for two sectors: Other non-metallic mineral products and motor vehicles and other transport equipment. Demand for domestic and imports have been divided into intermediate and final classifications, which are as well available in WIOD databases.

Regarding final results, we have obtained values for short-run Armington elasticities below unity for the first sector, while for motor vehicles and other transport equipment the resulting short-run Armington elasticities are above one. This fact, enables to classify domestic and imported products consumption into import inelastic and elastic, which has also implications in the nature of the products. Indeed, import elasticity implies that in that particular sector, domestic and imported goods are close to be perfect substitutes. This way, we can consider other non-metallic mineral products as import inelastic for intermediate and final classifications, and import elastic in the case of motor vehicles and other transport equipment. The estimation of values below unity in the first sector (other non-metallic mineral products) could be partly explained by the features of the products within this specific sector. Indeed, the technical constraints that present these products in the transportation avoid drastic consumption patterns changes among domestically product and imported other non-metallic mineral products. This is explaining what there is behind the predominance of domestic consumption over imports in this particular sector. In the case of motor vehicles and other transport equipment, the obtained values are very close to previous estimations done with WIOD databases. The elastic demand estimated for this second sector may be explained by the evolution of the sector into a scenario of increasing global competitiveness in which domestic consumers react heavily on relative changes in prices in the international market. In fact, the increasing predominance of imported motor vehicles in the total consumption of motor vehicles at the EU-28 level *(see figure 5)*, goes in line with the previous idea.

Moreover, we have obtained higher values for the long-run Armington elasticities than for the short-run, something that is also frequently described in the literature. In our case, all the long-run values for the Armington elasticities are above unity with the exception of the intermediate Armington elasticity under the value-added deflator approach.

Regarding further research there is still room to include additional exogenous variables which could control for specific factors such as free trade agreements at interregional level or custom barriers that could be affecting the current trade flow structure.

Additionally, there is a significant research interest in the estimation of NEST 2 *(see page 4)* under the release of the last version of the WIOD databases. In this new estimation of NEST 2 level elasticities, gravity models could be useful in order to capture the incidence of proximity in the import-export decision among different countries of origin. This research line could be implemented along the previous proposals referring the inclusion of additional exogenous variables for NEST 1.

Annex I: Additional graphical analysis

In this Annex 1 the goal is to represent simultaneously the temporal evolution of imports and domestic consumption (aggregating intermediate and final consumption), differentiating by two different groups of countries. On the one hand, the five biggest countries by GDP integrated in the EU-28 are going to be part of the first group and, in the other hand, the rest of the EU-28 countries will be presented. That way, the goal is to detect some different specific trends that were not analysed in section 4 that take into account the relationship among imported and domestically produced and consumed products among these two groups.

OTHER NON-METALLIC MINERAL PRODUCTS

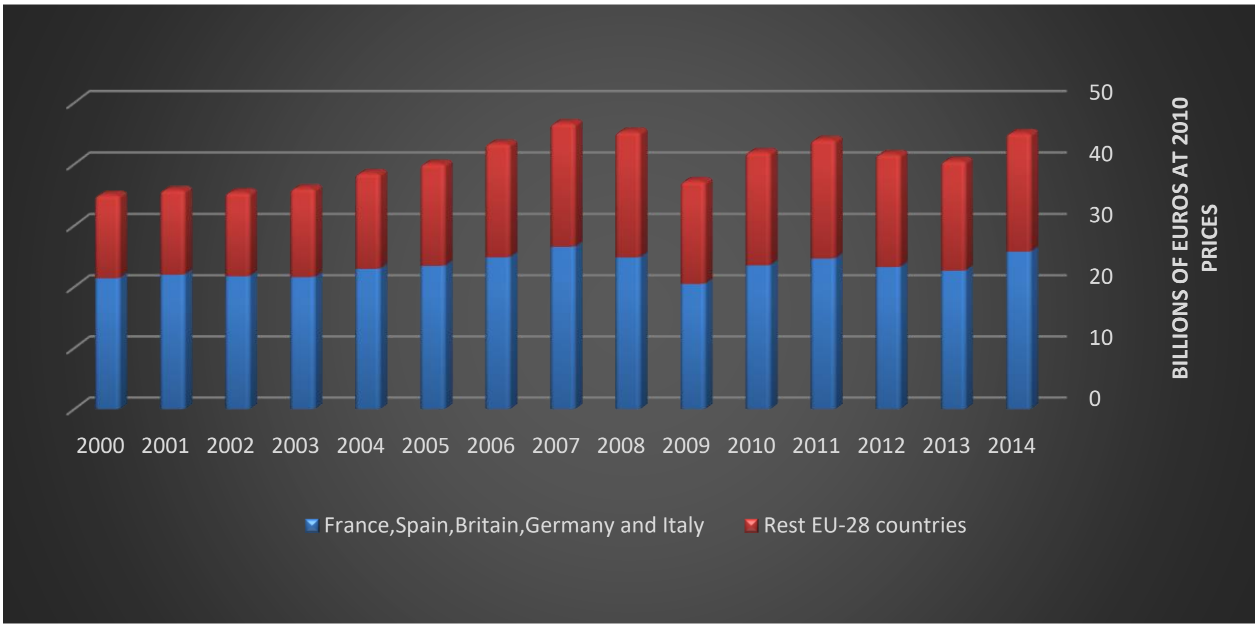


Figure 6: Temporal evolution of imported consumption at the EU-28 level of other non-metallic mineral products (disaggregated by group of countries)

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rate)

We will start by analysing the evolution of imported non-metallic mineral products. In this case, the analysis will differentiate among two different groups within the EU-28 countries. On the one hand, the evolution in both domestically produced consumption (domestic) and imported consumption will be analysed for France, Spain, Great Britain, Germany and Italy and in the other hand an analogous graphical analysis will be performed for the rest of the EU-28 countries. By doing so, we are going to be able not only to detect trends in the evolution of the consumption patterns by sector (as it has been outlined in the introduction) but to the specify the relative weight in the international trade flows and communitarian consumption.

In this case, the imported consumption on non-metallic mineral products experienced a constant growth over the first seven years of the analysis (up to the year 2007), when the imports in this particular sector of activity started to decline (motivated by the overall decrease in international trade levels caused by the recession that was starting in that year). For the next two years, the imported consumption continued to fall up to the year 2010 when the turning point in the downwards trend took place, recovering similar levels of pre-crisis consumption levels in the next four years. Overall, we can say that the main factor in the consumption pattern of imported non-metallic mineral products was not driven by particular “sector-shocks” but for a macroeconomic shock caused by the depression started in the year 2007. Nonetheless, the level of the starting available year 2000 was significantly smaller to the last year of the sample (2014), resulting the total imported consumption level of this last year of the EU-28 countries of about 42 thousands millions of euros.[15]

What regards the evolution of the relative weight in consumption within EU-28 countries, we cannot claim a relevant change in the consumption structure by group of countries, although a slight decline on the relative importance of the five biggest EU-28 countries can be observed from the year 2006.

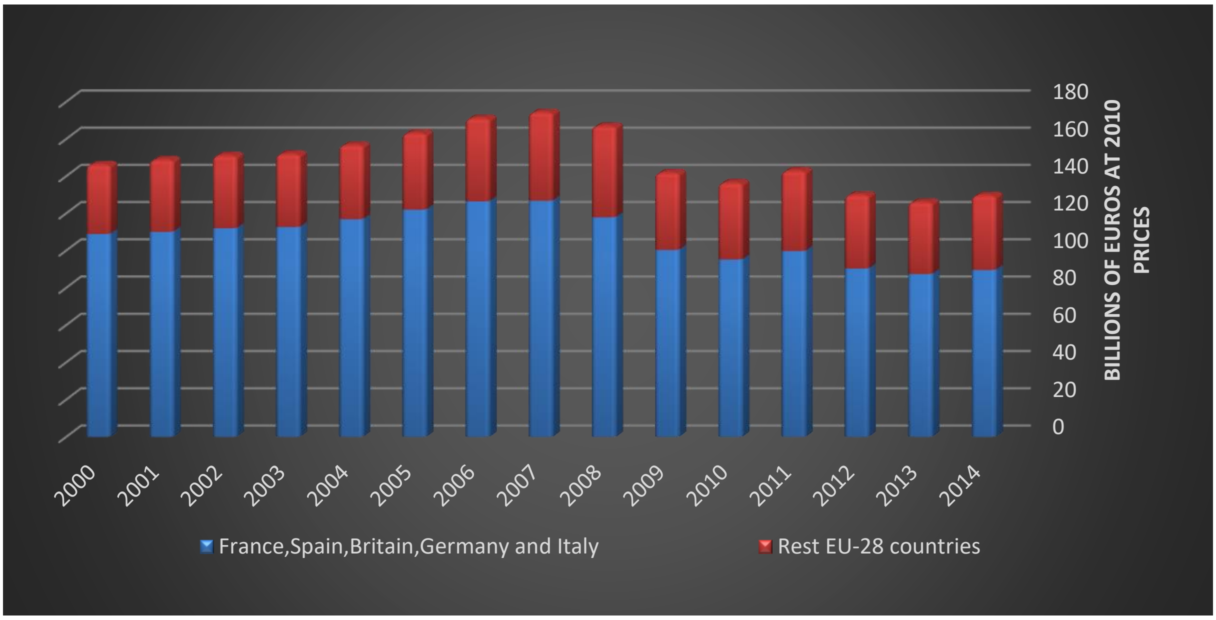


Figure 7: Temporal evolution of domestically produced consumption at the EU-28 level of other non-metallic mineral products (disaggregated by group of countries)

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rates)

[15] Consumption variables are deflated at constant prices and exchange rates (taking 2010 as the reference year).

Focusing on the analysis of domestically produced and consumed products, the first point that stands out is the clear setback in the domestically produced consumption that occurred in the year 2007. Indeed, the maximum point of consumption was reached in the pre-crisis year of 2007, and it has not recovered the pre-crisis period since then. The next aspect is no other but the predominance of domestically produced consumption with respect imported consumption in this particular sector of activity for the whole period of the analysis (2000-2014)

Moreover, we can derive another conclusion regarding the relevance of the five biggest communitarian countries in the consumption structure. What available data says, is that in both relative and absolute terms, the first group (Germany, Italy, Spain, France and Great Britain) have a clear predominance in the domestic consumption of non-metallic mineral products with regards the rest of the EU-28 countries, who rely more importantly (in relative terms) in imported consumption. This may be explained by the existence of a more productive auxiliary industry designed for the feeding of capital-intensive manufacture tractor industries in the five biggest countries.

MOTOR VEHICLES AND OTHER TRANSPORT EQUIPMENT

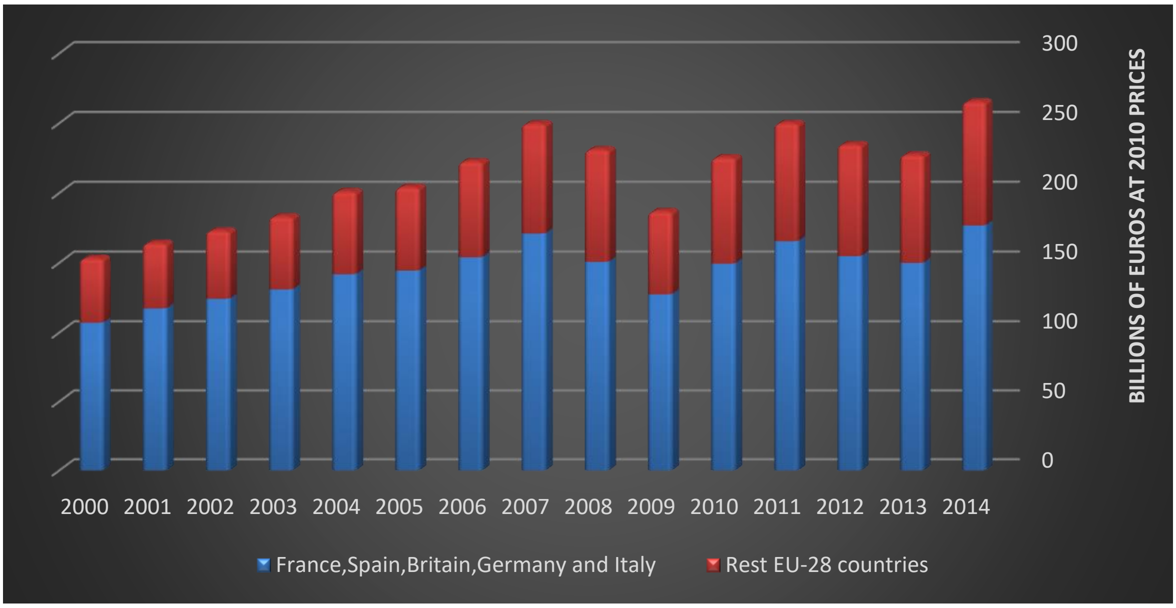


Figure 8: Temporal evolution of imported consumption at the EU-28 level of motor vehicles and other transport equipment (disaggregated by countries)

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rates)

Regarding the evolution of the imports in the motor vehicles sector, the trend that can be appreciated is pretty similar to the pattern that has been detailed for other non-metallic mineral products. As we can appreciate, the consumption of imported motor vehicles started by increasing since the first year of the sample up to the year 2007. As we all know, after the year 2007 that led to the starting point of the crisis, the consumption levels decreased overall until the year 2009, when the imported consumption of motor vehicles and other transport equipment reached his lowest level, 186.648,1 millions of euros.

After this important fall in the consumption volumes at the communitarian level, an important recovery took place in the following period reaching, in just two years, similar levels to the ones that were registered in the pre-crisis period. After this initial recovery, a slight decline followed in the years 2012 and 2013. Nonetheless, this light relapse was followed by a second recovery in the last year of the sample, reaching values slightly superior to 250.000 million euros.

Regarding the distribution of imported consumption between the two groups of countries we can see that (in relative terms) the first group (France, Spain, Italy, Great Britain and Germany) present higher levels of imports in this particular sector than in the case of textiles and similar relative values than in the case of other non-metallic mineral products.

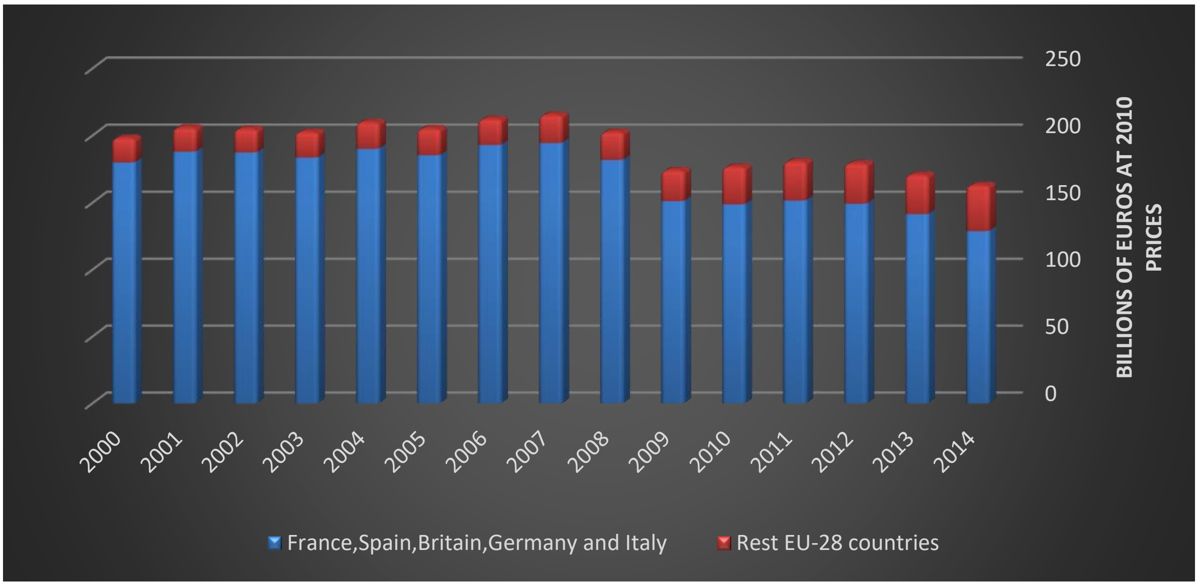


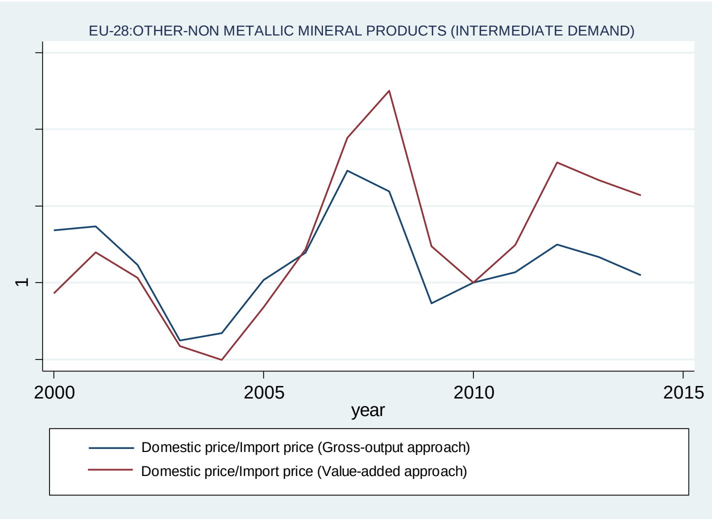
Figure 9: Temporal evolution of domestically produced consumption at the EU-28 level of motor vehicles and other transport equipment (disaggregated by group of countries)

Source: Own elaboration. Data extracted from the WIOD databases (expressed in euros at 2010 prices and exchange rates)

In the case of domestically produced domestic consumption of motor vehicles, the consumption path shows a fairly flat evolution of the consumption levels until the year 2007, where, as in the rest of the sectors, the consumption decreased significantly and did not recover the pre-crisis period levels, stabilizing around the level of 150.000 million euros.

What concerns to the consumption path by groups of countries, in this case we see clearly an overwhelming presence of the first group of countries which register the vast majority of the domestically produced consumption of motor vehicles for all the sample period. Clearly, this is an expected result as this sector is crucial in the industrial structure of the five countries included in the first group.

Annex II: Domestic and import prices



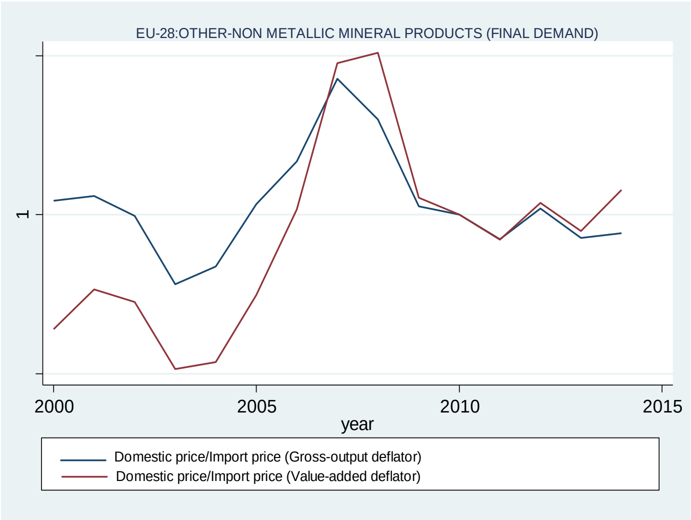
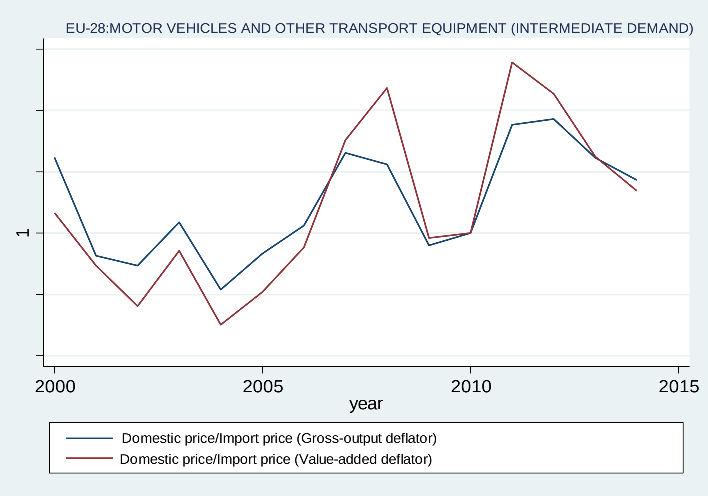


Figure 10: Evolution of the ratio of price at the EU-28 levels; other non-metallic mineral products

Source: Own elaboration. Data extracted from the WIOD databases (expressed at year 2010's exchange rates)



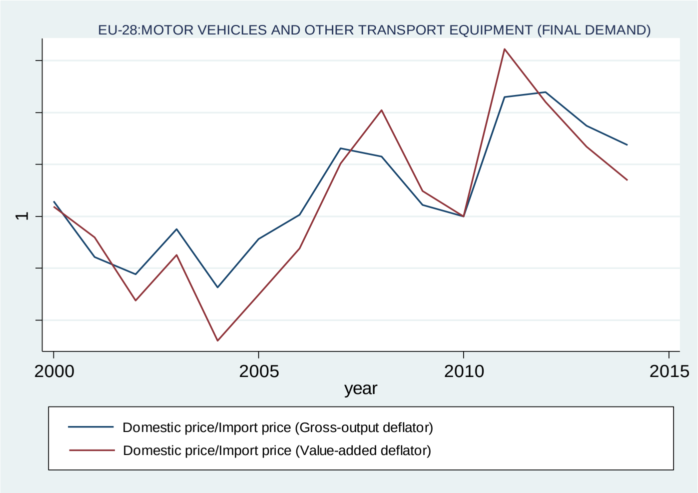


Figure 11: Evolution of the ratio of prices at the EU-29 level; motor vehicles and other transport equipment

Source: Own elaboration. Data extracted from the WIOD databases (expressed at year 2010's exchange rates)

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