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Final Degree Dissertation

Demand behaviour in Spain during the last three decades: What is the ideal microeconomic model to represent consumer preferences?

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Abstract:

This final degree dissertation analyses the recent evolution of Spanish Demand at the household level. The main aim is to study different models to discover how best to represent consumer preferences of Spanish households. Results show that the theoretical microeconomic model that best fits is the dynamic Rotterdam model, with homogeneity and symmetry restrictions imposed. Furthermore, it is possible to show how household spending has evolved in recent years. Our work will contribute to an understanding of the evolution of consumption, which represents around 60% of Spain's GDP. We provide empirical evidence, with OECD data for 36 years, taking as a sample the years from 1980 to 2015. Our central objective is to show the level of demand for three decades, allowing us to understand the degree of development, wellbeing, and growth of Spain, and to analyze in detail consumer preferences by showing results for income and price elasticities. This study tracks the evolution of income elasticities and the differences between direct and crossed price elasticities, as well as Marshallian and Hicksian price elasticities.

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1. Introduction

The study of patterns in consumer goods - and more exactly how private demand is allocated among different consumer goods -has generated broad interest throughout recent history, generating key inputs for many applications, such as changes in public finance policies and other estimations of economy-wide models.

However, little research has been undertaken concerning the latest data and most recent years of the Spanish economy in the field of private demand. Thus, the aim of this Final degree dissertation will be to show descriptive statistics of demand in Spain in the last three decades, by presenting, organizing, and summarizing all the data that has been gathered from the National Accounts of OECD Countries (OECD, 1988, 1997, 2001, 2010, 2012, 2016, 2017). The study will deal with the estimation of a range of classical models, and will select the most appropriate, following the theoretical and empirical economic fundamentals shown by Molina (1998), so that price and income elasticities can be analyzed.

According to the OECD "*Household spending is the amount of final consumption expenditure made by resident households to meet their everyday needs, such as: food, clothing, housing (rent), energy, transport, durable goods (notably, cars), health costs, leisure, and miscellaneous services. It is typically around 60% of gross domestic product (GDP) and is therefore an essential variable for economic analysis of demand".* Given the central importance of household spending, the analysis of demand in the Spanish economy can provide us with much essential information.

Analyzing demand in an economy allows us to track expenditure in such important sectors as medical and health-care systems, together with cultural activities, education, food, etc. This analysis will show household spending as a reflection of the degree of development and growth of a country, as well as progress in the wellbeing of the population. Furthermore, studying consumption allows us to identify the various economic factors that lead to higher or lower levels of demand. Therefore, expenditure within families is a primary factor in understanding the economic situation of a country. This does not deny the importance of other variables, such us distribution of income in the population, the degree of evolution of industry, natural resources, and other indicators related to financial stability. Even though these variables are important, the purpose of this final degree dissertation is to study in depth how demand has evolved during the last three decades.

Our main objective is to propose a micro-econometric model that represents the preferences of the Spanish population, through the presentation of two models that have been widely used in empirical estimations in recent years: the AIDS (Almost Ideal Demand System) model and the Rotterdam model. It has been said that *"Few papers in economics have a working life, in terms of citations and influence, longer than a decade or so. It is thus a very rare event for a paper to continue to be read, cited, taught and followed after almost half a century"* (Clements and Gao, 2014). The AIDS and Rotterdam models have not only continued to be cited, but their citations have constantly increased, year after year. Our analysis will be to compare these models to determine which of them better represents Spanish demand for the three decades under study.

Authors such as Molina (1994) has used the AIDS model to make predictions of Spanish food consumption, while others, such as Alley et al. (1992) have used the same model to estimate the demand for alcoholic beverages in British Columbia. The LAIDS (the Almost Ideal Demand System in its linear form) has been used to examine the effects of price changes on the cost of living of consumers (Molina, 1998). Moreover, this model has been used to analyse Spanish imports of vehicles, during the period 1963-1992 (Molina, 1997), and to track the economic decision-making process for Spanish Consumers (Molina, 1997). The Rotterdam Model for the estimation of demand systems (with Spanish data) has also been widely used, by authors such as Lluch (1971) and Lorenzo (1988). Regarding the estimation of demand functions in Spain, many different applications exist, such as using unemployment as a constraint in the model (García and Molina 1996).

The purpose of our theoretical model is to discover the true representation of elasticities, so that consumer preferences are shown correctly. The interpretation of the elasticities will be the key to showing how certain variables can affect demand in the groups/categories analyzed. First, we study the income elasticity and its evolution to know how variations in income affect the quantities demanded. Second, we analyze the direct and crossed price elasticities to find out how price changes affect the demand in a group. This analysis will distinguish between Marshalian and Hicksian elasticities in order to be able to appreciate the changes in demand that are associated with the income and substitution effects, and only with the substitution effect, without reflecting how the loss of real purchasing power will affect variations in the quantity demanded.

The following Section 2 is a descriptive study of demand in Spain. Section 3 explains our methodology and the data preparation. Section 4 provides a theoretical review of the different microeconomic models used. Section 5 presents the econometric methodology and the estimations of the most appropriate model. In Section 6, an analysis of the elasticities is carried out, and Section 7 lays out our conclusions. Following the bibliography, we have provided an Appendix, which includes important aspects of the study, such us the script used to estimate the system of equations.

2. Recent evolution of demand in Spain.

Before conducting the econometric analysis, it is important to examine some descriptive statistics by presenting, organizing, and summarizing the data that has been gathered, converted to a common base, and unified to maintain the trend of consumption in Spain from 1980 to 2015. The demand is analyzed for eight groups: Food**,** Clothing and footwear**,** Gross rent, fuel, and power**,** Furniture, furnishings, and equipment**,** Medical care and health, Transport and communications**,** Culture, education, and recreation, and Other goods and services. These eight categories will be analyzed, together with the total expenditure. First, we will present a brief analysis of total consumption, comparing it with the rate of growth of GDP. The years analysed are divided into sub-periods in order to attain better conclusions for the eight different groups, together with the evolution of prices and budget shares.

(Graph 2.1. about here)[1]

As can be seen in Graph 2.1., we can readily distinguish five different periods: 1980-1987, 1988-1993, 1994-2007, 2008-2012, and 2013-2015. The rate of growth of GDP follows the same pattern as the rate of growth of consumption over these five different periods. As noted in the Introduction, consumption constitutes 60% of GDP, so we can evaluate consumption by reviewing GDP and the economic-historical conditions in Spain in these years.

First Sub-period: 1980-1987.

[1] Graphs and tables are shown in Appendix I.

The data for 1980/1981 come from the last years of the transition from a dictatorship to democracy, so an increase in GDP growth is not surprising. Since 1982, Spain's economic policy was based on the control of inflation and salary moderation. At the beginning of this period, agreements were established between political parties, governments, and the trade unions, the 'Pactos de la Moncloa', concerning the devaluation of the peseta and the control of salaries. These accords led to unity among the various economic agents. This process of democratization culminated in the year 1986 with the entry of Spain to what was then known as the European Economic Community (later to become the European Union). By the year 1987, economic growth in Spain had reached 5.547%, due largely to the opening of the economy, the infusion of foreign funds, and Spanish companies beginning to be more competitive in global markets.

Second Sub-period: 1988-1993.

In 1988 the economy began to slow the rate of growth, but it was not until 1992 that Spain entered recession, where the rate of growth began to be negative.

The financial collapse of 1987 began in the Hong Kong markets and then spread to the rest of the world, with long-term effects in Spain that were mitigated, to some extent, by the high level of government investment in the Olympic Games of 1992. Perversely, these government expenditures increased the public deficit, and when the Olympics were over the Spanish economy declined again. By 1993, the reduction in GDP was striking; successive devaluations of the peseta produced high levels of inflation, that led to dramatic increases in salaries and in unemployment.

Third sub-period: 1994-2007.

During 1994 and 1995, employment grew. It is worth mentioning that between 1995 and 1996 growth is interrupted due to the non-approval of the budget and political conflicts over social security expenses. But since 1996, economic prosperity lasted for another decade. This period was characterized by the privatization of public companies, rapid growth in employment, and a real-estate boom. In 1999, a decrease in interest rates came about due to Spain's entry into the Economic Monetary Union, followed by the adoption of the Euro, which replaced the peseta in 2002. Low interest rates served to increase the demand for credit to buy real-estate and other durable consumer goods. As a result of the increased demand, companies were able to create more jobs. Immigration increased, as job opportunities sectors such as real-estate, hostelry, and domestic service produced an even greater expansion of domestic demand.

There were many incentives for private indebtedness, and speculation within the real-estate sector was rife. These incentives were associated with the creation of jobs in construction and related sectors, together with the decrease in interest rate associated with the macroeconomic stability of the eurozone. Inevitably, these factors began to weigh on Spain's economy.

Fourth sub-period: 2008-2012

Declining interest rates were accompanied by the progressive swelling of the real-estate bubble that led to high levels of debt and a growing inability to meet mortgage payments, all of which produced severe falls in GDP and very high levels of unemployment. A recovery began in 2010, but 2012 again saw the Spanish economy in crisis. Negative expectations in the Financial Markets of Spain triggered high levels of capital outflows, which led to even higher unemployment and a concomitant decline in demand.

Fifth sub-period: 2013-2015

By the end of 2013, the Spanish economy had begun to recover, ending the year with a positive rate of growth. It is important to note that Spain achieved this, in part, due to a decrease in the real effective exchange rate. This allowed exports to grow because of falling prices associated with lower salaries and higher unemployment. In other words, the Spanish economy suffered an internal devaluation. This brought more hardship for Spanish families in the year 2013. A moderate increase in GDP continued during the years 2014 and 2015, accompanied by some relief due to reductions in the unemployment rate.

We come now to a detailed examination of demand in real terms. The reference base year for our study is 2010, and we present the mean, the standard deviation, and the maximum and minimum values in each category.

(Table 2.1. about here)

As can be seen in table 2.1., the highest mean is achieved by the group Other goods and services, which includes expenditure related to restaurants, hotels, personal care, insurance, financial services, and other services.

The second-highest mean is in Housing, fuel and power. Disaggregating this group, we see that the subgroups are: Actual rentals for housing, Imputed rentals for housing[2], Maintenance and repair of the dwelling, Water supply and Electricity, and gas and other fuels. The highest mean obtained is in the subgroups related with the rentals, and the electricity. Starting with imputed rents, during the years analysed Spanish economy suffered a Real State Bubble that burst at the end of 2007. Since then, it has not been possible to observe a decrease in rent spending. Their demand has increased, on the one hand due to the complexity for obtaining credits after the crisis, together with the uncertainty of not having a permanent job position. On the other hand, a greater influx of tourists coming to Spanish cities such as Madrid, Barcelona and others, increased the rents for holiday homes (that go largely unregulated). In recent years, while it may seem that the Spanish economy is living in a Rental Bubble affecting the most popular tourist cities. Regarding electricity, the significant expenditures arise from increased taxes, and the costs of investment to support renewable energies. Since the start of the crisis, spending on electricity has continued to grow, so that electricity charges now represent about 46% of the total citizens pay (in electricity). Even though construction of nuclear power stations stopped in 1984, millions of Euros are paid each year to compensate for the investment lost. Additional costs are incurred to cover the expense of sending electricity to the Spanish islands, and subsidies are paid to a quota for the national coal, to compensate for cheaper, better-quality, imported coal. The electric companies also receive subsidies resulting from new regulations concerning free competition that have led to the entry of new companies. If this were not enough, consumers also pay 21% of VAT, along with a 5% ‘special tax’. The result is that Spanish consumers are paying the same taxes for a basic good as for a luxury good. Consequently, the group of Housing, fuel and power has one of the highest mean. Furthermore, this group shows the maximum value (after other goods) of expenditure for this period, €140,979 million. The lowest mean value of consumption is in Medical care and Health, due to the fact that the Welfare State has been growing slowly so the period of analysis started with a small amount of Euros spent in this group. The lowest minimum value is achieved also in this group during the years 1984-1985, when the period of fiscal consolidation[3]began.

[2]Imputed rentals for housing could be described as the price that the owner of a house would be willing to pay to live there.

[3] Fiscal consolidation in that case can be defined as specific policies and measures with the objective of reducing budget deficits.

As for the volatility shown in Table 2.1, measured by the standard deviation, we can see that the highest value is achieved in the group Others goods and services. In the graph 2.2, after the crisis of 2008, there is a large decline, indicating that individuals are sensitive to expenditures in restaurants, hotels, on personal care, and for all the services included in this category. This category is among the first to show an increase or decrease when there is a downturn in the economy. Housing, fuel, and power is the category with the second-highest standard deviation. Expenditure has continued to increase. The third-highest standard deviation occurs in the category of Transport and communications. As in Other goods and services, individuals attempt to cut their consumption in both communications and transport when the family economy is going through a bad period (linked to the overall economy)

(Graph 2.2 about here)

Now, we move to examine the evolution of demand in real terms[4]for the different categories in the various sub-periods, shown in Table 2.2.

(Table 2.2 about here)

The years 1980-1987 was a period of economic growth, and the groups that suffered the largest increases were Transport and communications and Other goods and services. As noted above, these categories are sensitive to the economic cycle.

In the next period (1988-1993), we can see that the groups Other goods/services and Transport and communications decreased their value with respect to the previous period, due to the fact that, during this period the Spanish economy was entering into recession. Those categories that increased the most with respect to the previous period were clothes and furniture (elements related to house, furnishings, and equipment), due to the fact that in 1986 the Spanish economy was slightly more open. There were more items to choose from, together with the possible decrease in prices due to increased competition.

What it is important to highlight is the very significant rise of medical care and health costs, by 60.6%. In this period, 1988-1993, there was a cyclical expansion in public expenditures, after the fiscal consolidation of 1984-1987, shown in graph 2.3.

(Graph 2.3 about here)

[4] The graphs showing consumption in real terms for every category can be found in Appendix II.

Between 1994 and 2007, the Spanish economy's prosperity was clearly reflected in demand. All groups had notable increases. The evolution of expenditure over this 14-year period did not stop growing. However, this pattern of continuous growth did not last. When the real-estate bubble burst, and the international financial crisis spread globally, the Spanish economy entered a period of recession, probably one of the worst crises that the economy has suffered, leading to an evident decrease in consumption in every category, except for housing and power (4.4%), due to the fact that private agents were heavily indebted in property, so that they continued to pay for housing without the possibility of decreasing this expenditure. Medical care also remained positive, with the highest rate of growth in the period (8.8%). This was associated with a range of factors: individuals need health-care, and the numbers of the elderly had been growing for years – a group who usually need more medical health care services and products. Therefore, even though the effects of the crisis were severe, the category of Medical care and health maintained positive growth. It is clear in Table 2.1 that this group has the third-lowest standard deviation, implying that health expenditures are maintained because they are not as sensitive as the demand for Other goods or services into the Economic Cycle.

From 2013 to 2015, demand for all the groups had a positive evolution, another indicator that the Spanish economy had begun to recover. The highest growth during this period was in the group Transport and communications, at 8.75%.

Concerning the full evolution from the beginning of our period of analysis in 1980 to the end in 2015, the largest increase was in health-care. The Welfare State grew slowly but steadily during this time. Disaggregating this group, we can see that the increase is largely due to advances in technology, which implied larger investments in medical products, appliances, and equipment, all while the elderly population continued to grow. The second-highest increase is in Transport and communications. In todays more globalized world (relative to the one at the beginning of the period), individuals travel more, own more personal vehicles, and online purchases have notably increased, leading to increases in shipping costs. Lowest rate of growth in this period has been in Clothes and footwear, with only a 7.9% increase.

We now move onto the analysis of the basic statistics for prices: the mean, the standard deviation, and the maximum and minimum values in each category, as shown in Table

2.3. Prices respond quickly to the arrival of new information, providing us with more in-depth information on our variable of study, demand.

(Table 2.3. about here)

(Graph 2.4. about here)

The group with the highest price average is Food. It has been increasing constantly until 1996, and then flattening out for almost 10 years. Food is followed by Education, recreation and culture, which has followed a progressive path. The lowest average is found in Housing, fuel and power, the main reason being that during the first years of this analysis this group was at one of the lowest price levels before the crisis, after which it accelerated rapidly. The group with the greatest volatility in prices is Transport and Communications, due to the fact that prices adapt to demand and, as we have seen, it is one of the groups most sensitive to economic conditions

The minimum level of prices is achieved by Other goods and services, followed closely by Housing, fuel and power. As can be seen in Graph 2.4, the group of Other goods and services prices eventually catch up to Housing, fuel and power, surpassing that category in 1985. The maximum value is attained by the prices of food in the year 2015.

Now, we analyze the evolution of prices for the different sub-periods, all the data appears in Table 2.4.

(Table 2.4. about here)

In the years 1980-1987, the lowest level of growth in prices was in Housing, fuel and power, at 80.7%. Other goods and services had the largest increase in prices, of 129.5%. In general, within this period, we can say that the agreements made in the "Pactos de Moncloa" were not the best for the economy. One such agreement was the peseta devaluation that led to high levels of inflation, so that this period had the fastest growth in total prices, due to the policies. *(First Sub-period 1980-1987)*

In the *Second Sub-period,* Food had the lowest rate of growth, at around 26%. These years were a period of crisis, which usually implies that prices do not grow at a high rate. Furthermore, it was accompanied by an opening-up of the economy, in joining the EEC. Increased competition held down the growth of prices in comparison with the earlier period, although it is worth mentioning that growth was still positive, due to the successive peseta devaluations.

In the *Third sub-period: 1994-2007* (the one before the crisis), it is important to note the rapid growth in Housing, fuel and electricity prices (72.2%). The price increase in Other goods and services is also high, since during periods of expansion individuals tend to spend more money in Restaurants, hotels, health-care, financial services, and so on. Furthermore, the bubble was also beginning to affect the financial markets. Higher levels of household spending in a bubble appeared to be capable of lasting forever, which made prices rise even more quickly. Individuals could pay more, which increased demand for services, as well as accelerating the growth of prices.

In the *Fourth sub-period:2008-2012*, prices still rose but not with the same velocity as in the period in which the economy was overheating. The fastest growth was still in Housing, fuel and power, with a 10.24% increase, while the lowest was in the group of Clothing and footwear, with a negative figure of -1.64%.

In the last period under study, we can see negative growth in prices in Transport and communications, as well as in Housing, fuel and power. The latter can be seen as a corrective mechanism after the severe increase in prices before the crisis. Additionally, there were many negative signs in this period, and any positive growth at all was very small. As in the *Fifth sub-period:2013-2015*, there was a decrease in the real effective exchange rate because of a fall in the level of prices associated with lower salaries and higher unemployment. The Spanish economy has suffered a hard internal devaluation before it could enter the recovery phase. This can be easily seen in the analysis of this Table 2.4, where the total growth of prices for this period is -1.2%.

Looking at the entire period (1980-2015), one of the largest increases are, as expected, in Housing, fuel and electricity, at 444.4 %. This group began the period with almost the lowest level of prices, but then began to accelerate. This is not due to Housing alone; the electricity bills paid by Spanish families at the end of every month also rose dramatically. The prize for the fastest growth goes to Other goods and services (insurance, financial services...), at a rate of 568.1% (from 0.16 to 1.073)

We now analyze the basic statistics for budget shares: the mean, the standard deviation, and the maximum and minimum values in each category as shown in Table 2.5. The evolution for the whole period for each category is shown in Graph 2.5.

(Table 2.5 about here)

(Graph 2.5 about here)

The group with the highest expenditure mean value in the budget share is Other goods and services, at 25%. This category includes several services, and its budget share constantly increased until the crisis, reaching the highest value (28%) over the whole period. The second-highest in terms of budget share is Food. During the years 1980 to 2002, Food had the highest percentage in the total expenditure (after other goods and services), but since 2002, Housing, fuel and power began to have the largest percentage participation in the budget (after Other goods and services). This is associated with the Real-estate Bubble *(Third sub-period: 1994-2007)*. Housing, fuel and power even surpassed the group of Other goods and services in just one year.

In general terms as can be easily appreciated in Graph 2.5., Food constantly decreased its share in the budget, and almost the same happened with Clothes and Furniture. The budget share of Culture, recreation and education more or less maintained its position, although it suffered a decrease in the most recent years. The expenditure over the total on Health and medical care progressively and smoothly increased since the beginning of the period, largely due to an increase in the elderly population, the upward trend in the Welfare State (compared to the one of Spain in 1980), and an increment in investment in new technologies and medical equipment. However, it still represents the lowest value in the budget share, together with Clothes and Furniture (this last includes: furnishings, household textiles and appliances, equipment for household garden, glassware, tableware, household utensils, and goods and services for household maintenance).

3. Methodology

The methodology followed begins by gathering all the data from the OECD, starting from the year 1980, then creating our own database. Before conducting the descriptive analysis and estimating the models, it is necessary to homogenize the data for the 36 years under analysis.

First, as different formats were used (given that the collection of data in 1980 was not the same as the one in 2015) special attention must be paid to ensure the same categories in all the periods analyzed, and making sure to convert pesetas into Euros where. Second, the demand for the different years and different groups has been converted into the same base due to the fact that the data gathered have different year bases. It was in constant and current prices: 1980, 1986, 2000, 2005 and 2010. The base selected has been the most recent, 2010.[5]

Additionally, during these years under analysis with different bases, the ways of measuring consumption have changed; meaning that for the same period (year) different values for consumption appeared with wide differences. Consequently, demand over the whole period has been unified to maintain the trend. As it is possible to observe, gathering the data has been one of the main laborious tasks.

Once all the data is organized and rationalised, an in-depth description of the values for consumption of the Spanish population during the years from 1980 to 2015 has been carried out (as we have seen in Section 2). Demand has been broken down into eight different groups: Food, Clothing and footwear, Gross rent, fuel and power, Furniture, furnishing and equipment, Health, Transport and communications, Recreation, education and cultural activities, and Other goods and services. These eight groups have been selected in order to consider the well-being and the degree of development of the country. Following this, a theoretical review of the classical models for estimating demand functions has been carried out. The models are presented in the following section.

4. Microeconomic models.

Given the necessity of estimating a system of equations, estimate at the same time 8 different equations, it should be noted that the estimation has involved a high level of complexity[6]. The different proposed models (AIDS and Rotterdam) have been estimated, and different specification tests have been applied to ensure compliance with econometric properties. That is to say, with the purpose of making sure that the residuals can be adjusted to the typical structure of white noise. Given that we are dealing with time-series data, it is important to test for joint autocorrelation in the system. Two fundamental statistics -the Harvey test (1982) and the statistic ρ- have been used. In the final stages of the process, the model that does not present autocorrelation problems and accomplishes its goal with the desired theoretical properties (rationality of the consumer) is selected to analyze in detail the elasticities.

[5] The process can be seen with more detail in Appendix III.

[6] Transcriptions used in the estimation of the models can be seen in the Appendix IV

The estimation of demand systems has been widely employed since the first theoretical model and empirical application appeared in 1954. This model was the linear expenditure system, also known as LES, was initially proposed by Richard Stone in a formulation based on a utility function of Stone-Geary (Stone, 1954). Since 1954, many theoretical and empirical papers have been published to capture the patterns of demand. To represent the demand of an entire country, as well as consumer preferences, new models were developed, such as the AIDS and the Rotterdam model.

A complete system of demand equations, known as the consumer unitary model, shows a function in which the endogenous variable, the quantity demanded, depends on other exogenous variables that are prices and the available income of consumers.

$$q_i = q_i(p, y) \qquad (i = 1, \dots, n)$$

There are different ways for obtaining a demand function. For this purpose, the literature has proposed different alternatives. From an intuitive point of view, the estimation of an expenditure or demand function should be easily carried out, but to come up with a direct or indirect utility function will be much more laborious. Therefore, we will focus in establishing an expenditure function or in formulating the demand functions directly.

Starting from an expenditure function to determine the Complete System of Demand Equations, the best-known model is the AIDS. The Almost Ideal Demand System is one most often applied in empirical works. It stems from a PIGLOG expenditure function, which, when working with logarithms, is a more flexible and less restrictive function than that obtained with the LES (Deaton and Muellbauer 1980). Among the models that are formulated directly, with no associated utility or expenditure function, we highlight the Rotterdam Model (Barten, 1964 and Theil, 1965).

Before an in-depth analysis of the models, it is necessary to examine certain properties developed from economic theory. On the one hand, they highlight characteristics and implications in the consumer-optimization process. On the other hand, these properties can be seen as restrictions on the model and imposed in the empirical specification. The five restrictions fall into two distinct groups: the Engel and Cournot adding-up restrictions, obtained from the budgetary restriction, and the Homogeneity, Symmetry, and Negativity conditions, gathered from the consumer optimization process. They are defined as follows:

1. Engel adding-up condition:

   Any variation appearing in the available income of the consumer should be absorbed by the variation of quantities demanded over the different goods, leading to:

   $$\sum_{i}^{n} w_i e_i = 1$$

   With w_i being the percentage spent in the acquisition of Qi and e_i the income elasticity for the demand of Qi.

2. Cournot adding-up condition:

   Variations in prices of any good are captured by changing the demand of other goods, meaning that a change in price will produce a change in the equilibrium:

   $$\sum_{i}^{n} w_i e_{ij}^{y} = -w_j \qquad j = 1, \dots, n$$

   With e_{ij}^{y}being the crossed-price elasticity.

3. Homogeneity condition:

   Given that the demand functions q (p,y) are homogeneous of degree zero in prices and income, this means that when the available income increases along with prices, the consumer will not increase the quantity demanded.

   $$\sum_{j}^{n} e_{ij}^{y} = -e_i$$

4. Symmetry condition:

   The crossed effects are equal

   $$S_{ij} = S_{ji} \qquad (i \neq j; i, j = 1, \dots, n)$$

5. Negativity condition:

   When the price of a particular good increases, the quantity demanded will decrease, and vice-versa.

4.1.Almost ideal demand system

The AIDS was proposed in 1980 by two authors, Deaton and Muellbauer, from an expenditure function with PIGLOG preferences. This function implies a high degree of flexibility.

$$\log c(p, u) = (1 - u)\ \log a(p) + u\ \log b(p)$$

Where 0 < u < 1, the homogeneous linear functions a (p) y b (p) can be interpreted as the subsistence expenditure when u = 0. The maximum is satisfied when u=1. The authors chose to work with logs in such a way as to obtain a flexible expenditure function:

$$\log a(p) = \alpha_o + \sum_{k}^{n} \alpha_k \log p_k + \frac{1}{2}\sum_{k}^{n}\sum_{j}^{n} \gamma_{kj}^{*} \log p_k \log p_j$$

$$\log b(p) = \log a(p) + \beta_o \prod_{k} p_k^{\beta_k}$$

Substituting, we obtain the following expenditure function:

$$\log c(p,u) = \log a(p) - u \log a(p) + u \log b(p) =$$

$$= \log a(p) - \mathrm{u} \log a(p) + u \log a(p) + u\beta_o \prod_{k} p_k^{\beta_k} =$$

$$= \log a(p) + u\beta_o \prod_{k} p_k^{\beta_k}$$

$$\log c(p,u) = \alpha_o + \sum_{k}^{n} \alpha_k \log p_k + \frac{1}{2}\sum_{k}^{n}\sum_{j}^{n} \gamma_{kj}^{*} \log p_k \log p_j + u\beta_o \prod_{k} p_k^{\beta_k}$$

With $\alpha_o,\ \beta_i and \gamma_{ij}^{*}$being parameters.

The demand functions are obtained by applying Hotelling's Theorem to the cost function:

$$\frac{\partial c(p,u)}{\partial p_i} = h_i$$

Multiplying both sides by $p_i/c(p,u)$:

$$\frac{\partial c(p,u)}{\partial p_i}\frac{p_i}{c(p,u)} = \frac{\partial \log c(p,u)}{\partial \log p_i} = \frac{p_i h_i}{c(p,u)} = w_i$$

Where w_i is the budgetary share in the good i.

To obtain this logarithmic derivative, first the function is developed as follows:

$$\log c(p,u) = \alpha_o + \alpha_1 \log p_1 + \cdots + \alpha_i \log p_i + \cdots + \alpha_n \log p_n +$$

$$+ \frac{1}{2}\gamma_{11}^{*}(\log p_1)^2 + \cdots + \frac{1}{2}\gamma_{1i}^{*} \log p_1 \log p_i + \cdots + \frac{1}{2}\gamma_{1n}^{*} \log p_1 \log p_n +$$

$$+\frac{1}{2}\gamma_{21}^{*}\log p_2 \log p_1+\cdots+\frac{1}{2}\gamma_{2i}^{*}\log p_2 \log p_i+\cdots+\frac{1}{2}\gamma_{2n}^{*}\log p_2 \log p_n+\ldots+$$

$$+\frac{1}{2}\gamma_{i1}^{*}\log p_i \log p_1+\cdots+\frac{1}{2}\gamma_{ii}^{*}\log(p_i)^2+\cdots+\frac{1}{2}\gamma_{in}^{*}\log p_i \log p_n+\cdots+$$

$$+\frac{1}{2}\gamma_{n1}^{*}\log p_2 \log p_1+\cdots+\frac{1}{2}\gamma_{ni}^{*}\log p_n \log p_i+\cdots+\frac{1}{2}\gamma_{nn}^{*}(\log p_n)^2+$$

$$+u\beta_o p_1^{\beta_1}p_2^{\beta_2}\ldots p_i^{\beta_i}\ldots p_n^{\beta_n}$$

Making the derivative:

$$\frac{\partial \log c(p,u)}{\partial \log p_i}= \alpha_i+\frac{1}{2}\gamma_{1i}^{*}\log p_1+\frac{1}{2}\gamma_{2i}^{*}\log p_2+\cdots+\gamma_{ii}^{*}\log p_i+\cdots+\frac{1}{2}\gamma_{ni}^{*}\log p_n+$$

$$+\frac{1}{2}\gamma_{i1}^{*}\log p_1+\frac{1}{2}\gamma_{i2}^{*}\log p_2+\cdots+\frac{1}{2}\gamma_{in}^{*}\log p_n+\cdots+u\beta_o p_1^{\beta_1}\ldots p_n^{\beta_n}\frac{\partial(p_i^{\beta_i})}{\partial \log p_i}$$

Given that:

$$\frac{\partial(p_i^{\beta_i})}{\partial \log p_i}=\frac{\partial(p_i^{\beta_i})}{\partial p_i}\frac{\partial p_i}{\partial \log p_i}=\beta_i p_i^{\beta_i-1}p_i=\beta_i p_i^{\beta_i}$$

Thus, we obtain:

$$w_i=\alpha_i+\sum_{j}^{n}\gamma_{ij}\log p_j+\beta_i u\beta_o\prod_{k}p_k^{\beta_k}$$

$$being\ \gamma_{ij}=\frac{1}{2}(\gamma_{ij}^{*}+\gamma_{ji}^{*})$$

The rational agent will spend all the income:

$$y=c(p,u)\rightarrow \log y=\log c(p,u)$$

$$\log c(p,u)=\alpha_o+\sum_{k}^{n}\alpha_k\log p_k+\frac{1}{2}\sum_{k}^{n}\sum_{j}^{n}\gamma_{kj}^{*}\log p_k\log p_j+\ u\beta_o\prod_{k}p_k^{\beta_k}$$

Where;

$$u\beta_o\prod_{k}p_k^{\beta_k}=\log y-\alpha_o-\sum_{k}^{n}\alpha_k\log p_k-\frac{1}{2}\sum_{k}^{n}\sum_{j}^{n}\gamma_{kj}^{*}\log p_k\log p_j$$

And by substituting the Hicksian demands, we obtain the Marshalian demands. A different form has been used for log P in the empirical estimation known as Stone's Index approximation (Wong et al., 2017)

$$w_i = \alpha_i + \sum_j^n \gamma_{ij} \log p_j + \beta_i \left[\log y - \alpha_o - \sum_k^n \alpha_k \log p_k - \frac{1}{2} \sum_k^n \sum_j^n \gamma_{kj}^* \log p_k \log p_j \right]$$

$$w_i = \alpha_i + \sum_j^n \gamma_{ij} \log p_j + \beta_i \log \frac{y}{P} (i = 1, \dots, n)$$

$$\log P = \alpha_o + \sum_k^n \alpha_k \log p_k + \frac{1}{2} \sum_k^n \sum_j^n \gamma_{kj}^* \log p_k \log p_j$$

In this way, the AIDS for n goods includes n equations and n+2 parameters per equation:

$$\begin{cases} w_1 = \alpha_1 + \gamma_{11} \log p_1 + \gamma_{12} \log p_2 + \cdots + \gamma_{1i} \log p_i + \cdots + \gamma_{1n} \log p_n + \beta_1 \log \frac{y}{P} \\ w_2 = \alpha_{12} + \gamma_{21} \log p_1 + \gamma_{22} \log p_2 + \cdots + \gamma_{2i} \log p_i + \cdots + \gamma_{2n} \log p_n + \beta_2 \log \dfrac{y}{P} \\ \dots \\ w_n = \alpha_{n1} + \gamma_{n1} \log p_1 + \gamma_{n2} \log p_2 + \cdots + \gamma_{ni} \log p_i + \cdots + \gamma_{nn} \log p_n + \beta_n \log \dfrac{y}{P} \end{cases}$$

The restrictions that the theory establishes on the model are adding-up, homogeneity, symmetry, and negativity. These restrictions can be verified testing certain linear restrictions in the parameters of the system.

First, the aggregation condition requires:

$$\sum_i^n w_i = 1 \rightarrow \sum_i^n \alpha_i = 1; \sum_i^n \gamma_{ij} = \sum_i^n \beta_i = 1 \qquad (j = 1, \dots, n)$$

Second, the homogeneity property establishes that the functions are homogeneous of degree zero in prices and incomes, given that $\theta > 0$:

$$w_i(\theta p, \theta y) = w_i(p, y) \rightarrow \sum_j^n \gamma_{ij} = 0 \qquad (i = 1, \dots, n)$$

Third, the symmetry imposes that:

$$S_{ij} = S_{ji} \rightarrow \gamma_{ij} = \gamma_{ji} \qquad (i \neq j; \quad i, j = 1, \dots, n)$$

Finally, the condition of negativity establishes that the cross-substitution matrix $\{S_{ij}\}$ will be negative and semi-definite. This last property cannot be imposed on the parameters of the model, as the other conditions previously stated. However, it is possible to test this condition using the estimated parameters.

Obtaining the elasticity expressions and beginning with price elasticity, given that:

$$q_i = \frac{y w_i}{p_i}$$

$$e_{ij} = \frac{\partial \log q_i}{\partial \log p_j} = \frac{\partial \log y}{\partial \log p_j} + \frac{\partial \log w_i}{\partial \log p_j} - \frac{\partial \log p_i}{\log p_j} = -\delta_{ij} + \frac{\partial \log y}{\partial \log p_j} + \frac{\partial \log w_i}{\partial \log p_j}$$

From this equation, the marshalian price elasticities are obtained, considering $\frac{\partial \log y}{\partial \log p_i} = 0$

$$e_{ij}^{y} = -\delta_{ij} + \frac{\partial \log w_i}{\partial \log p_j}$$

Therefore, the marshalian price elasticities are:

$$e_{ij}^{y} = -\delta_{ij} + \frac{\partial w_i}{\partial \log p_j} \frac{1}{wi} = -\delta_{ij} \left[\gamma_{ij} - \beta_i \frac{\partial \log P}{\partial \log p_j} \right] \frac{1}{w_i}$$

$$\frac{\partial \log P}{\partial \log p_j} = \alpha_j + \sum_{k}^{n} \gamma_{kj} \log p_k$$

On the other hand, the income elasticity is given by:

$$e_i = \frac{\partial \log q_i}{\partial \log y} = 1 + \frac{\partial \log w_i}{\partial \log p_j} = 1 + \frac{\beta_i}{w_i} \qquad (i, j = 1, \dots, n)$$

Finally, the hicksian price elasticities will be:

$$e_{ij}^{u} = e_{ij}^{y} + e_i w_j \qquad (i = 1, \dots, n)$$

4.2.Rotterdam Model

The other model that will be applied in this work is the Rotterdam model, which is not associated with any particular utility function. It was proposed initially by Barten (1964 and 1967) and Theil (1965) and developed then by Theil (1975 and 1976). This model starts from a general demand system which is approximated through its logarithmic differentiation:

$$q_i = q_i(p, y) \qquad (i = 1, \dots, n)$$

$$dlogq_i = \frac{\partial \log q_i}{\partial \log p_1} dlogp_1 + \cdots + \frac{\partial logq_i}{\partial logp_n} dlogp_n + \frac{\partial logq_i}{\partial logy} dlogy$$

$$= \sum_j^n \frac{\partial \log q_i}{\partial \log p_j} dlogp_j + \frac{\partial \log q_i}{\partial \log y} dlogy$$

$$dlogq_i = \sum_j^n e_{ij}^y dlogp_j + e_i dlogy$$

With e_{ij}^y and $e_i$being the Marshallian price and income elasticities.

In order to obtain the demand equation, it is recalled that the Slutsky Equation is $e_{ij}^y = e_{ij}^u - w_j e_i$. Substituting :

$$dlogq_i = \sum_j^n e_{ij}^u dlogp_j + e_i dlogy - \sum_j^n w_j e_i \log p_j =$$

$$= \sum_j^n e_{ij}^u dlogp_j + e_i \left[dlogy - \sum_j^n w_j \log p_j \right]$$

And multiplying both sides by w_i

$$w_i d \log q_i = \sum_j^n w_i e_{ij}^u dlogp_j + w_i e_i \left[dlogy - \sum_j^n w_j d \log p_j \right]$$

So that:

$$\theta_{ij}^* = w_i e_{ij}^u = \frac{p_i q_i}{y} \frac{p_j}{q_i} \left(\frac{\partial q_i}{\partial p_j} \right)_u = \frac{p_i p_j}{y} \left(\frac{\partial q_i}{\partial p_j} \right)_u$$

$$\mu_j = w_j e_i = \frac{p_j q_j}{y} \frac{y}{q_i} \frac{\partial q_i}{y} = p_j \frac{\partial q_i}{\partial y}$$

Therefore;

$$w_i d \log q_i = \sum_j^n \theta_{ij}^* dlogp_j + \mu_j \left[dlogy - \sum_j^n w_j d \log p_j \right]$$

The term between brackets is $dlog\bar{y}$ where $\bar{y} = y/p$ .In order to see that, the budgetary equation is differentiated:

$$y = \sum_{j}^{n} p_j q_j$$

$$dy = \sum_{j}^{n} p_j dq_j + \sum_{j}^{n} q_j\, dp_j \rightarrow \ \frac{dy}{y} = \sum_{j}^{n} \frac{p_j q_j}{y}\frac{dq_j}{q_j} + \sum_{j}^{n} \frac{q_j q_j}{y}\frac{dp_j}{p_j} \rightarrow$$

$$\rightarrow dlogy = \sum_{j}^{n} w_j dlogq_j + \sum_{j}^{n} w_j dlogp_j = dlogq + dlogp$$

Then;

$$dlog\bar{y} \ = d\log y - d\log p = d\log y - \sum_{j}^{n} w_j dlogp_j$$

Consequently, the Rotterdam model is as follows:

$$w_i d\log q_i = \sum_{j}^{n} \theta_{ij}^{*} dlogp_j + \mu_j\, dlog\bar{y}$$

$$w_i d\log q_i = \theta_{i1}^{*} dlog\, p_1 + \cdots + \theta_{in}^{*} dlogp_n + \mu_j dlog\bar{y} \quad (i = 1, \ldots, n)$$

Thus, the complete system of Rotterdam demand equations for n goods includes n equations with n+1 parameters per equation:

$$\begin{cases} w_1 d\log q_1 = \theta_{11}^{*} dlogp_1 + \cdots + \theta_{1n}^{*} dlogp_n + \mu_1 dlog\bar{y} \\ w_2 d\log q_2 = \theta_{21}^{*} dlogp_1 + \cdots + \theta_{2n}^{*} dlogp_n + \mu_2 dlog\bar{y} \\ \ldots \\ w_n d\log q_n = \theta_{n1}^{*} dlogp_1 + \cdots + \theta_{nn}^{*} dlogp_n + \mu_n dlog\bar{y} \end{cases}$$

The theoretical conditions to impose can be verified by testing certain linear restrictions on the coefficients of the model:

$$\sum_{i}^{n} \mu_i = 1\,, \sum_{i}^{n} \theta_{ij}^{*} = 0 \quad (j = 1, \ldots, n) \qquad\qquad Adding - up$$

$$\sum_{j}^{n} \theta_{ij}^{*} = 0 \quad (i = 1, \ldots, n) \qquad\qquad Homogeneity$$

$$\theta_{ij}^{*} = \theta_{ji}^{*} \qquad (j, i = 1, \ldots, n) \qquad\qquad Symmetry$$

Finally, from the expressions obtained, the expenditure and price elasticities will be specified easily. First, recalling that $\theta_{ij}^{*} \ = w_i e_{ij}^{u}$, the hicksian price elasticity will be:

$$e_{ij}^{u} = \frac{\theta_{ij}^{*}}{w_i} \qquad (i,j = 1,\dots,n)$$

In the same way, from $\mu_i = w_i e_i$, we obtain the expenditure elasticity:

$$e_i = \frac{\mu_i}{w_i} \quad (i = 1,\dots,n)$$

Finally, the Slutksy Equation allows to obtain the marshalian price elasticity:

$$e_{ij}^{y} = e_{ij}^{u} - w_j e_i \quad (i,j = 1,\dots,n)$$

5. Econometric methods.

5.1. SURE estimation.

The process for the econometric estimation of the models previously explained begins with the general specification. The stochastic formulation is obtained by adding one perturbation per equation. The perturbationsu_i, represent stochastic variables that gather changes in preferences, errors from the mean in the dependent variable, and the effect in the omitted variables:

$$\begin{cases} w_{1=}w_1(p_1, p_2, \dots, p_n, y) + u_1 \\ w_{2=}w_2(p_1, p_2, \dots, p_n, y) + u_2 \\ \dots \\ w_{n=}w_n(p_1, p_2, \dots, p_n, y) + u_n \end{cases}$$

Some of the theoretical properties that a complete system of demand equations should fulfill imply certain restrictions in the model, for example, the aggregation condition $\sum_i u_{i=}0$.Thus, from the n equations of the system, only n-1 are independent. In order to avoid the singularity of the variance matrix, we should remove an equation from the initial system and estimate the subsystem of the n-1 equations:

$$\begin{cases} w_{1=}w_1(p_1, p_2, \dots, p_n, y) + u_1 \\ w_{2=}w_2(p_1, p_2, \dots, p_n, y) + u_2 \\ \dots \\ w_{n-1=}w_{n-1}(p_1, p_2, \dots, p_n, y) + u_{n-1} \end{cases}$$

This could be expressed in the matrix form:

$$\begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_{n-1} \end{bmatrix} = \begin{bmatrix} X & & & \\ & X & & \\ & & \dots & \\ & & & X \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \dots \\ \beta_{n-1} \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \\ \dots \\ u_{n-1} \end{bmatrix}$$

The estimation of this model as $w = X\beta + u$ by OLS (OLS estimation of every equation separately) will not be optimum if the normal assumptions of errors with mean cero,$E(u_{it}) = 0, \forall i \text{ and } \forall t,$ are considered. The contemporary correlation implies that the endogenous variables are inter-related at each moment of time through their stochastic components. On the other hand, the non-existence of serial correlation implies that the endogenous variables are not inter-related at different moments of time.

$$E(u_{it}^2) = \sigma_{ii}, \forall i \text{ and } \forall t, \qquad E(u_{it,}u_{jt}) = \sigma_{ij}, \forall i, j \text{ and } \forall t$$

$$E(u_{it,}u_{is}) = 0, \forall i \text{ and } \forall t \neq s, \qquad E(u_{it,}u_{js}) = 0, \forall i, j \text{ and } \forall t \neq s$$

Thus, E(u)=0, and the variance and covariance matrix E(uu')=$\sum\otimes V$=I_T are:

$$\sum = \begin{bmatrix} \sigma_{11} & \sigma_{12} & & \sigma_{1n} \\ \sigma_{21} & \sigma_{22} & & \sigma_{2n} \\ & \dots & \dots & \\ \sigma_{n1} & \sigma_{n2} & & \sigma_{nn} \end{bmatrix}$$

The existence of contemporary correlation shows that the endogenous variables of the model contain important information about the remaining variables. This leads us to consider that the estimation of all the variables together will provide more information. It will be more efficient to work with all of them together than to work with each of them separately. Therefore, we can benefit from the information provided by the existing correlation between the error terms. Consequently, the system of demand equations should be considered as a group and be estimated by GLS (generalized least squares) The estimator in GLS of β is:

$$b^* = (X'V^{-1}X)^{-1}X'V^{-1}Y$$

$$Being\ V^{-1} = \sum \otimes I_T$$

Given that $\sum is$ unknown, it will be complicated to obtain b*. To solve this problem, Zellner (1962) proposed a two-stage procedure in which b* is substituted by an estimation obtained from the residuals, calculated by applying OLS to every equation in the subsystem separately, then using the matrix to get the GLS vector of parameters.

The estimator obtained following this procedure is called SURE (seemingly unrelated regression equations):

$$\widehat{b^*} = (X'\hat{V}^{-1}X)^{-1}X'\hat{V}^{-1}W$$

With $\hat{V}^{-1}$, being the estimation of V^{-1}

This SURE method of joint estimation, as has been shown by Zellner, provides efficient estimators and asymptotic equivalents to the ones obtained through the Maximum Likelihood method with complete information. The particular advantages of this type of estimation are, on the one hand, the benefits from estimating all the variables together, due to the fact that it takes into account the contemporary correlation among the perturbations. On the other hand, the possibility of testing a theoretical property implies that restrictions between the parameters of the different equations could be established.

Once the model has been estimated, specification tests should be applied, with the aim of ensuring that the system accomplishes the desired econometric properties. These tests make sure that the residuals can be adjusted to the typical structure of white noise. In particular, given that the type of data processed is time-series, it would be necessary to test for joint autocorrelation in the system. Two fundamental statistics -the Harvey tests (1982) and the statistic ρ- can be used. The Harvey test (1982) begins with the initial model that is expressed in general terms, $w_{it} = X_i B_i + u_{it}$. First, the residual regression is obtained for each of the estimated equations in the initial model, with its values lagged one period, $u_{it} = r_i u_{it-1} + \varepsilon_{it}$, where r_i is the individual autocorrelation coefficient, and ε_{it} is a random perturbation distributed normally with mean zero and constant covariance. The product of the sample size by the sum of the autocorrelation coefficients squared is distributed asymptotically asX^2, with many degrees of freedom as residual regressions have been performed. The null hypothesis of no autocorrelation will be rejected when the Harvey statistic value is higher than the critical value in the X^2distribution tables. The ρ statistic is obtained in a similar way to the Harvey test beginning, again, from the general model $w_{it} = X_i B_i + u_{it}$, assuming that the error is specified as $u_{it} = \rho u_{it-1} + \varepsilon_{it}$, where ρ is the common autocorrelation coefficient to all the equations of the system, and ε_{it} is a random perturbation distributed as previously specified. Substituting this hypothesis in the initial model, we obtain:

$$w_{it} = X_t B_i + \rho(w_{it-1} - X_{i-1}B_i) + \varepsilon_{it}$$

The individual significance of the autocorrelation coefficient ρ individual significance is tested by means of the statistic t-Student, asymptotically deduced from the joint estimation. The null hypothesis of no autocorrelation, $H_o: \rho = 0$, is rejected when the coefficient value of the t of the estimator is higher than the critical value in tables.

As regards the statistics used to test the theoretical hypothesis, the usual test is Wald (W), this is distributed asymptotically as X^2 with as many degrees of freedom as the restrictions being tested. However, given that this test is biased to the rejection of the null hypothesis, it is adjusted by a correction factor in order to approximate the asymptotic distribution to the finite one. In this sense, it is possible to explain the factor proposed by Mauleón (1984), which is defined as follows: FC = (1-n/T)(1-k/T), with n being the number of equations estimated in the system, k the number of parameters of the equation, and T the sample size. Consequently, the W test corrected is WxFC and it will also be distributed as X^2 with as many degrees of freedom as the restrictions tested.

5.2. Model estimation

The first estimation of the AIDS is the static version:

$$\begin{cases} w_{1t} = \alpha_{10} + \gamma_{11} \log p_{1t} + \cdots + \beta_{1n+1} \log \left(\frac{Y_t}{P_t^*}\right) + u_{1t} \\ w_{2t} = \alpha_{20} + \gamma_{21} \log p_{1t} + .. + \beta_{2n+1} \log \left(\frac{Y_t}{P_t^*}\right) + u_{2t} \\ \ldots \\ w_{n-1t} = \alpha_{n-10} + \gamma_{n-11} \log p_1 + \cdots + \beta_{n-1n+1} \log \left(\frac{Y_t}{P_t^*}\right) + u_{n-1t} \end{cases}$$

Testing for the existence of autocorrelation problems, in this particular case, the Harvey test yields H= 44.02, which is a higher value than the critical value in tables of the distribution X^2 with 7 degrees of freedom at a significance level 5%, 14.067. Given the problems of autocorrelation that the static version exhibits, we follow the steps of Deaton and Muellbauer (1980), who chose to make the model dynamic by specifying the independent term as a function of the lagged endogenous variable and of a temporal trend. When we add only the lag of the dependent variable, the H obtained is equal to 13.82, closer to the critical value of 14.067. However, when we add a temporal trend, the Harvey test will be H=7.8395. This H is well below the critical value, implying that it is not possible to reject the null hypothesis of no autocorrelation. Therefore, the new formulation for each equation will add $\alpha_{it} = \alpha_i + \alpha w_{it-1} + \alpha_i t$.

Then, it is necessary to test for the theoretical hypothesis of homogeneity and symmetry. The values in the Wald corrected test, with the factor correction being equal to FC=(1-(7/35))*(1-(11/35)), are as follows: WC= 51.33 for homogeneity and WC= 123.82 for the homogeneity and symmetry. Both of them surpass the critical values in tables of the distribution X^2 with 7 and 28 degrees of freedom (at a significance level of 5%), of 14.067 and 41.337, respectively. Thus, both hypotheses are rejected statistically.

In conclusion, the AIDS static version, as well as the AIDS estimated dynamic models does not satisfy the minimum requirements when using Spanish Temporal Series from 1980 to 2015 of the eight groups (Food, Clothing and footwear, Gross rent, fuel and power, Furniture, furnishings and equipment, Medical care and health, Transport and communications, Culture, education and recreation, and Other goods and services). Consequently, the estimated model cannot be used to obtain meaningful conclusions, from a strict economic point of view.

Then, the Rotterdam model is estimated. The same process as before is followed.

$$\begin{cases} w_{1t} d\log q_{1t} = \theta^*_{11} dlogp_{1t} + \cdots + \mu_1 dlog\bar{y}_t + u_1 \\ w_{2t} d\log q_{2t} = \theta^*_{21} dlogp_{1t} + \cdots + \mu_2 dlog\bar{y}_t + u_2 \\ \ldots \\ w_{n-1t} d\log q_{n-1t} = \theta^*_{n-11} dlogp_{1t} + \cdots + \mu_{n-1t} dlog\bar{y}_t + u_{n-1t} \end{cases}$$

With the static version of the model, this system presents a Harvey test value of H= 9.6454, clearly below the critical value in tables of the distribution X^2 with 7 degrees of freedom, of 14.067; that is to say, it is possible to reject the presence of autocorrelation. Then, testing for the theoretical hypothesis of Homogeneity and symmetry, the values of the Wald corrected tests(FC=(1-(7/35))*(1-(9/35))=0.59) for the static version are WC=16.07 for the homogeneity condition and WC=44.4704 for both, homogeneity and symmetry, that are higher than the critical values in tables of the distribution X^2 with 7 and 28 degrees of freedom at a significance level of 5%, of 14.067 and 41.337. Therefore, these hypotheses can be rejected statistically. Consequently, Homogeneity and Symmetry are not accomplished in the model. Therefore, our next step will be consider a dynamic model to observe if the model accomplishes the desired theoretical properties, as before, we add a constant, a lag of the dependent variable and a temporal trend for each equation.

$$\alpha_{it} = \alpha_i + \alpha Z_{it-1} + \alpha_{i2} t$$

Testing for autocorrelation in this new version yields a value for the Harvey test of H=10.4778 , so the presence of autocorrelation is rejected.

Then, testing for the theoretical hypothesis of Homogeneity and symmetry, the values of the Wald corrected tests(FC=(1-(7/34))*(1-(11/34))=0.53) for the dynamic version are WC= 17.13 for the homogeneity condition and WC= 40.30591 for both, homogeneity and symmetry. The value of the Wald corrected test is lower than the critical values in tables of the distribution X^2 with 28 degrees of freedom, of 41.337. This implies that we are in the region of acceptance, or that it is not possible to reject the null hypothesis of homogeneity and symmetry. Thus, it is possible to impose homogeneity and symmetry together in the Rotterdam dynamic model. Before starting to make some calculus, or derive conclusions, it is necessary to test for autocorrelation in the homogeneous and symmetric version of the Rotterdam dynamic system. The H of the Harvey test is equal to 13.5654, lower than the critical values in tables of the distribution X^2 with 7 degrees of freedom (at a significance level of 5%), of 14.067 (See the complete table for the autocorrelation tests carried in Appendix V)

It is concluded that the Rotterdam dynamic model, which includes as restrictions homogeneity and symmetry, meets the econometric and microeconomic requirements that allow us to adequately represent Spanish consumer behaviour from 1980 to 2015 for the eight groups.

The parameters of the model can be observed in Appedix VI. It could be said that the estimated equation for the category of food (equation 1) has the higher number of parameters estimated that are individually significant at a 5% confidence level. The equation with the lowest value of significant parameters is equation 5, representing category five, Medical care and Health.

6. Empirical results.

To conduct a thorough analysis of the elasticities, the income elasticities are studied together with their evolution, and then, the price elasticities will be evaluated, distinguishing between Marshallian and Hicksian price elasticities

The income-elasticities estimated from the selected model, which is the dynamic, Rotterdam system with homogeneity, and symmetry restrictions imposed, appear in the Table 6.1.

(Table 6.1. about here)

This analysis shows how the eight different categories react against declines or increases in the available income. First, we need to define the concept of income-elasticity, which is the variation produced in the quantity demanded of a good or service when there is a variation in the available income of the consumer (keeping the rest of the variables constant). This variation is measured in percentages. If the income increases or decreases by 1%, the value of the income-elasticity will give us the percentage change in the good or service analysed. The values that are possible to obtain can be classified as being lower than 1, equal to 1, or higher than 1.

A value for the elasticity lower than 1 means that the good or service is a "necessary good"; that is to say, the ones that do not produce large variations when there are changes in the available income. Even if the income decreases, these goods will still be consumed.

From the preferences of the Spanish consumers, the necessary good is Food, with an average income-elasticity of 0.8023. This elasticity has increased during the period analysed, except for the years of the crisis when it decreased gradually. In the year 2015, its value recovered but was still lower than in 1994. The years analyzed have an income-elasticity larger than in the year 1980. This could be associated with the diverse variety of products for consumption because of the openness to the rest of the world. In the year 1988, it began to increase because of the entry of Spain into the EEC, when consumers had more access to a broader range of products. Therefore, as the available income increased, consumption grew from variety.

Note that the income-elasticity for food is lower than one. Therefore, Food does not suffer larger variations in the presence of economic downturns, nor will it increase dramatically in the event of an expansion. As demonstrated by Engel's law (in the mid-19th century), the demand for food does not increase at the same speed as does income and vice versa. This has been shown in studies related to household budgets, with different available incomes and in time-series studies for a wide range of countries. Typical results indicate an elasticity around the values of 0.4 to 0.7 (Feinstein, 1999).

In the same group with income-elasticity lower than one for Spanish population, we also find expenditure on rents and electricity, given that they are both necessary for living. Even when variations in available income appear, this is an expenditure that will be only slightly modified, (around a value of 0.6). Before the crisis, given the economic growth that the Spanish economy was enjoying, accompanied by the expansion of the Real-estate sector, we see the highest elasticities achieved, given that individuals were able to increase their spending on this category when disposable income increased.

As regards Medical care, it is important to note the lower value, due to the fact that people only consume what is absolutely necessary. Even if income increases, individuals in Spain will not vary much their expenditure on medical services, and vice versa. The income- elasticity mean is close to the one for Rent and power, although on Medical products has continued to decrease, reaching a value of 0.39. The Medical care group has experienced the largest increase in demand in the whole period, at 295.40%. Although the effects of the crisis were severe, the demand for this group maintained positive growth, primarily because such expenditures are not as sensitive to the economic cycle as the demand for other groups. It is worth recalling that this group has the second-lowest standard deviation in the budget share and the third-lowest in terms of real consumption. Furthermore, the numbers of the elderly had been growing for years – a group who usually need more medical health care services and products.

The groups that have the value 1, will have unitary elasticity, which implies that the demand for these particular goods or services will increase or decrease to the same extent as does the available income. Of interest here are Culture, recreation and education, because they are around the value 1 in the last two periods under analysis. This is due to the fact that culture and education are not necessary goods, but neither are they luxury goods. When income increases/decreases, expenditure on these will increase/decrease to a greater extent than the expenditures on food or rent because, while they are not essential, they are still in more demand than other categories analysed, such as expenditure on clothes.

Those goods and services that present an elasticity greater than one are known as "luxury goods", because small changes in the available income will produce larger variations in the quantity demanded. Looking at the mean, from the lowest to the highest, Transport and communications could be considered luxury goods because a 1% change in available income will produce variations of consumption in this category of 1.177%. This is the lowest among the group of luxury goods, due to the need for transport for almost all activities. This category remains above the value one because it includes shipping costs for consumption of other goods, the purchase of a vehicle, etc. The next category is Clothes and Footwear, with a mean of 1.26, but this is not really representative since we begin the period for this category with elasticity less than one, and in the last period, the group has the highest value, at 1.78 - almost double that of the whole period. The Spanish economy is very sensitive to change in its consumption of clothes when income changes. When families experience a decrease in their available income, they will doubly decrease the amount spent on clothes. Moreover, as shown in Section 2, Table 2.2, this group experienced the lowest increase in real demand for the whole period, only 7%, in comparison with a growth in other groups of more than 100%. This is particularly important due to the fact that the budget share of clothes has steadily decreased (along with the demand for this product). It is possible that individuals in Spain have lost purchasing power due to internal devaluation and to the stagnation of salaries in the most recent periods. Therefore, the clothing industry has been affected, as for example the recent drop in the stock price of Inditex, due to the fact that the company has not been able to achieve the level of profits expected. As the elasticity shows, Spanish consumers decrease their consumption of clothes by 1.78% whenever their income decreases by 1%. It is true that we are extrapolating the data to 2018, but as we can see in the evolution of the elasticities, in two years values do not change dramatically.

In the category of Other goods and services, the mean value is 1.2694, which as expected denotes a "luxury good"; when income decreases, spending on these goods will decrease much more. In our analysis of the standard deviation, this category is the most volatile, reacting quickly and with great variation to the economic situation. The evolution of this elasticity has more or less remained close to the mean, except for the year 2013, when it was slightly higher. The highest mean value is achieved in Furniture, furnishings and equipment, with an income-elasticity value of 1.2899, but recently values around 1.6. It is intuitive to assume that, with less money coming into Spanish households, they will cut their spending in this group. When income is rising they will tend to spend more on newer and better furniture and renewing household equipment...

Let us analyze the price elasticities that can be defined as the variations in the quantity demanded of a good or service when there are variations in price. Price-elasticity can be crossed when we analyze variations in the quantities demanded of a good when there are changes in the prices of other products or different services (the other variables remain constant in both cases ceteris paribus).This variation is measured in percentages, that is, if the price increases or decreases by 1%, the elasticity shows in what percentage the quantity demanded of the good or service under study increase or decrease.

In addition, we must distinguish between Marshallian and Hicksian elasticities. First, it is necessary to bear in mind that when the price of a product or service increases, two possible effects arise. The first is the substitution effect. That is to say, if a product/service increases its price, the consumer will decrease the quantity demanded of this product and will try to replace it with another one, or simply modify the "basket of goods" by buying other products. The second is the income effect, which can be expressed as follows: if a product/service increases its price, and the consumer wants to continue buying the same amount or at least part of what was bought before, this will have negative effects on income. The consumer will have less real purchasing power (although the nominal is maintained). In a situation in which the consumer will have to decrease expenditure on certain goods, or on the same good that has increased its price, such a decrease is not associated with the increase in the price, but with the decrease in real purchasing power. The consumer will have less money to spend on goods and will probably buy less of everything (unless they are inferior goods, in which case, when there is lower purchasing power, there will also be higher consumption).

These effects, substitution and income, both of them are both captured by Marshallian elasticities. Hicksian elasticities do not take into account the income effect, and simply consider the substitution effect. That is to say, in a situation in which the price of a product increases, the consumer is given sufficient income to compensate for the change in price. This allows us to determine the possibility of substitution with other goods, that is, if demand switches to another product and the consumer does not lose purchasing power.

(Table 6.2. about here)

The Marshallian price elasticities for the eight different groups under study appear in Table 6.2. First, looking at the main diagonal of the previous table, we can see the direct-price elasticities, all of them being negative. Thus, there is no inferior good and almost all of them are higher than the value of one. It is important to note that in an economy with limited disposable income, demand is more sensitive to changes in price and the elasticities are greater. From the direct-price elasticities, and starting with the first group, food, we see that the elasticity is negative and higher than one. Perhaps this raises the question if food is a necessary good, why we obtain an elasticity higher than 1. The answer is that this group includes alcoholic beverages, tobacco, and narcotics.

Similar direct-price elasticities are obtained for Clothes, Furniture, and Recreation and culture. Thus, when there is an increase of 1% in prices, the impact in consumption will be greater, decreasing by around 1.3% demand. It is important to note that the elasticity for the group of Clothes is 1.4%. This is one of the groups to have suffered high growth in prices since 1980, for a total growth of 369% by 2015 (see Section 2 and Table 2.4.) This, obviously, is associated with a constant decrease in the quantities demanded for this group and the respective decrease in the budget share for Spanish families (see Section 2, Graph 2.5.)

For the group Transport and communications, the direct price-elasticity is slightly higher. When prices for transport and communications decrease by 1%, consumers will be willing to increase their consumption by 1.6%. (This could be important to take into account for certain industries, such as the automotive sector.)

Considering the Health group, the direct-price elasticities is -2%, but it is important to disaggregate this category in order to understand it. This group includes not only medical products, but also appliances and equipment, out-patient services, and hospital services. Most of the expenditure is related to out-patient services (around 50% in this group). Thus, it should appreciate that increasing prices for equipment will significantly reduce demand, Government will move its demand to other group such as education and will renew equipment in other period. Regarding out-patient services, families will significantly reduce it by decreasing its visits to the dentist, physiotherapist... It must be remembered that, where medical services and products are considered, we are also referring to a part of the demand that is mainly associated with the elderly - a population that has limited pensions to spend, and so price increases can mean that they need to reduce the amounts spent in this area in favour of consumption of food and electricity.

The elasticity of Rent, water, and electricity is very low - the lowest direct-price elasticity among the groups –and it is associated with the fact that individuals consume the lowest amount possible of electricity, because of its prominence in Spanish family budgets. When prices increase, families can barely reduce their expenditure on electricity because they are already consuming the minimum. The same happens with rents; individuals cannot readily respond to rent increases, because, after all, families need to live somewhere.

We now analyze the crossed-price elasticities, considering only those that are significant at a 5% significance level. For Food, an increase of 1% in the price leads to a decrease of 0.11% in consumption of the Health group. Concerning Rent, water and electricity, an increase of 1% there will diminish the demand for Other goods and services by 0.43% (with this being one the largest crossed-price elasticities).As long as Spanish families continue to consume water and electricity, and pay the rent, they will need to decrease consumption of some other group; in this case, they will reduce their expenditure on restaurants, hotels, catering services, insurance, financial services, etc.
If the price of clothes increases, consumption of this group will decrease proportionally more than the increase in price, so that the money "saved" on clothes will go to an increase in the consumption of the Food group of 0.32%.

The same will happen in the group of Furniture, furnishing and equipment, with crossed price elasticity for food of 0.39%.

Concerning Medical care and Health, the most important crossed-price elasticity is for Recreation, culture and education, with an elasticity of 0.6%. A decrease in consumption of health services/products because of price changes increases the consumption of recreational and cultural activities.

One significant crossed-price in the Recreation, culture and education activities elasticity is the one associated with food, given that a 1% increase in price in this group will shift demand to the Food group, increasing its consumption by 0.2%.

For Other groups and services, the direct price elasticity is inelastic (below one), and all crossed-price elasticities are negative, implying that when the price of this group increases, the demand for other groups will decrease. This group includes not only restaurants and holiday accommodations, but also insurance that has been increasing, along with financial services, personal care, etc. that represent an important percentage of total spending in the group.

(Table 6.3. about here)

Focusing our attention in the Hicksian price elasticities that appear in Table 6.3, and more exactly on the direct-price elasticities, they are almost the same as the Marshallian ones, except for the category of Other goods and services, which is more inelastic than before. Thus, if the price of Other goods and services increases, while Spanish families maintain their real available income, they will also keep up the demand for this group, specifically, a 1% change in price will produce a 0.43% change in demand.

Note that, with Hicksian price elasticity, only the substitution effect will be incorporated in the elasticities. Second, all crossed-price elasticities that take a negative value are characteristic for goods that are net complements. On the contrary, when the crossed-price elasticities take a positive value, they are net substitutes, given that if the price of a product increases and the demand for other products increases, then there is a certain degree of replacement among the products analyzed.

For Food, for every 1% increase in price, an associated decrease in demand of 1.3% will be produced. In this case, when real income is unchanged, families will replace this decrease in consumption with an increase in demand for Clothes, Rent, water and electricity, Furniture and equipment, Transport and communication, and Recreation and cultural activities by 0, 2%. Something similar happens with the group of Clothes; the decrease of 1.3% due to the 1% increase in price will be substituted by consuming 0.5% more of food, and 0.45% more of Rent, water and electricity.

For Rent, water and electricity, since demand is inelastic, it will be not really modified. Consequently, when the price for this group increases by 1%, it will only produce changes for Food with a positive increase of 0.15%, Clothes 0.13%, and almost the same percentages for Transport and Recreation activities. On the other hand, the demand for Other goods and services will be diminished by 0.26%, with this being one the largest crossed-price elasticities.

In Furniture and equipment, a price increase of 1% in this group will lead to a decrease in demand of 1.2%. In this particular case, the associated decrease will be transferred to an increase in demand for Food of 0.6117%, to transport and communications of 0.2697%, and to Other goods and services with a percentage increase of almost 0.4%. Thus, individuals are not so willing to maintain their demand for furniture and household appliances. When prices increase, they will move to another group to spend their income.

For medical products and services, the decrease in consumption for this group by 1.98% as a result of a 1% increase its price will immediately lead to increased demand for Rent, water and electricity of 0.57%, and for Recreation, Culture and education of 0.62%. When the cost of, for example, renewing equipment in hospitals increases and starts to be reflected in prices, demand will decrease and consumption will transfer to education or other cultural activities.

Analyzing the substitution effect for Transport and communications, a decrease in consumption for this group due to a 1% increase in prices will increase the consumption of Food by 0.32%, Furniture by 0.11%, and Other goods and services by 0.6%, with this being the highest crossed-price elasticity.

The decrease of 1.3% of consumption in Recreation and cultural activities because of a 1% increase in price will be substituted by a 0.48% increase in the demand for Food and by a 0.34% increase in consumption of Rent, water and electricity.

The category of Other goods and services is one of the least affected; an increase in price of 1% will lead to a decrease of consumption of -0.43%. This will produce an increase in the demand for Transport and communications of 0.28% and a smaller increase of 0.1% in furniture and equipment. Meanwhile, the group of Rent, water and electricity will be affected negatively, decreasing demand by 0.21%.

7. Conclusions.

After carrying out the estimations of the AIDS and the Rotterdam model for the Spanish economy in the years 1980-2015, for the eight categories of expenditure, we conclude that the Rotterdam Model fits the Spanish economy correctly. We began this final degree dissertation with the primary aim of finding the best micro-econometric model to represent consumer preferences, and our results show that the Rotterdam Model, with the logarithmic differentiation of the classical demand function, allows us to achieve our objective. This model has been widely employed through the long history of the complete system of demand equations due to its simplicity in formulation and interpretation. One empirical treatment of this same model is by Kiefer (1984), for households in Belgium. In that case, the model of Rotterdam also accomplished with homogeneity and symmetry restrictions. Other author such as Molina (1998) has shown that the Rotterdam model can be used to show the preferences of Spanish households, using data from 1964 to 1995. Today this model is still valid and continues representing the preferences and demand of Spanish households.

Our main conclusions, obtained with OECD data are as follows: first, even though the real-estate bubble seems to be over, there has not been any notable decrease in the prices of rent. Consequently, it could be said that the Spanish economy is living in a Rental Bubble in recent years. Furthermore, the crisis led to an evident decline in demand for almost every group, except for Housing and power. Second, demand of Medical care has grown steadily, apparently not affected by the crisis. (This is good news for the Welfare State.) Third, in the sub-period 2013-2015 we have been able to appreciate a total evolution of prices of -1.2% showing the internal devaluation in Spain to overcome the crisis. This led to the fact that demand for all groups started to have positive growth, another indicator that the Spanish economy was recovering. Fourth, the groups with the highest volatility in prices are Other goods and services, Housing, fuel and power and Transport and Communications.

The largest budget share is that of Food during the years 1980 to 1986. Then, Others goods and services represented the highest percentage of the total expenditure. Since 2002, the group Housing, fuel and power has begun to have one of the largest percentage participation in the budget, while Food has been steadily decreasing its share. Almost the same has happened with clothes and furniture, but more smoothly. The budget share of Culture, recreation and education has suffered a decrease in the most recent years, while expenditure on Health and medical care has been progressively increasing, although it still represents the smallest portion of the budget, just below the groups of Clothes and Furniture.

The elasticities obtained with the Rotterdam model have shown the following results: from the preferences of the Spanish consumers, the necessary goods are Food, Rents and electricity, and Medical care. Even though the effects of the crisis were severe, the group of Medical care and health maintained its positive growth. Only Culture, recreation and education has a value close to 1, and this unitary elasticity implies that the demand will increase or decrease in the same way as does the available income. Transport and communications, Clothes and Footwear, Other goods and services and Furniture, furnishings and equipment are all, in the Rotterdam Model, defined as luxury goods.

All the Marshallian direct-price elasticities are negative, with the largest being in the Health group, at -2% (not only showing the quantity and prices of medical products but also of out-patient services and medical equipment). The category of Rent, water and electricity displays the lowest direct-price elasticity. Demand does not vary too much for these necessary products when there are changes in its own price.

The Marshallian crossed-price elasticities shown that increases in the prices of food will decrease consumption in the Health group. Spanish families will shift their expenditure from Health services and products to food in order to compensate for increases in Food prices. Almost the same thing happens with Rent, water and electricity: a 1% price increase reduces the demand for Other goods and services by 0.43%. If Spanish households keep constant their demand for these services/products (Rent, water and electricity) with inelastic demand, they need to decrease demand for other groups.

The demand of the Clothes group will decrease by a larger amount than the increase in its price, so that the “savings” not expended on clothes will increase the consumption of the group Food. The same happens with the group of Furniture, furnishing and equipment.

Regarding Medical care and Health, the most important crossed-price elasticity is that of Recreation, culture and education, having a value of 0.6%. As explained earlier, Government may decrease its consumption of Health and transfer more money to education or other cultural activities. Following cultural and recreation activities, the crossed–price elasticity associated with food is at 0.2%. The last group, Other goods and services, presents crossed-price elasticities that are all negative; if the price of this group increases, the demand for other groups will decrease in order to maintain consumption at the same level in this group (Other goods/services).

Let us now summarize Hicksian crossed-prices elasticities, that is to say, without taking into account the impact on the available income. Beginning with Food, a 1% increase in price leads to a decrease in its own demand of 1.3%. Families will replace this decrease in consumption with an increase in demand for Clothes, Rent, water and electricity, Furniture and equipment, Transport and communication and Recreation and cultural activities. This is important, given the possibility that Spanish families may buy more food than needed given their ability to decrease food consumption by 1.3%. This has important policy implications for the taxation of food. With the group of Clothes, a decrease of 1.3% due to a 1% price increase, substituted for by consuming more Food and more Rent, water and electricity.

For Rent, water and electricity, as demand is inelastic, an increase in price only produces changes for Food, Clothes, Transport and Recreation activities with positive increases, while the demand for Other goods and services will be diminished. For Furniture and equipment, a price increase of 1% is transferred to an increase in demand for Food, Transport and communications and to Other goods and services, so that these goods/services can be considered net substitutes for furniture and equipment.

As regards Medical products and services, a decrease in consumption for this group resulting from an increase in price will immediately lead to an increase of demand for the groups of Rent, water and electricity, Recreation, and Culture and education that could imply that Government will decrease its demand and transfer more money to education or other cultural activities.

Analyzing the substitution effect for Transport and communications, a decrease in consumption for this group will imply greater consumption of Food, Furniture, and Other goods and services. Variations in the consumption in Recreation and culture activities will lead to changes - with opposite signs - in Food and Rent, water and electricity. For the last category, Other goods and services, an increase in price of 1% will produce an increase in the demand for Transport and communications and a small increase in furniture and equipment, while the group of Rent, water and electricity will be affected negatively, decreasing its demand.

Even though this has been a close approximation to track demand in the Spanish economy, and to ascertain the degree of replacement among the categories analyzed, there is still much research to do in this field.

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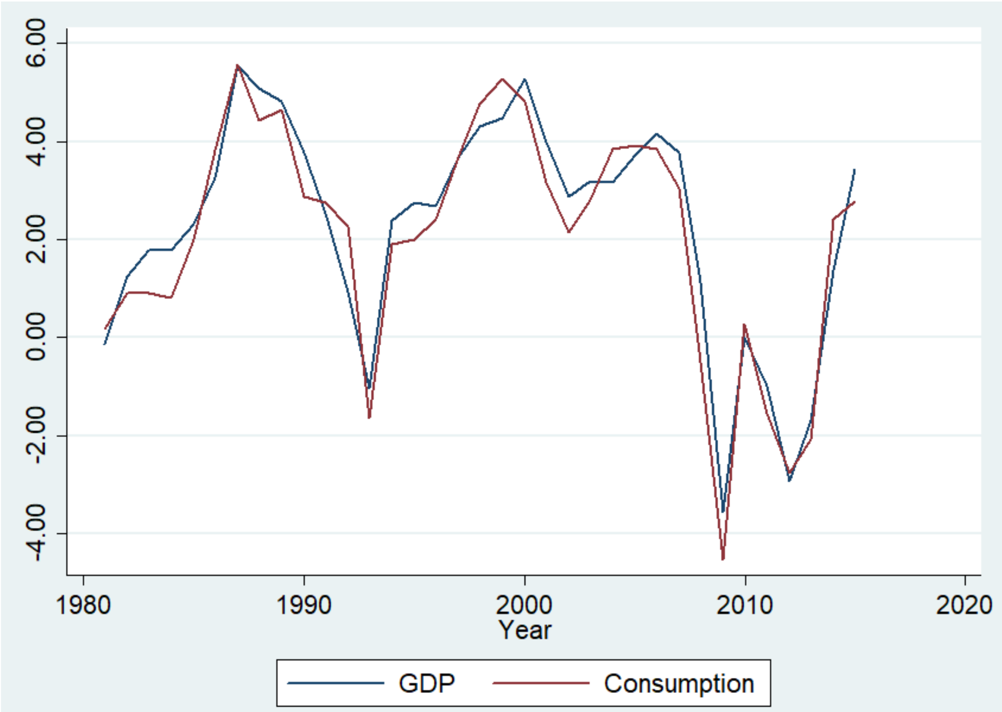
Appendix I

Graph 2.1. GDP and consumption rates of growth (%)



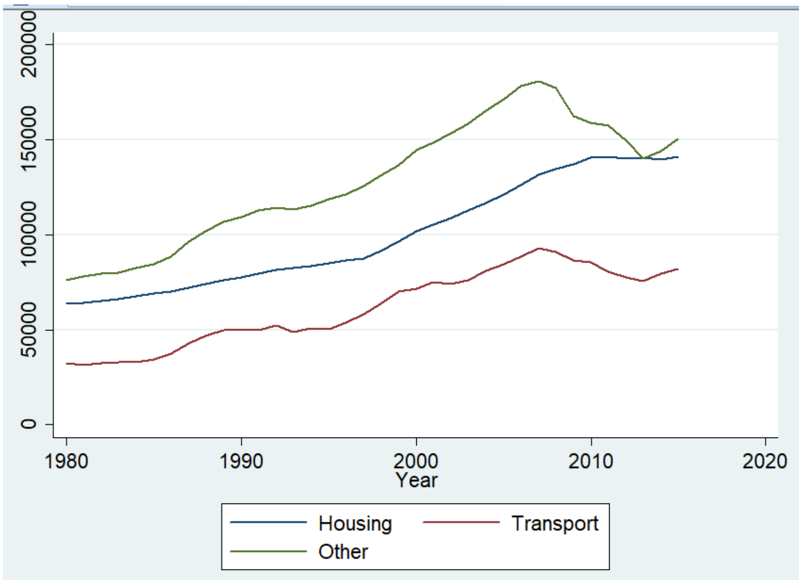
Source: Own elaboration.

Table 2.1. Demand in real terms (base year 2010, millions of Euros)

Category	*Mean*	*Std. Dev.*	*Min*	*Max*
Food	80193.34	19327.6	59385.68	111193.4
Clothing and footwear	28980.14	3550.24	23430.55	36836.42
Housing, fuel and power	99518.96	27960.81	63858.59	140979
Furniture, furnishings and equ.	24513.03	5197.48	16928.35	34137.3
Medical care and health	14619.38	6769.09	5769.44	25020
Transport and communications	61833.34	20058.87	31689.4	92913.9
Culture, education and recreation	40762.36	12841.24	23203.57	60233.59
Other goods and services	128236	32314.77	76321.96	181050.6
Total	471846.9	118457.6	302445.2	645373.4

Source: Own elaboration.

Graph 2.2. Demand of the groups with the highest standard deviation and GDP (base year 2010, million EUR)



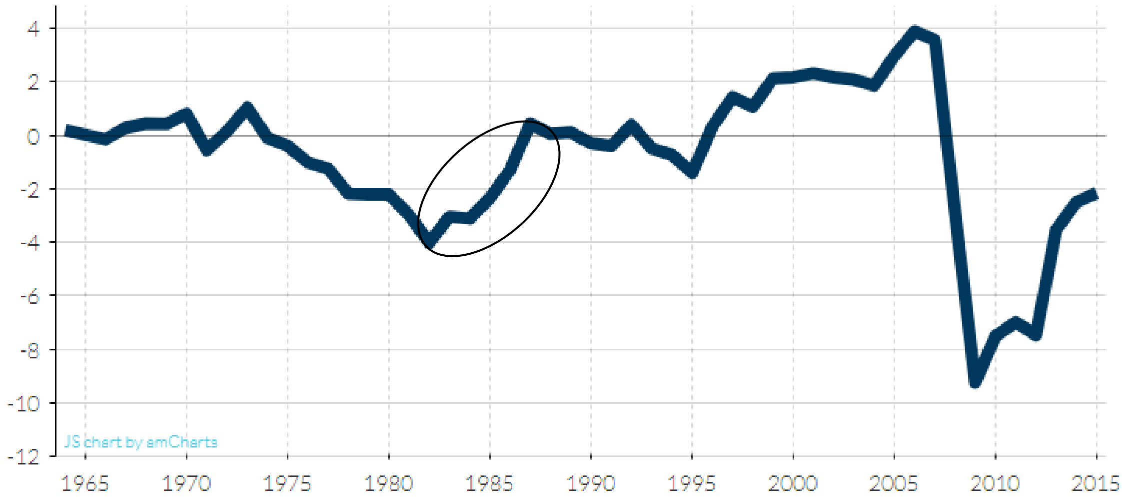
Source: Own elaboration

Table 2.2. Evolution of demand in real terms (base year 2010)

Category	*1980-87*	*1988-93*	*1994-2007*	*2008-12*	*2013-2015*	*1980-2015*
Food	4,23%	6,31%	66,54%	-7,62%	0,08%	67,78%
Clothing	0,51%	4,22%	27,06%	-16,27%	4,16%	7,90%
Housing, fuel ,power	13,33%	11,22%	57,13%	4,24%	0,05%	120,77%
Furniture and equ.	5,55%	13,66%	51,71%	-19,26%	4,71%	47,07%
Medical care	0,36%	60,07%	86,92%	8,80%	7,78%	295,40%
Transport and com.	31,64%	4,17%	83,22%	-14,84%	8,75%	153,03%
Culture, edu. and recr.	16,24%	16,80%	78,08%	-10,84%	4,75%	135,87%
Other goods and ser.	26,55%	11,07%	56,86%	-15,70%	7,39%	97,41%
Total	14,99%	11,29%	56,69%	-8,34%	5,27%	100,59%

Source: Own elaboration.

Graph 2.3. Public surplus/ deficit as a percentage of GDP (1964-2015)



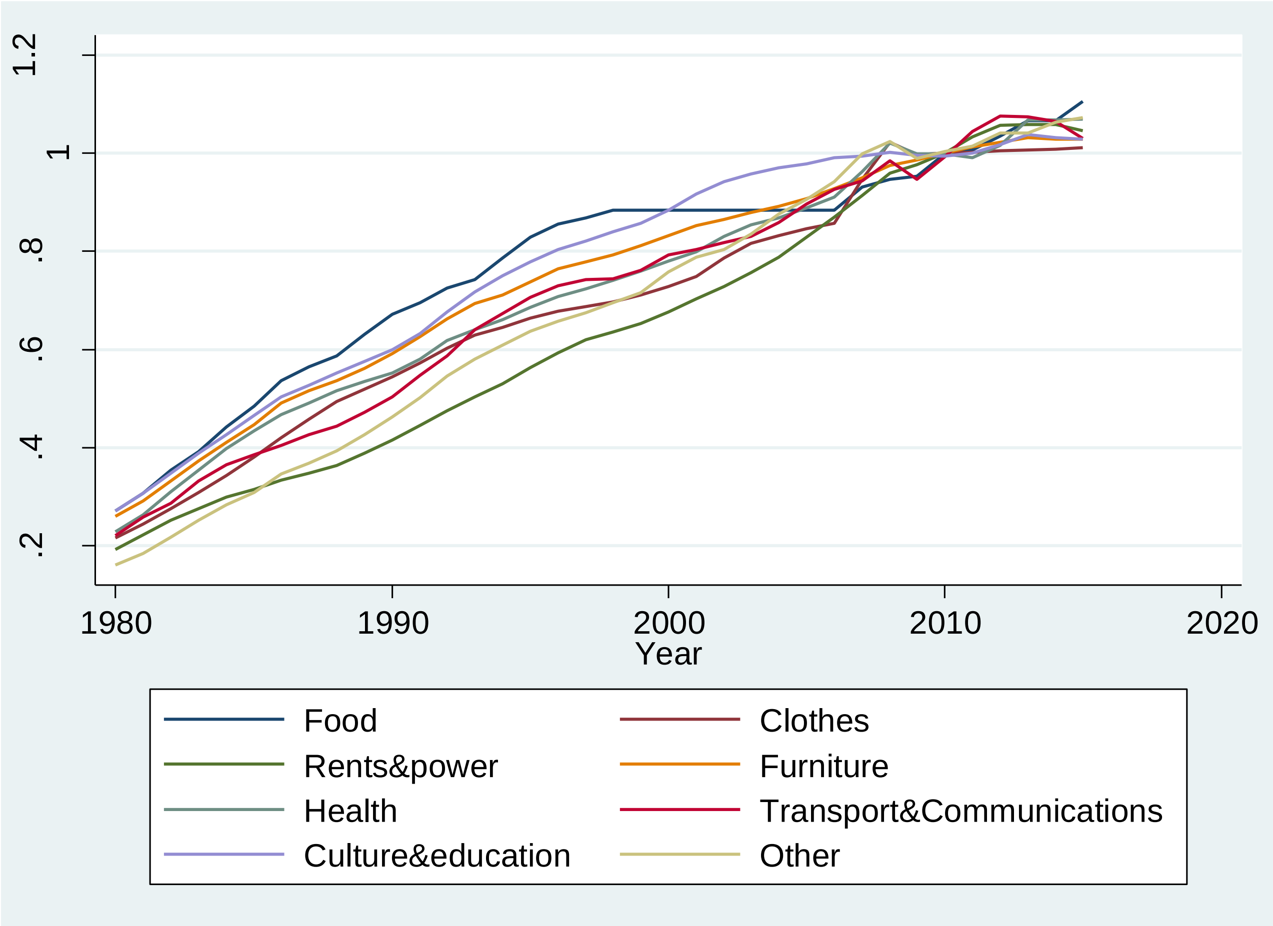
Source: Funcas Blog.

Table 2.3. Prices (base year 2010)

Category	Mean	Std. Dev.	Min	Max
Food	0.77259	0.22896	0.2701	1.106
Clothing and footwear	0.68612	0.24944	0.2154	1.022
Housing, fuel and power	0.63550	0.28080	0.1922	1.059
Furniture, furnishings and equ.	0.73840	0.23573	0.2598	1.032
Medical care and health	0.71657	0.24865	0.2280	1.070
Transport and communications	0.70321	0.26230	0.2192	1.076
Culture, edu. and recreation	0.76635	0.24215	0.2700	1.038
Other goods and services	0.67151	0.29223	0.1606	1.073
Total	0.71198	0.27070	0.2173	1.071

Source: Own elaboration

Graph 2.4. Prices (base year 2010)



Source: Own elaboration.

Table 2.4. Evolution of prices (base year 2010)

Category	*1980-87*	*1988-93*	*94-2007*	*2008-12*	*2013-15*	*1980-2015*
Food	109,0%	26,7%	18,4%	9,26%	3,7%	309,6%
Clothing and footwear	112,7%	27,4%	46,8%	-1,64%	0,5%	369,5%
Housing, fuel and power	80,7%	38,5%	72,2%	10,24%	-1,3%	444,2%
Furnit., furnishings and equ.	98,7%	29,3%	33,6%	4,85%	-0,4%	295,8%
Medical care and health	115,0%	24,2%	46,0%	-0,48%	0,2%	369,4%
Transport and commun.	94,4%	44,2%	40,1%	9,26%	-4,1%	370,0%
Culture, edu. and recreation	95,2%	30,1%	32,4%	1,47%	-0,9%	281,1%
Other goods and services	129,5%	47,4%	64,2%	1,72%	3,1%	568,1%
Total	102,5%	35,2%	51,1%	4,58%	-1,2%	387,0%

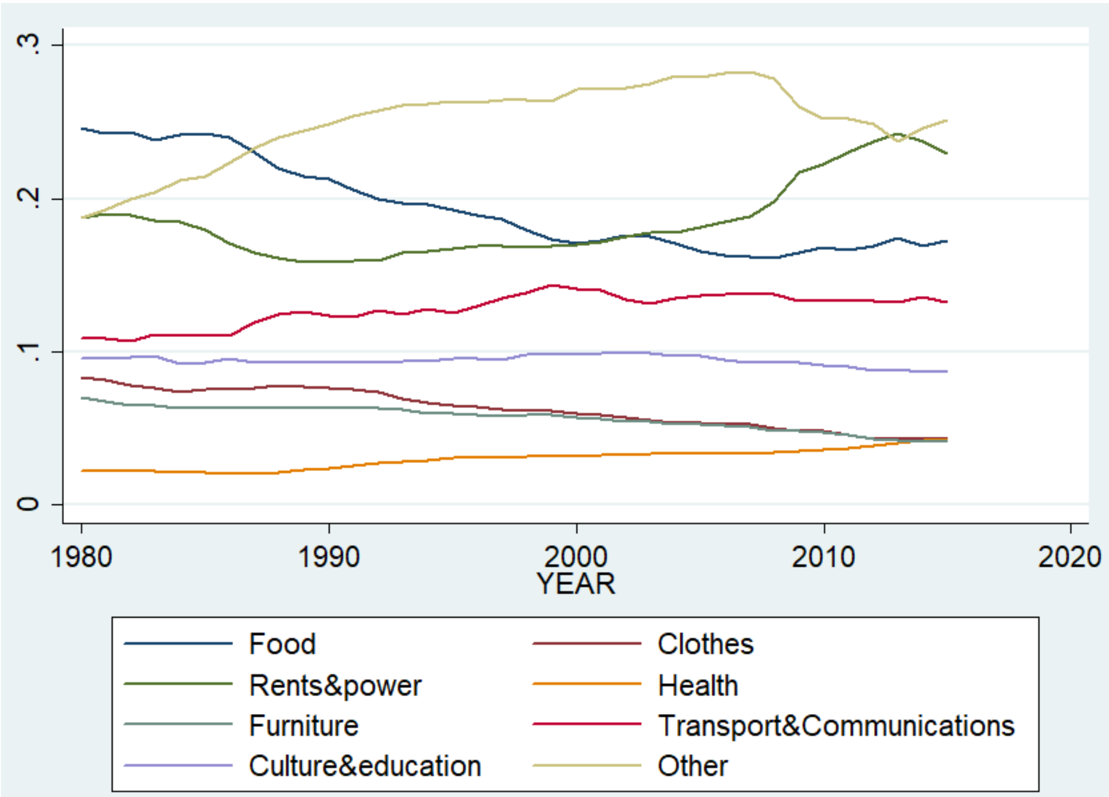
Source: Own elaboration.

Table 2.5. Budget Shares.

Category	*Mean*	*Std. Dev.*	*Min*	*Max*
Food	19,42%	0.0295312	16,1%	24,6%
Clothing and footwear	6,27%	0.0127249	4,3%	8,3%
Housing, fuel and power	18,52%	0.0250968	15,9%	24,3%
Furniture, furnishings and equ.	5,66%	0.007979	4,1%	7,0%
Medical care and health	2,97%	0.0064528	2,0%	4,2%
Transport and communications	12,76%	0.0106322	10,7%	14,4%
Culture, edu. and recreation	9,41%	0.0032869	8,7%	9,9%
Other goods and services	24,99%	0.0261669	18,7%	28,3%

Source : Own elaboration

Graph 2.5. Budget shares



Source: Own elaboration.

Table 6.1. Average Income- Elasticities and their evolution

	1980	*1988*	*1994*	*2008*	*2013*	*2015*	*Mean*
Food	.6922***	.7938***	.8371***	.8090***	.7902***	.8216***	.8023*** (0.000)
Clothes	.9648***	1.1073***	1.1884***	1.6459***	1.7824***	1.7806***	1.2605*** (0.000)
Rent, water, electricity	.5762***	.5974***	.5936***	.5921***	.4997***	.5197***	.5816*** (0.000)
Furnit, equipment	1.1573***	1.2474***	1.2275***	1.3656***	1.5768***	1.5670***	1.2899*** (0.000)
Medical care	.7938***	.8678***	.5815***	.4989***	.4141***	.3998***	*.5700**** *(0.000)*
Transport and commun.	1.4000***	1.1704***	1.2123***	1.0839***	1.1518***	1.1021***	1.1773*** (0.000)
Recreation, cult. and edu.	1.1847***	1.1725***	1.1118***	.9889***	1.0068***	1.0000***	1.0749*** (0.000)
Other good and services	1.3613***	1.2269***	1.2162***	1.2672***	1.4172***	1.3732***	1.2694*** (0.000)

P-values in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration.

Table 6.2. Marshallian price-elasticities.

	Food	*Clothes*	*Rent, water, electr.*	*Furnit. equip*	*Medical care*	*Transp. commun*	*Culture, edu, recr.*	*Other goods services*
Food	-1.35*** (0.000)	.3250*** (0.0082)	.0616 (0.2865)	.3935*** (0.0002)	.0256 (0.9029)	.1198 (0.2876)	.2964*** (0.0075)	-.24*** (0.0002)
Clothes	.0658 (0.1820)	-1.4*** (0.000)	.0992** (0.0362)	-.1373 (0.1831)	-.1455 (0.5042)	-.0106 (0.8861)	-.0664 (0.4857)	-.0736 (0.1441)
Rent, power	.0605 (0.4197)	.1843 (0.2497)	-.55*** (0.000)	-.0947 (0.5099)	.4537 (0.1277)	-.01460 (0.9112)	.1219 (0.3990)	-.61*** (0.000)
Furnit and equipm.	.0524 (0.1442)	-.1112 (0.1847)	0.0131 (0.7070)	-1.28*** (0.000)	.0542 (0.8084)	.0494 (0.2960)	-.1778* (0.0980)	-.0424 (0.1778)
Medical care	-.1148** (0.0026)	-.0864 (0.3762)	.0629 (0.3745)	.0093 (0.9397)	-2.0*** (0.000)	.0115 (0.8315)	.0183* (0.0639)	-.01467 (0.18)
Transport and comm.	0.1033 (0.2194)	-.0317 (0.8263)	.0666 (0.79)	.1062 (0.3382)	.1276 (0.5827)	-1.598*** (0.0000)	-.0233 (0.8508)	-.07552 (0.3404)
Recreat., cult. edu.	0.1015* (0.0864)	-.1035 (0.4122)	.0907 (0.1111)	-0.3049* (0.0815)	.5735** (0.0493)	-.0238 (0.7778)	-1.38*** (0.000)	-.13** (0.0142)
Other good and services	-.0088 (0.9341)	-.0586 (0.7906)	-.43*** (0.0000)	.0252 (0.8801)	0.3410 (0.3106)	.2891 (0.1223)	-.0257 (0.8841)	-.91*** (0.000)

P-values in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration.

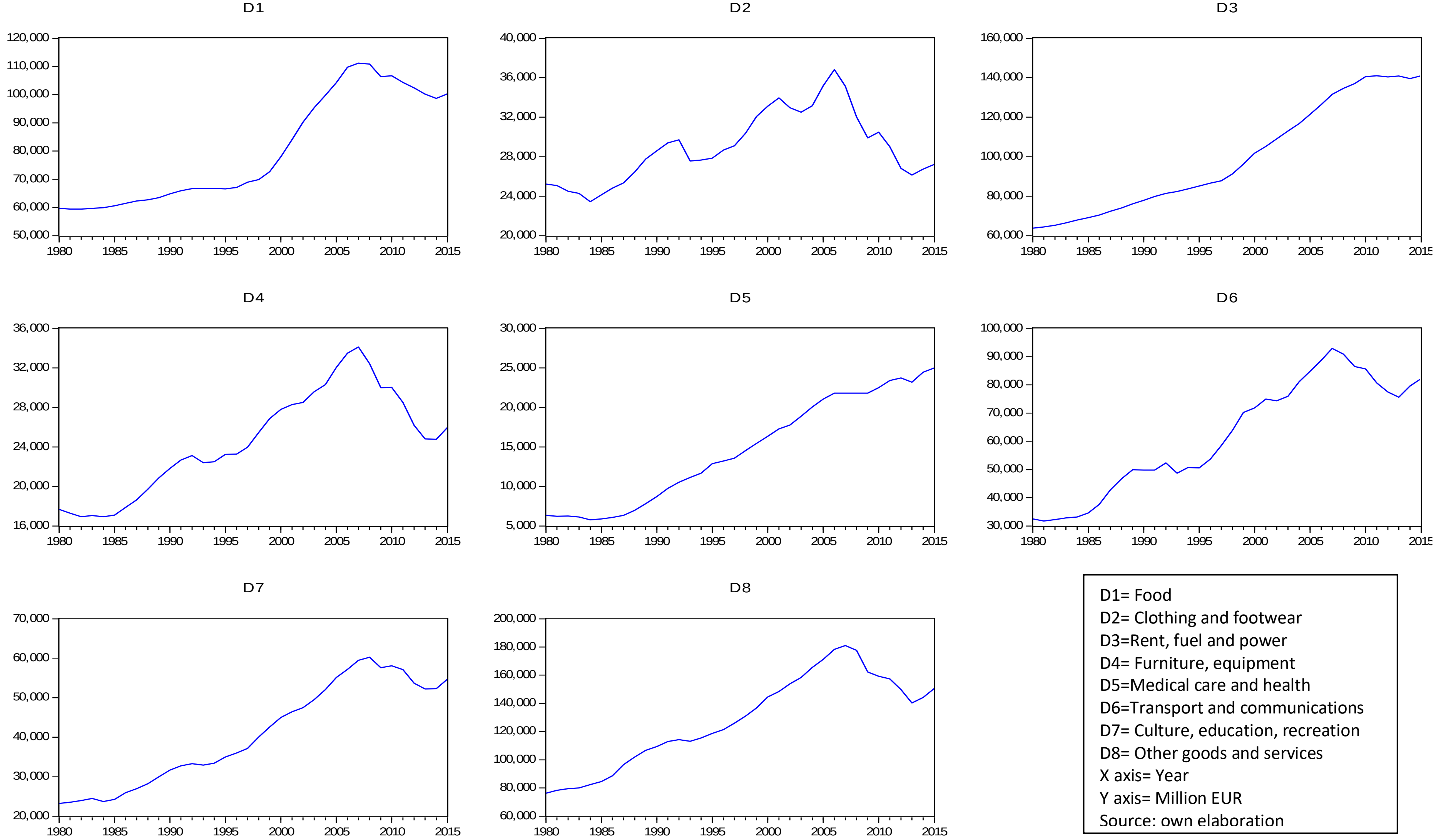
Table 6.3. Hicksian price-elasticities.

	Food	*Clothes*	*Rent, water, electr.*	*Furnit. and equip*	*Medical care Health*	*Transp. and commun.*	*Culture, edu. recr.*	*Other goods services*
Food	**-1.2***** (0.0000)	0.5382*** (0.0000)	.1599*** (0.007)	.6117*** (0.000)	.1220 (0.5741)	.3189*** (0.0047)	-.48*** (0.0000)	.0799 (0.2332)
Clothes	.20*** (0.0000)	**-1.3***** (0.0000)	.1361*** (0.0039)	-.0559 (0.5850)	-.1094 (0.6106)	0.6398 (0.3838)	.0017 (0.9860)	.0659 (0.1987)
Rent, water and electricity	.1962*** (0.0072)	.4458*** (0.003)	**-.43***** (0.000)	.1730 (0.2130)	.5720** (0.0460)	0.2297* (0.0673)	.3450** (0.0139)	-.21*** (0.0072)
Furnit, equipment	.1881*** (0.000)	-.05 (0.5850)	.0433 (0.213)	**-1.2***** (0.0000)	.0839 (0.7074)	.1106** (0.0175)	-.1219 (0.2568)	.0720** (0.0233)
Medical care	.0209 (0.5741)	-.0499 (0.61)	.0797** (0.0460)	.0466 (0.7074)	**-1.98**** (0.0000)	.0455 (0.4020)	.2141** (0.0311)	.0532 (0.1294)
Transport and comm.	.2390*** (0.0047)	.1280 (0.3838)	.1403* (0.0673)	.2697** (0.0175)	.1998 (0.4020)	**-1.5***** (0.0000)	.1130 (0.3701)	.2858*** (0.0008)
Recreation, cult. and edu.	.2372*** (0.0000)	.0022 (0.9860)	.1394** (0.0139)	-.1967 (0.2568)	.6213** (0.0311)	.07478 (0.3701)	**-1.3***** (0.0000)	.0821 (0.1288)
Other good and services	.1269 (0.2332)	.2797 (0.1987)	-.27** (0.0072)	.3715** (0.0233)	.4940 (0.1294)	.6052*** (0.0008)	.2629 (0.1288)	**-.43***** (0.0049)

P-values in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration.

Appendix II


D1
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
1980 1985 1990 1995 2000 2005 2010 2015
D2
40,000
36,000
32,000
28,000
24,000
20,000
1980 1985 1990 1995 2000 2005 2010 2015
D3
160,000
140,000
120,000
100,000
80,000
60,000
1980 1985 1990 1995 2000 2005 2010 2015
D4
36,000
32,000
28,000
24,000
20,000
16,000
1980 1985 1990 1995 2000 2005 2010 2015
D5
30,000
25,000
20,000
15,000
10,000
5,000
1980 1985 1990 1995 2000 2005 2010 2015
D6
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
1980 1985 1990 1995 2000 2005 2010 2015
D7
70,000
60,000
50,000
40,000
30,000
20,000
1980 1985 1990 1995 2000 2005 2010 2015
D8
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
1980 1985 1990 1995 2000 2005 2010 2015
D1= Food
D2= Clothing and footwear
D3=Rent, fuel and power
D4= Furniture, equipment
D5=Medical care and health
D6=Transport and communications
D7= Culture, education, recreation
D8= Other goods and services
X axis= Year
Y axis= Million EUR
Source: own elaboration

Appendix III

Year 80 to year 10

$$P_{10}^{t} = \frac{P_{80}^{t}}{P_{80}^{10}}$$

$$P_{80}^{10} = P_{80}^{86} x\, P_{86}^{95} x\, P_{95}^{00} x\, P_{00}^{05} x\, P_{05}^{10}$$

$$P_{95}^{00} = \frac{\frac{1}{P_{00}^{99}}}{\frac{1}{P_{95}^{99}}} = \frac{P_{99}^{00}}{P_{99}^{95}} = P_{95}^{00}$$

Year 86 to year 10

$$P_{10}^{t} = \frac{P_{86}^{t}}{P_{86}^{10}}$$

$$P_{86}^{10} = P_{86}^{95} x\, P_{95}^{00} x\, P_{00}^{05} x\, P_{05}^{10}$$

Year 95 to year 10

$$P_{10}^{t} = \frac{P_{95}^{t}}{P_{95}^{10}}$$

$$P_{95}^{10} = P_{95}^{00} x\, P_{00}^{05} x\, P_{05}^{10}$$

Year 00 toy ear 10

$$P_{10}^{t} = \frac{P_{00}^{t}}{P_{00}^{10}}$$

$$P_{00}^{10} = P_{00}^{05} x\, P_{05}^{10}$$

Year 05 to year 10

$$P_{10}^{t} = \frac{P_{05}^{t}}{P_{05}^{10}}$$

Appendix IV

AIDS model

1) Generation of the variables used.

```
gen Y=D1+D2+D3+D4+D5+D6+D7+D8

egen MP1 = mean(P1)

egen MP2 = mean(P2)

egen MP3 = mean(P3)

egen MP4 = mean(P4)

egen MP5 = mean(P5)

egen MP6 = mean(P6)

egen MP7 = mean(P7)

egen MP8 = mean(P8)

gen Q1=D1/P1

gen Q2=D2/P2

gen Q3=D3/P3

gen Q4=D4/P4

gen Q5=D5/P5

gen Q6=D6/P6

gen Q7=D7/P7

gen Q8=D8/P8

egen MQ1 = mean(Q1)

egen MQ2 = mean(Q2)

egen MQ3 = mean(Q3)

egen MQ4 = mean(Q4)

egen MQ5 = mean(Q5)

egen MQ6 = mean(Q6)

egen MQ7 = mean(Q7)
```

```
egen MQ8 = mean(Q8)

gen W1=D1/Y

gen W2=D2/Y

gen W3=D3/Y

gen W4=D4/Y

gen W5=D5/Y

gen W6=D6/Y

gen W7=D7/Y

gen W8=D8/Y

egen MW1 = mean(W1)

egen MW2 = mean(W2)

egen MW3 = mean(W3)

egen MW4 = mean(W4)

egen MW5 = mean(W5)

egen MW6 = mean(W6)

egen MW7 = mean(W7)

egen MW8 = mean(W8)

tset Year
local i=1
while `i'<=8{
gen LP`i'=log(P`i')
local i=`i'+1
}
gen LY=log(Y)
gen IND=LY-W1*LP1-W2*LP2-W3*LP3-W4*LP4-W5*LP5-W6*LP6-W7*LP7-W8*LP8
```

2) Estimating the AIDS model with the main aim of testing for autocorrelation:

```
sureg (W1: W1 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND) (W2: W2 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8
IND) (W3: W3 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND) (W4: W4 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8
IND) (W5: W5 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND) (W6: W6 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8
IND) (W7: W7 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND)

lmareg3
```

3) Making the model dynamic and testing autocorrelation

```
gen trend=_n

local i=1

while `i'<=8{

gen LW`i'=l.W`i'

local i=`i'+1

}

constraint 1 _b[W1:LW1]=_b[W2:LW2]

constraint 2 _b[W2:LW2]=_b[W3:LW3]

constraint 3 _b[W3:LW3]=_b[W4:LW4]

constraint 4 _b[W4:LW4]=_b[W5:LW5]

constraint 5 _b[W5:LW5]=_b[W6:LW6]

constraint 6 _b[W6:LW6]=_b[W7:LW7]

sureg (W1: W1 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW1) (W2: W2 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 trend IND LW2)  (W3: W3 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW3)  (W4: W4 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 trend IND LW4) (W5: W5 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 trend IND LW5) (W6: W6 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW6) (W7: W7 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW7), constraints (1-6)

lmareg3
```

4) Proposing the dynamic model.

```
constraint 16 _b[eq1:LW1]=_b[eq2:LW2]

constraint 17 _b[eq2:LW2]=_b[eq3:LW3]

constraint 18 _b[eq3:LW3]=_b[eq4:LW4]

constraint 19 _b[eq4:LW4]=_b[eq5:LW5]

constraint 20 _b[eq5:LW5]=_b[eq6:LW6]

constraint 21 _b[eq6:LW6]=_b[eq7:LW7]

sureg (eq1: W1 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW1) (eq2: W2 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW2)  (eq3: W3 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW3)  (eq4: W4 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW4) (eq5: W5 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW5) (eq6: W6 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW6) (eq7: W7 LP1 LP2 LP3 LP4 LP5 LP6 LP7 LP8 IND trend LW7), constraints (16-21)
```

```
gen A8= 1-
(_b[eq1:_cons]+_b[eq2:_cons]+_b[eq3:_cons]+_b[eq4:_cons]+_b[eq5:_cons]+_b[eq6:_cons]+_
b[eq7:_cons])
sum A8
testnl 1-
(_b[eq1:_cons]+_b[eq2:_cons]+_b[eq3:_cons]+_b[eq4:_cons]+_b[eq5:_cons]+_b[eq6:_cons]+_
b[eq7:_cons]) = 0

gen B81=-
(_b[eq1:LP1]+_b[eq2:LP1]+_b[eq3:LP1]+_b[eq4:LP1]+_b[eq5:LP1]+_b[eq6:LP1]+_b[eq7:LP1])
sum B81
testnl  -
(_b[eq1:LP1]+_b[eq2:LP1]+_b[eq3:LP1]+_b[eq4:LP1]+_b[eq5:LP1]+_b[eq6:LP1]+_b[eq7:LP1])=
0
gen B82=-
(_b[eq1:LP2]+_b[eq2:LP2]+_b[eq3:LP2]+_b[eq4:LP2]+_b[eq5:LP2]+_b[eq6:LP2]+_b[eq7:LP2])
sum B82
testnl
(_b[eq1:LP2]+_b[eq2:LP2]+_b[eq3:LP2]+_b[eq4:LP2]+_b[eq5:LP2]+_b[eq6:LP2]+_b[eq7:LP2])

gen B83=-
(_b[eq1:LP3]+_b[eq2:LP3]+_b[eq3:LP3]+_b[eq4:LP3]+_b[eq5:LP3]+_b[eq6:LP3]+_b[eq7:LP3])
sum B83
testnl -
(_b[eq1:LP3]+_b[eq2:LP3]+_b[eq3:LP3]+_b[eq4:LP3]+_b[eq5:LP3]+_b[eq6:LP3]+_b[eq7:LP3]) =
0

gen B84=-
(_b[eq1:LP4]+_b[eq2:LP4]+_b[eq3:LP4]+_b[eq4:LP4]+_b[eq5:LP4]+_b[eq6:LP4]+_b[eq7:LP4])
sum B84
testnl -
(_b[eq1:LP4]+_b[eq2:LP4]+_b[eq3:LP4]+_b[eq4:LP4]+_b[eq5:LP4]+_b[eq6:LP4]+_b[eq7:LP4]) =
0

gen B85=-
(_b[eq1:LP5]+_b[eq2:LP5]+_b[eq3:LP5]+_b[eq4:LP5]+_b[eq5:LP5]+_b[eq6:LP5]+_b[eq7:LP5])
sum B85
testnl -
(_b[eq1:LP5]+_b[eq2:LP5]+_b[eq3:LP5]+_b[eq4:LP5]+_b[eq5:LP5]+_b[eq6:LP5]+_b[eq7:LP5]) =
0

gen B86=-
(_b[eq1:LP6]+_b[eq2:LP6]+_b[eq3:LP6]+_b[eq4:LP6]+_b[eq5:LP6]+_b[eq6:LP6]+_b[eq7:LP6])
sum B86
```

```
testnl -
(_b[eq1:LP6]+_b[eq2:LP6]+_b[eq3:LP6]+_b[eq4:LP6]+_b[eq5:LP6]+_b[eq6:LP6]+_b[eq7:LP6])=
0

gen B87=-
(_b[eq1:LP7]+_b[eq2:LP7]+_b[eq3:LP7]+_b[eq4:LP7]+_b[eq5:LP7]+_b[eq6:LP7]+_b[eq7:LP7])
sum B87
testnl -
(_b[eq1:LP7]+_b[eq2:LP7]+_b[eq3:LP7]+_b[eq4:LP7]+_b[eq5:LP7]+_b[eq6:LP7]+_b[eq7:LP7])=
0

gen C8=-
(_b[eq1:IND]+_b[eq2:IND]+_b[eq3:IND]+_b[eq4:IND]+_b[eq5:IND]+_b[eq6:IND]+_b[eq7:IND])
sum C8
testnl -
(_b[eq1:IND]+_b[eq2:IND]+_b[eq3:IND]+_b[eq4:IND]+_b[eq5:IND]+_b[eq6:IND]+_b[eq7:IND])
= 0
```

5) Homogeneity test

```
testnl (_b[eq1:LP1]+_b[eq1:LP2]+_b[eq1:LP3]+_b[eq1:LP4]+ _b[eq1:LP5] +
_b[eq1:LP6]+_b[eq1:LP7]+_b[eq1:LP8]=0)(_b[eq2:LP1]+_b[eq2:LP2]+_b[eq2:LP3]+_b[eq2:LP4]
+ _b[eq2:LP5] +
_b[eq2:LP6]+_b[eq2:LP7]+_b[eq2:LP8]=0(_b[eq3:LP1]+_b[eq3:LP2]+_b[eq3:LP3]+_b[eq3:LP4]+
_b[eq3:LP5]+
_b[eq3:LP6]+_b[eq3:LP7]+_b[eq3:LP8]=0)(_b[eq4:LP1]+_b[eq4:LP2]+_b[eq4:LP3]+_b[eq4:LP4]
+ _b[eq4:LP5]+
_b[eq4:LP6]+_b[eq4:LP7]+_b[eq4:LP8]=0)(_b[eq5:LP1]+_b[eq5:LP2]+_b[eq5:LP3]+_b[eq5:LP4]
+ _b[eq5:LP5]+
_b[eq5:LP6]+_b[eq5:LP7]+_b[eq5:LP8]=0)(_b[eq6:LP1]+_b[eq6:LP2]+_b[eq6:LP3]+_b[eq6:LP4]
+ _b[eq6:LP5]+
_b[eq6:LP6]+_b[eq6:LP7]+_b[eq6:LP8]=0)(_b[eq7:LP1]+_b[eq7:LP2]+_b[eq7:LP3]+_b[eq7:LP4]
+ _b[eq7:LP5]+ _b[eq7:LP6]+_b[eq7:LP7]+_b[eq7:LP8]=0)
```

6)Testing for homogeneity and symmetry.

```
testnl (_b[eq1:LP1]+_b[eq1:LP2]+_b[eq1:LP3]+_b[eq1:LP4]+ _b[eq1:LP5] +
_b[eq1:LP6]+_b[eq1:LP7]+_b[eq1:LP8]=0)(_b[eq2:LP1]+_b[eq2:LP2]+_b[eq2:LP3]+_b[eq2:LP4]
+ _b[eq2:LP5] +
_b[eq2:LP6]+_b[eq2:LP7]+_b[eq2:LP8]=0(_b[eq3:LP1]+_b[eq3:LP2]+_b[eq3:LP3]+_b[eq3:LP4]+
_b[eq3:LP5]+
_b[eq3:LP6]+_b[eq3:LP7]+_b[eq3:LP8]=0)(_b[eq4:LP1]+_b[eq4:LP2]+_b[eq4:LP3]+_b[eq4:LP4]
+ _b[eq4:LP5]+
_b[eq4:LP6]+_b[eq4:LP7]+_b[eq4:LP8]=0)(_b[eq5:LP1]+_b[eq5:LP2]+_b[eq5:LP3]+_b[eq5:LP4]
+ _b[eq5:LP5]+
_b[eq5:LP6]+_b[eq5:LP7]+_b[eq5:LP8]=0)(_b[eq6:LP1]+_b[eq6:LP2]+_b[eq6:LP3]+_b[eq6:LP4]
+ _b[eq6:LP5]+
```

_b[eq6:LP6]+_b[eq6:LP7]+_b[eq6:LP8]=0)(_b[eq7:LP1]+_b[eq7:LP2]+_b[eq7:LP3]+_b[eq7:LP4] + _b[eq7:LP5]+ _b[eq7:LP6]+_b[eq7:LP7]+_b[eq7:LP8]=0)(_b[eq1:LP2]-_b[eq2:LP1]=0)(_b[eq1:LP3]-_b[eq3:LP1]=0)(_b[eq1:LP4]-_b[eq4:LP1]=0)(_b[eq1:LP5]-_b[eq5:LP1]=0)(_b[eq1:LP6]-_b[eq6:LP1]=0)(_b[eq1:LP7]-_b[eq7:LP1]=0)(_b[eq2:LP3]-_b[eq3:LP2]=0)(_b[eq2:LP4]-_b[eq4:LP2]=0)(_b[eq2:LP5]-_b[eq5:LP2]=0)(_b[eq2:LP6]-_b[eq6:LP2]=0)(_b[eq2:LP7]-_b[eq7:LP2]=0)(_b[eq3:LP4]-_b[eq4:LP3]=0)(_b[eq3:LP5]-_b[eq5:LP3]=0)(_b[eq3:LP6]-_b[eq6:LP3]=0)(_b[eq3:LP7]-_b[eq7:LP3]=0)(_b[eq4:LP5]-_b[eq5:LP4]=0)(_b[eq4:LP6]-_b[eq6:LP4]=0)(_b[eq4:LP7]-_b[eq7:LP4]=0)(_b[eq5:LP6]-_b[eq6:LP5]=0)(_b[eq5:LP7]-_b[eq7:LP5]=0)(_b[eq6:LP7]-_b[eq7:LP6]=0)

Rotterdam Model

1) Generation of the variables.

```
gen Y=D1+D2+D3+D4+D5+D6+D7+D8
egen MP1 = mean(P1)
egen MP2 = mean(P2)
egen MP3 = mean(P3)
egen MP4 = mean(P4)
egen MP5 = mean(P5)
egen MP6 = mean(P6)
egen MP7 = mean(P7)
egen MP8 = mean(P8)

gen Q1=D1/P1
gen Q2=D2/P2
gen Q3=D3/P3
gen Q4=D4/P4
gen Q5=D5/P5
gen Q6=D6/P6
gen Q7=D7/P7
gen Q8=D8/P8
egen MQ1 = mean(Q1)
egen MQ2 = mean(Q2)
egen MQ3 = mean(Q3)
egen MQ4 = mean(Q4)
egen MQ5 = mean(Q5)
egen MQ6 = mean(Q6)
egen MQ7 = mean(Q7)
egen MQ8 = mean(Q8)
gen W1=D1/Y
gen W2=D2/Y
gen W3=D3/Y
gen W4=D4/Y
gen W5=D5/Y
```

```
gen W6=D6/Y
gen W7=D7/Y
gen W8=D8/Y
egen MW1 = mean(W1)
egen MW2 = mean(W2)
egen MW3 = mean(W3)
egen MW4 = mean(W4)
egen MW5 = mean(W5)
egen MW6 = mean(W6)
egen MW7 = mean(W7)
egen MW8 = mean(W8)
tset Year
gen lY=log(Y)
gen llY=l.lY
gen dlY=lY-llY
local i=1
while `i'<=8{
gen lP`i'=log(P`i')
gen llP`i'=l.lP`i'
gen dlP`i'=lP`i'-llP`i'
gen lQ`i'=log(Q`i')
gen llQ`i'=l.lQ`i'
gen dlQ`i'=lQ`i'-llQ`i'
local i=`i'+1
}
gen Z1=W1*dlQ1
gen Z2=W2*dlQ2
gen Z3=W3*dlQ3
gen Z4=W4*dlQ4
gen Z5=W5*dlQ5
gen Z6=W6*dlQ6
gen Z7=W7*dlQ7
gen Z8=W8*dlQ8
gen WP=W1*dlP1+W2*dlP2+W3*dlP3+W4*dlP4+W5*dlP5+W6*dlP6+W7*dlP7+W8*dlP8
gen dlYWP=dlY-WP
```

2) Autocorrelation test.

```
sureg (Z1: Z1 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z2: Z2 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z3: Z3 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z4: Z4 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z5: Z5 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z6: Z6 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)(Z7: Z7 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP, noconstant)

lmareg3
```

3) Dynamic model.

```
local i=1
while `i'<=8{
gen LZ`i'=l.Z`i'
local i=`i'+1
}
gen trend=_n

constraint 29 _b[Z1:LZ1]-_b[Z2:LZ2] = 0
constraint 30 _b[Z2:LZ2]=_b[Z3:LZ3]
constraint 31 _b[Z3:LZ3]=_b[Z4:LZ4]
constraint 32 _b[Z4:LZ4]=_b[Z5:LZ5]
constraint 33 _b[Z5:LZ5]=_b[Z6:LZ6]
constraint 34 _b[Z6:LZ6]=_b[Z7:LZ7]

sureg (Z1: Z1 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ1)(Z2: Z2 dlP1 dlP2 dlP3
dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ2)(Z3: Z3 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8
dlYWP trend LZ3)(Z4: Z4 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ4)(Z5: Z5 dlP1
dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ5)(Z6: Z6 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7
dlP8 dlYWP trend LZ6)(Z7: Z7 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ7),
constraints(29-34)

lmareg 3
```

4) Proposing the model.

```
constraint 29 _b[eq1:LZ1]-_b[eq2:LZ2] = 0
constraint 30 _b[eq2:LZ2]=_b[eq3:LZ3]
constraint 31 _b[eq3:LZ3]=_b[eq4:LZ4]
constraint 32 _b[eq4:LZ4]=_b[eq5:LZ5]
constraint 33 _b[eq5:LZ5]=_b[eq6:LZ6]
constraint 34 _b[eq6:LZ6]=_b[eq7:LZ7]

sureg (eq1: Z1 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP LZ1)(eq2: Z2 dlP1 dlP2 dlP3 dlP4
dlP5 dlP6 dlP7 dlP8 dlYWP LZ2)(eq3: Z3 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP
LZ3)(eq4: Z4 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP LZ4)(eq5: Z5 dlP1 dlP2 dlP3 dlP4
dlP5 dlP6 dlP7 dlP8 dlYWP LZ5)(eq6: Z6 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP
LZ6)(eq7: Z7 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP LZ7), constraints (29-34)

gen B8= 1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP])
gen C81=-
(_b[eq1:dlP1]+_b[eq2:dlP1]+_b[eq3:dlP1]+_b[eq4:dlP1]+_b[eq5:dlP1]+_b[eq6:dlP1]+_b[eq7:dl
P1])
```

gen C82=-
(_b[eq1:dlP2]+_b[eq2:dlP2]+_b[eq3:dlP2]+_b[eq4:dlP2]+_b[eq5:dlP2]+_b[eq6:dlP2]+_b[eq7:dl
P2])
gen C83=-
(_b[eq1:dlP3]+_b[eq2:dlP3]+_b[eq3:dlP3]+_b[eq4:dlP3]+_b[eq5:dlP3]+_b[eq6:dlP3]+_b[eq7:dl
P3])
gen C84=-
(_b[eq1:dlP4]+_b[eq2:dlP4]+_b[eq3:dlP4]+_b[eq4:dlP4]+_b[eq5:dlP4]+_b[eq6:dlP4]+_b[eq7:dl
P4])
gen C85=-
(_b[eq1:dlP5]+_b[eq2:dlP5]+_b[eq3:dlP5]+_b[eq4:dlP5]+_b[eq5:dlP5]+_b[eq6:dlP5]+_b[eq7:dl
P5])
gen C86=-
(_b[eq1:dlP6]+_b[eq2:dlP6]+_b[eq3:dlP6]+_b[eq4:dlP6]+_b[eq5:dlP6]+_b[eq6:dlP6]+_b[eq7:dl
P6])
gen C87=-
(_b[eq1:dlP7]+_b[eq2:dlP7]+_b[eq3:dlP7]+_b[eq4:dlP7]+_b[eq5:dlP7]+_b[eq6:dlP7]+_b[eq7:dl
P7])
gen C88=-
(_b[eq1:dlP8]+_b[eq2:dlP8]+_b[eq3:dlP8]+_b[eq4:dlP8]+_b[eq5:dlP8]+_b[eq6:dlP8]+_b[eq7:dl
P8])

5) Homogeneity test.

testnl (_b[eq1:dlP1]+_b[eq1:dlP2]+_b[eq1:dlP3]+_b[eq1:dlP4]+ _b[eq1:dlP5]+ _b[eq1:dlP6]+ _b[eq1:dlP7]+ _b[eq1:dlP8]=0)(_b[eq2:dlP1]+_b[eq2:dlP2]+_b[eq2:dlP3]+_b[eq2:dlP4]+ _b[eq2:dlP5]+ _b[eq2:dlP6]+ _b[eq2:dlP7]+ _b[eq2:dlP8]=0)(_b[eq3:dlP1]+_b[eq3:dlP2]+_b[eq3:dlP3]+_b[eq3:dlP4]+ _b[eq3:dlP5]+ _b[eq3:dlP6]+ _b[eq3:dlP7]+ _b[eq3:dlP8]=0)(_b[eq4:dlP1]+_b[eq4:dlP2]+_b[eq4:dlP3]+_b[eq4:dlP4]+ _b[eq4:dlP5]+ _b[eq4:dlP6]+ _b[eq4:dlP7]+ _b[eq4:dlP8]=0)(_b[eq5:dlP1]+_b[eq5:dlP2]+_b[eq5:dlP3]+_b[eq5:dlP4]+ _b[eq5:dlP5]+ _b[eq5:dlP6]+ _b[eq5:dlP7]+ _b[eq5:dlP8]=0)(_b[eq6:dlP1]+_b[eq6:dlP2]+_b[eq6:dlP3]+_b[eq6:dlP4]+ _b[eq6:dlP5]+ _b[eq6:dlP6]+ _b[eq6:dlP7]+ _b[eq6:dlP8]=0)(_b[eq7:dlP1]+_b[eq7:dlP2]+_b[eq7:dlP3]+_b[eq7:dlP4]+ _b[eq7:dlP5]+ _b[eq7:dlP6]+ _b[eq7:dlP7]+ _b[eq7:dlP8]=0)

6) Homogeneity and symmetry test.

testnl (_b[eq1:dlP1]+_b[eq1:dlP2]+_b[eq1:dlP3]+_b[eq1:dlP4]+ _b[eq1:dlP5]+ _b[eq1:dlP6]+ _b[eq1:dlP7]+ _b[eq1:dlP8]=0)(_b[eq2:dlP1]+_b[eq2:dlP2]+_b[eq2:dlP3]+_b[eq2:dlP4]+ _b[eq2:dlP5]+ _b[eq2:dlP6]+ _b[eq2:dlP7]+ _b[eq2:dlP8]=0)(_b[eq3:dlP1]+_b[eq3:dlP2]+_b[eq3:dlP3]+_b[eq3:dlP4]+ _b[eq3:dlP5]+ _b[eq3:dlP6]+ _b[eq3:dlP7]+ _b[eq3:dlP8]=0)(_b[eq4:dlP1]+_b[eq4:dlP2]+_b[eq4:dlP3]+_b[eq4:dlP4]+ _b[eq4:dlP5]+ _b[eq4:dlP6]+ _b[eq4:dlP7]+ _b[eq4:dlP8]=0)(

_b[eq5:dlP1]+_b[eq5:dlP2]+_b[eq5:dlP3]+_b[eq5:dlP4]+ _b[eq5:dlP5]+ _b[eq5:dlP6]+ _b[eq5:dlP7]+ _b[eq5:dlP8]=0)(_b[eq6:dlP1]+_b[eq6:dlP2]+_b[eq6:dlP3]+_b[eq6:dlP4]+ _b[eq6:dlP5]+ _b[eq6:dlP6]+ _b[eq6:dlP7]+ _b[eq6:dlP8]=0)(_b[eq7:dlP1]+_b[eq7:dlP2]+_b[eq7:dlP3]+_b[eq7:dlP4]+ _b[eq7:dlP5]+ _b[eq7:dlP6]+ _b[eq7:dlP7]+ _b[eq7:dlP8]=0)(_b[eq1:dlP2]-_b[eq2:dlP1]=0)(_b[eq1:dlP3]-_b[eq3:dlP1]=0)(_b[eq1:dlP4]-_b[eq4:dlP1]=0)(_b[eq1:dlP5]-_b[eq5:dlP1]=0)(_b[eq1:dlP6]-_b[eq6:dlP1]=0)(_b[eq1:dlP7]-_b[eq7:dlP1]=0)(_b[eq2:dlP3]-_b[eq3:dlP2]=0)(_b[eq2:dlP4]-_b[eq4:dlP2]=0)(_b[eq2:dlP5]-_b[eq5:dlP2]=0)(_b[eq2:dlP6]-_b[eq6:dlP2]=0)(_b[eq2:dlP7]-_b[eq7:dlP2]=0)(_b[eq3:dlP4]-_b[eq4:dlP3]=0)(_b[eq3:dlP5]-_b[eq5:dlP3]=0)(_b[eq3:dlP6]-_b[eq6:dlP3]=0)(_b[eq3:dlP7]-_b[eq7:dlP3]=0)(_b[eq4:dlP5]-_b[eq5:dlP4]=0)(_b[eq4:dlP6]-_b[eq6:dlP4]=0)(_b[eq4:dlP7]-_b[eq7:dlP4]=0)(_b[eq5:dlP6]-_b[eq6:dlP5]=0)(_b[eq5:dlP7]-_b[eq7:dlP5]=0)(_b[eq6:dlP7]-_b[eq7:dlP6]=0)

7) Autocorrelation with homogeneity and symmetry imposed on the model .

constraint 1 _b[Z1:dlP1]+_b[Z1:dlP2]+_b[Z1:dlP3]+_b[Z1:dlP4]+ _b[Z1:dlP5]+ _b[Z1:dlP6]+ _b[Z1:dlP7]+ _b[Z1:dlP8] = 0

constraint 2 _b[Z2:dlP1]+_b[Z2:dlP2]+_b[Z2:dlP3]+_b[Z2:dlP4]+ _b[Z2:dlP5]+ _b[Z2:dlP6]+ _b[Z2:dlP7]+ _b[Z2:dlP8] = 0

constraint 3 _b[Z3:dlP1]+_b[Z3:dlP2]+_b[Z3:dlP3]+_b[Z3:dlP4]+ _b[Z3:dlP5]+ _b[Z3:dlP6]+ _b[Z3:dlP7]+ _b[Z3:dlP8] = 0

constraint 4 _b[Z4:dlP1]+_b[Z4:dlP2]+_b[Z4:dlP3]+_b[Z4:dlP4]+ _b[Z4:dlP5]+ _b[Z4:dlP6]+ _b[Z4:dlP7]+ _b[Z4:dlP8] = 0

constraint 5 _b[Z5:dlP1]+_b[Z5:dlP2]+_b[Z5:dlP3]+_b[Z5:dlP4]+ _b[Z5:dlP5]+ _b[Z5:dlP6]+ _b[Z5:dlP7]+ _b[Z5:dlP8] = 0

constraint 6 _b[Z6:dlP1]+_b[Z6:dlP2]+_b[Z6:dlP3]+_b[Z6:dlP4]+ _b[Z6:dlP5]+ _b[Z6:dlP6]+ _b[Z6:dlP7]+ _b[Z6:dlP8] = 0

constraint 7 _b[Z7:dlP1]+_b[Z7:dlP2]+_b[Z7:dlP3]+_b[Z7:dlP4]+ _b[Z7:dlP5]+ _b[Z7:dlP6]+ _b[Z7:dlP7]+ _b[Z7:dlP8] = 0

constraint 8 _b[Z1:dlP2]-_b[Z2:dlP1] = 0

constraint 9 _b[Z1:dlP3]-_b[Z3:dlP1] = 0

constraint 10 _b[Z1:dlP4]-_b[Z4:dlP1] = 0

constraint 11 _b[Z1:dlP5]-_b[Z5:dlP1] = 0

constraint 12 _b[Z1:dlP6]-_b[Z6:dlP1] = 0

constraint 13 _b[Z1:dlP7]-_b[Z7:dlP1] = 0

constraint 14 _b[Z2:dlP3]-_b[Z3:dlP2] = 0

constraint 15 _b[Z2:dlP4]-_b[Z4:dlP2] = 0 constraint 16 _b[Z2:dlP5]-_b[Z5:dlP2] = 0

constraint 17 _b[Z2:dlP6]-_b[Z6:dlP2] = 0

constraint 18 _b[Z2:dlP7]-_b[Z7:dlP2] = 0

constraint 19 _b[Z3:dlP4]-_b[Z4:dlP3] = 0

constraint 20 _b[Z3:dlP5]-_b[Z5:dlP3] = 0

constraint 21 _b[Z3:dlP6]-_b[Z6:dlP3] = 0

constraint 22 _b[Z3:dlP7]-_b[Z7:dlP3] = 0

constraint 23 _b[Z4:dlP5]-_b[Z5:dlP4] = 0

constraint 24 _b[Z4:dlP6]-_b[Z6:dlP4] = 0

constraint 25 _b[Z4:dlP7]-_b[Z7:dlP4] = 0

constraint 26 _b[Z5:dlP6]-_b[Z6:dlP5] = 0

constraint 27 _b[Z5:dlP7]-_b[Z7:dlP5] = 0

constraint 28 _b[Z6:dlP7]-_b[Z7:dlP6] = 0

constraint 29 _b[Z1:LZ1]-_b[eq2:LZ2] = 0

constraint 29 _b[Z1:LZ1]-_b[Z2:LZ2] = 0

constraint 30 _b[Z2:LZ2]=_b[Z3:LZ3]

constraint 31 _b[Z3:LZ3]=_b[Z4:LZ4]

constraint 32 _b[Z4:LZ4]=_b[Z5:LZ5]

constraint 33 _b[Z5:LZ5]=_b[Z6:LZ6]

constraint 34 _b[Z6:LZ6]=_b[Z7:LZ7]

sureg (Z1: Z1 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ1)(Z2: Z2 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ2)(Z3: Z3 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ3)(Z4: Z4 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ4)(Z5: Z5 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ5)(Z6: Z6 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ6)(Z7: Z7 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ7), constraints(1-34)

lmareg3

8) Final model proposed.

constraint 1 _b[eq1:dlP1]+_b[eq1:dlP2]+_b[eq1:dlP3]+_b[eq1:dlP4]+ _b[eq1:dlP5]+ _b[eq1:dlP6]+ _b[eq1:dlP7]+ _b[eq1:dlP8] = 0 constraint 2 _b[eq2:dlP1]+_b[eq2:dlP2]+_b[eq2:dlP3]+_b[eq2:dlP4]+ _b[eq2:dlP5]+ _b[eq2:dlP6]+ _b[eq2:dlP7]+ _b[eq2:dlP8] = 0

constraint 3 _b[eq3:dlP1]+_b[eq3:dlP2]+_b[eq3:dlP3]+_b[eq3:dlP4]+ _b[eq3:dlP5]+ _b[eq3:dlP6]+ _b[eq3:dlP7]+ _b[eq3:dlP8] = 0

constraint 4 _b[eq4:dlP1]+_b[eq4:dlP2]+_b[eq4:dlP3]+_b[eq4:dlP4]+ _b[eq4:dlP5]+ _b[eq4:dlP6]+ _b[eq4:dlP7]+ _b[eq4:dlP8] = 0

constraint 5 _b[eq5:dlP1]+_b[eq5:dlP2]+_b[eq5:dlP3]+_b[eq5:dlP4]+ _b[eq5:dlP5]+ _b[eq5:dlP6]+ _b[eq5:dlP7]+ _b[eq5:dlP8] = 0

constraint 6 _b[eq6:dlP1]+_b[eq6:dlP2]+_b[eq6:dlP3]+_b[eq6:dlP4]+ _b[eq6:dlP5]+ _b[eq6:dlP6]+ _b[eq6:dlP7]+ _b[eq6:dlP8] = 0

constraint 7 _b[eq7:dlP1]+_b[eq7:dlP2]+_b[eq7:dlP3]+_b[eq7:dlP4]+ _b[eq7:dlP5]+ _b[eq7:dlP6]+ _b[eq7:dlP7]+ _b[eq7:dlP8] = 0

constraint 8 _b[eq1:dlP2]-_b[eq2:dlP1] = 0

constraint 9 _b[eq1:dlP3]-_b[eq3:dlP1] = 0

constraint 10 _b[eq1:dlP4]-_b[eq4:dlP1] = 0

constraint 11 _b[eq1:dlP5]-_b[eq5:dlP1] = 0

constraint 12 _b[eq1:dlP6]-_b[eq6:dlP1] = 0

constraint 13 _b[eq1:dlP7]-_b[eq7:dlP1] = 0

constraint 14 _b[eq2:dlP3]-_b[eq3:dlP2] = 0

constraint 15 _b[eq2:dlP4]-_b[eq4:dlP2] = 0

constraint 16 _b[eq2:dlP5]-_b[eq5:dlP2] = 0

constraint 17 _b[eq2:dlP6]-_b[eq6:dlP2] = 0

constraint 18 _b[eq2:dlP7]-_b[eq7:dlP2] = 0

constraint 19 _b[eq3:dlP4]-_b[eq4:dlP3] = 0

constraint 20 _b[eq3:dlP5]-_b[eq5:dlP3] = 0

constraint 21 _b[eq3:dlP6]-_b[eq6:dlP3] = 0

constraint 22 _b[eq3:dlP7]-_b[eq7:dlP3] = 0

constraint 23 _b[eq4:dlP5]-_b[eq5:dlP4] = 0

constraint 24 _b[eq4:dlP6]-_b[eq6:dlP4] = 0

constraint 25 _b[eq4:dlP7]-_b[eq7:dlP4] = 0 constraint 26 _b[eq5:dlP6]-_b[eq6:dlP5] = 0

constraint 27 _b[eq5:dlP7]-_b[eq7:dlP5] = 0

constraint 28 _b[eq6:dlP7]-_b[eq7:dlP6] = 0

constraint 29 _b[eq1:LZ1]-_b[eq2:LZ2] = 0

constraint 30 _b[eq2:LZ2]=_b[eq3:LZ3]

constraint 31 _b[eq3:LZ3]=_b[eq4:LZ4]

constraint 32 _b[eq4:LZ4]=_b[eq5:LZ5]

constraint 33 _b[eq5:LZ5]=_b[eq6:LZ6]

constraint 34 _b[eq6:LZ6]=_b[eq7:LZ7]

sureg (eq1: Z1 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ1)(eq2: Z2 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ2)(eq3: Z3 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ3)(eq4: Z4 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ4)(eq5: Z5 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ5)(eq6: Z6 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ6)(eq7: Z7 dlP1 dlP2 dlP3 dlP4 dlP5 dlP6 dlP7 dlP8 dlYWP trend LZ7), constraints (1-34)

9) Income elasticities.

```
local i=1
while `i'<=7{
gen E`i'R=(_b[eq`i':dlYWP]/MW`i')
sum E`i'R
testnl (_b[eq`i':dlYWP]/MW`i')=0
local i=`i'+1
}
gen E8R=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/MW8
sum E8R
testnl (1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/MW8=0
```

10) Evolution of income elasticities.

```
local i=1
while `i'<=7{
gen E`i'R1=(_b[eq`i':dlYWP]/W`i') if Year==1980
sum E`i'R1
local i=`i'+1
}
```

```
gen E8R1=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 1980
sum E8R1
local i=1
while `i'<=7{
gen E`i'R2=(_b[eq`i':dlYWP]/W`i') if Year==1988
sum E`i'R2
local i=`i'+1
}
gen E8R2=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 1988
sum E8R2
local i=1
while `i'<=7{
gen E`i'R3=(_b[eq`i':dlYWP]/W`i') if Year==1994
sum E`i'R3
local i=`i'+1
}
gen E8R3=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 1994
sum E8R3
local i=1
while `i'<=7{
gen E`i'R4=(_b[eq`i':dlYWP]/W`i') if Year==2008
sum E`i'R4
local i=`i'+1
}
gen E8R4=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 2008
sum E8R4
local i=1
while `i'<=7{
gen E`i'R5=(_b[eq`i':dlYWP]/W`i') if Year==2013
sum E`i'R5
local i=`i'+1
}
gen E8R5=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 2013
sum E8R5
local i=1
```

```
while `i'<=7{
gen E`i'R6=(_b[eq`i':dlYWP]/W`i') if Year==2015
sum E`i'R6
local i=`i'+1
}
gen E8R6=(1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlYWP]+_b[eq6:dlYW
P]+_b[eq7:dlYWP]))/W8 if Year== 2015
sum E8R6
```

11) Marshallian price elasticities.

```
gen E11M=(_b[eq1:dlP1]/MW1)-MW1*(_b[eq1:dlYWP]/MW1)
sum E11M
testnl (_b[eq1:dlP1]/MW1)-MW1*(_b[eq1:dlYWP]/MW1)=0
local i=2
while `i'<=8{
gen E1`i'M= (_b[eq1:dlP`i']/MW1)-MW1*(_b[eq1:dlYWP]/MW1)
sum E1`i'M
testnl (_b[eq1:dlP`i']/MW1)-MW1*(_b[eq1:dlYWP]/MW1)=0
local i=`i'+1
}
*****************GROUP 2*********
local i=1
while `i'<=8{
gen E2`i'M= (_b[eq2:dlP`i']/MW2)-MW`i'*(_b[eq2:dlYWP]/MW2)
sum E2`i'M
testnl (_b[eq2:dlP`i']/MW2)-MW`i'*(_b[eq2:dlYWP]/MW2)=0
local i=`i'+1
}
********************GROUP 3*************
local i=1
while `i'<=8{
gen E3`i'M= (_b[eq3:dlP`i']/MW3)-MW`i'*(_b[eq3:dlYWP]/MW3)
sum E3`i'M
testnl (_b[eq3:dlP`i']/MW3)-MW`i'*(_b[eq3:dlYWP]/MW3)=0
local i=`i'+1
}
******************************GROUP 4********
local i=1
while `i'<=8{
gen E4`i'M= (_b[eq4:dlP`i']/MW4)-MW`i'*(_b[eq4:dlYWP]/MW4)
sum E4`i'M
testnl (_b[eq4:dlP`i']/MW4)-MW`i'*(_b[eq4:dlYWP]/MW4)=0
local i=`i'+1
```

```
}
*******************************GROUP5********
local i=1
while `i'<=8{
gen E5`i'M= (_b[eq5:dlP`i']/MW5)-MW`i'*(_b[eq5:dlYWP]/MW5)
sum E5`i'M
testnl (_b[eq5:dlP`i']/MW5)-MW`i'*(_b[eq5:dlYWP]/MW5)=0
local i=`i'+1
}
*******************************GROUP 6********
local i=1
while `i'<=8{
gen E6`i'M= (_b[eq6:dlP`i']/MW6)-MW`i'*(_b[eq6:dlYWP]/MW6)
sum E6`i'M
testnl (_b[eq6:dlP`i']/MW6)-MW`i'*(_b[eq6:dlYWP]/MW6)=0
local i=`i'+1
}
*******************************GROUP 7********
local i=1
while `i'<=8{
gen E7`i'M= (_b[eq7:dlP`i']/MW7)-MW`i'*(_b[eq7:dlYWP]/MW7)
sum E7`i'M
testnl (_b[eq7:dlP`i']/MW7)-MW`i'*(_b[eq7:dlYWP]/MW7)=0
local i=`i'+1
}
********************************GROUP 8********
local i=1
while `i'<=8{
gen E8`i'M= ((-
(_b[eq1:dlP`i']+_b[eq2:dlP`i']+_b[eq3:dlP`i']+_b[eq4:dlP`i']+_b[eq5:dlP`i']+_b[eq6:dlP`i']+_b[eq
7:dlP`i']))/MW8)-MW`i'*((1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlP`i']+_b[eq6:dlP`i']+
_b[eq7:dlP`i']))/MW8)
sum E8`i'M
testnl ((-
(_b[eq1:dlP`i']+_b[eq2:dlP`i']+_b[eq3:dlP`i']+_b[eq4:dlP`i']+_b[eq5:dlP`i']+_b[eq6:dlP`i']+_b[eq
7:dlP`i']))/MW8)-MW`i'*((1-
(_b[eq1:dlYWP]+_b[eq2:dlYWP]+_b[eq3:dlYWP]+_b[eq4:dlYWP]+_b[eq5:dlP`i']+_b[eq6:dlP`i']+
_b[eq7:dlP`i']))/MW8)=0
local i=`i'+1
}
```

12)Hicksian price elasticities.

```
local i=1
while `i'<=8{
gen E1`i'H= (_b[eq1:dlP`i']/MW1)
```

```
sum E1`i'H
testnl (_b[eq1:dlP`i']/MW1)=0

local i=`i'+1
}
*********************** GROUP2************************
local i=1
while `i'<=8{
gen E2`i'H=(_b[eq2:dlP`i']/MW2)
sum E2`i'H
testnl (_b[eq2:dlP`i']/MW2)=0
local i=`i'+1
}
*********************** GROUP 3************************
local i=1
while `i'<=8{
gen E3`i'H= (_b[eq3:dlP`i']/MW3)
sum E3`i'H
testnl (_b[eq3:dlP`i']/MW3)=0

local i=`i'+1
}
*******************************GROUP 4****************
local i=1
while `i'<=8{
gen E4`i'H= (_b[eq4:dlP`i']/MW4)
sum E4`i'H
testnl (_b[eq4:dlP`i']/MW4)=0
local i=`i'+1
}
******************************GROUP5********
local i=1
while `i'<=8{
gen E5`i'H= (_b[eq5:dlP`i']/MW5)
sum E5`i'H
testnl (_b[eq5:dlP`i']/MW5)=0
local i=`i'+1
}
*******************************GROUP 6*******
local i=1
while `i'<=8{
gen E6`i'H= (_b[eq6:dlP`i']/MW6)
sum E6`i'H
testnl (_b[eq6:dlP`i']/MW6)=0
local i=`i'+1
```

```
}
*******************************GROUP 7********
local i=1
while `i'<=8{
gen E7`i'H= (_b[eq7:dlP`i']/MW7)
sum E7`i'H
testnl (_b[eq7:dlP`i']/MW7)=0
local i=`i'+1
}
********************************GRUPO 8************
local i=1
while `i'<=8{
gen E8`i'H= ((-
(_b[eq1:dlP`i']+_b[eq2:dlP`i']+_b[eq3:dlP`i']+_b[eq4:dlP`i']+_b[eq5:dlP`i']+_b[eq6:dlP`i']+_b[eq
7:dlP`i']))/MW8)
sum E8`i'H
testnl ((-
(_b[eq1:dlP`i']+_b[eq2:dlP`i']+_b[eq3:dlP`i']+_b[eq4:dlP`i']+_b[eq5:dlP`i']+_b[eq6:dlP`i']+_b[eq
7:dlP`i']))/MW8)=0
local i=`i'+1
}
```

Appendix V

Table Appendix V. System Autocorrelation Tests (sure).Rotterdam dynamic version with the constraints of symmetry and homogeneity:

* System Autocorrelation Tests (sure)
==
*** Single Equation Autocorrelation Tests:
Ho: No Autocorrelation in eq. #: Pij=0
Eq. Z1 : Harvey LM Test = 2.9187 Rho = 0.0858 P-Value > Chi2(1) 0.0876
Eq. Z2 : Harvey LM Test = 0.2263 Rho = 0.0067 P-Value > Chi2(1) 0.6342
Eq. Z3 : Harvey LM Test = 1.3328 Rho = 0.0392 P-Value > Chi2(1) 0.2483
Eq. Z4 : Harvey LM Test = 4.1176 Rho = 0.1211 P-Value > Chi2(1) 0.0424
Eq. Z5 : Harvey LM Test = 0.9084 Rho = 0.0267 P-Value > Chi2(1) 0.3406
Eq. Z6 : Harvey LM Test = 0.0007 Rho = 0.0000 P-Value > Chi2(1) 0.9793
Eq. Z7 : Harvey LM Test = 4.0609 Rho = 0.1194 P-Value > Chi2(1) 0.0439

*** Overall System Autocorrelation Tests:
Ho: No Overall System Autocorrelation: P11 = P22 = PMM = 0
- Harvey LM Test = 13.5654 P-Value > Chi2(7) 0.0595

Source: own elaboration

Appendix VI.

Table Appendix VI. Estimated parameters

.	e q1	eq2	eq3	eq4	eq5	eq6	eq7
θ^*_{i1}	-0.205***	0.034***	0.033***	0.032***	0.004	0.040***	0.040***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.574)	(0.005)	(0.000)
θ^*_{i2}	0.034***	-0.08***	0.028***	-0.003	-0.003	0.008	0.000
	(0.000)	(0.000)	(0.004)	(0.585)	(0.611)	(0.384)	(0.986)
θ^*_{i3}	0.033***	0.028***	-0.09***	0.009	0.017**	0.029*	0.029**
	(0.007)	(0.004)	(0.000)	(0.213)	(0.046)	(0.067)	(0.014)
θ^*_{i4}	0.032***	-0.003	0.009	-0.06***	0.002	0.014**	-0.010
	(0.000)	(0.585)	(0.213)	(0.000)	(0.707)	(0.018)	(0.257)
θ^*_{i5}	0.004	-0.003	0.017**	0.002	-0.06***	0.006	0.018**
	(0.574)	(0.611)	(0.046)	(0.707)	(0.000)	(0.402)	(0.031)
θ^*_{i6}	0.040***	0.008	0.029*	0.014**	0.006	-0.18***	0.009
	(0.005)	(0.384)	(0.067)	(0.018)	(0.007)	(0.000)	(0.370)
θ^*_{i7}	0.040***	0.000	0.029**	-0.010	0.018**	0.009	-0.11***
	(0.000)	(0.986)	(0.014)	(0.257)	(0.031)	(0.370)	(0.000)
θ^*_{i8}	0.021	0.018	-0.06***	0.019**	0.014	0.077***	0.022
	(0.233)	(0.199)	(0.007)	(0.023)	(0.129)	(0.001)	(0.129)
μ_i	0.136***	0.080***	0.121***	0.067***	0.016***	0.149***	0.090***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
α_{i2}	0.000***	-0.000	0.000***	-0.00***	0.000	-0.000**	-0.000**
	(0.000)	(0.586)	(0.000)	(0.001)	(0.563)	(0.019)	(0.023)
α	0.071**						
	(0.01)						
α		0.071**					
		(0.010)					
α			0.071**				
			(0.010)				
α				0.071**			
				(0.010)			
α					0.071**		
					(0.010)		
α						0.071**	
						(0.010)	
α							0.071**
							(0.010)
αi	-0.005***	-0.000	0.003***	0.001**	0.000	0.005***	0.002**
	(0.000)	(0.600)	(0.003)	(0.024)	(0.644)	(0.006)	(0.017)
R^2	0.953	0.916	0.904	0.950	0.866	0.845	0.900

P-values in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration