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Embodied pollution in Spanish household consumption: a disaggregate analysis

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Abstract

In this paper we apply an environmentally extended input-output model to analyse a specific issue related to the Environmental Kuznets Curve hypothesis. The purpose is to study whether the consumption structure of 'wealthier' households has a positive effect on the reduction of environmental pressures. Combining information from different databases, we analysed the impact of the consumption of Spanish households in 2000 on atmospheric pollution. We considered nine gases: the six greenhouse gases (CO_2, CH_4, N_2O, SF_6, HFCs, and PFCs) and three other gases (SO_2, NO_x, and NH_3). We classified households by quintiles of per capita expenditure and equivalent expenditure. We found that there was a positive and very high relationship between the level of expenditure and direct and indirect emissions generated by household consumption; however, the emission intensities tended to decrease with the expenditure level for the various atmospheric pollutants, with the exception of SF_6, HFCs and PFCs.

Keywords: consumption patterns, atmospheric pollution, environmental Kuznets curve, input-output analysis, Spain.

JEL: C67, Q51.

Resumen

En este artículo aplicamos un modelo input-output ampliado medioambientalmente para analizar un aspecto específico de la hipótesis de la curva de Kuznets ambiental. El propósito del estudio es analizar si las estructuras de consumo de los hogares con una mejor 'posición económica' pueden tener un efecto positivo para reducir las presiones medioambientales. Para ello combinamos información de diferentes bases de datos para analizar el impacto de la contaminación atmosférica del consumo de diferentes hogares españoles en el año 2000. Consideramos nueve gases, i.e. los seis gases de efecto invernadero (CO_2, CH_4, N_2O, SF_6, HFCs, y PFCs) y otros tres gases (SO_2, NO_x, y NH_3). Clasificamos los hogares en quintiles de gasto per capita y quintiles de gasto equivalente. Los resultados obtenidos muestran que hay una relación positiva y elevada entre el nivel de gasto y las emisiones directas e indirectas generadas por el consumo de los hogares; sin embargo, las intensidades de emisión tienden a disminuir con el nivel de gasto para los diferentes gases, con la excepción de SF_6, HFCs, y PFCs.

1. Introduction

The worldwide deterioration in environmental quality has acquired increasing interest among academics and politicians in recent years. Specifically, the environmental effects of economic growth have been strongly influenced by the Environmental Kuznets Curve (EKC) hypothesis. This hypothesis postulates an inverted-U-shaped relationship between environmental pressures and per capita income, i.e. as income increases environmental pressures grow until a certain level is reached after which these pressures diminish (Grossman and Krueger, 1991; Shafik and Bandyopadhyay, 1992). However, following de Bruyn and Opschoor's (1997) differentiation, an absolute (or strong) and relative (or weak) delinking might be distinguished between economic growth and environmental pressures. In the first case, there would be an absolute reduction in environmental pressures; whereas in the second one, there would only be a reduction in environmental pressures per unit of income, which would not be enough for environmental improvement.

According to the EKC literature the two main factors provoked by the own process of economic growth which may explain this environmental improvement are technological changes and changes in the structure of the final demand (Roca, 2003)[1]. Thus, it seems important to focus the research not only on the supply-side such as the production process but also on the demand-side where consumers play an active role in the process of reducing environmental pressures (United Nations, 2007).

The aim of this paper is not to test whether an EKC holds for Spain but rather to study one of the elements that determines the relationship between income growth and environmental pressures. Specifically, this paper analyses

[1] In an open economy, the 'delinking' might also be due to the importation of polluting intensive commodities. In such an instance, however, there is no genuine delinking but merely a displacement of environmental costs (Arrow *et al.*, 1995; Suri and Chapman, 1998; Muradian and Martínez-Alier, 2001).

emissions associated with varying levels of private consumption taking into account that consumption structures are also different for different consumption levels. We believe that a comparative static analysis of this kind is very relevant to the EKC debate and it is also relevant for determining the relative responsibilities in emissions for different households.

In this study we combine statistical information drawn from various databases and use an environmentally extended input-output model to evaluate the impact of the consumption of Spanish households, classified by quintiles of expenditure, on atmospheric pollution in 2000. We examine the emissions of nine gases: the six greenhouse gases (CO_2, CH_4, N_2O, SF_6, HFCs, and PFCs) and three gases associated with local and regional environmental problems (SO_2, NO_x, and NH_3). We conclude that the more a household spends the more emissions it generates; however, the atmospheric pollution emitted per unit of household consumption generally decreases with expenditure level. These outcomes were confirmed by the expenditure elasticity values estimated for each of the gases by performing a multivariate regression. Expenditure elasticity was found to be always positive, as well as lower than one for all the gas emissions with the exception of the synthetic greenhouse gases whose elasticity was greater than one.

This type of approach was introduced in the end of the 1970s for analysing how much energy a household requires to maintain its standard of living. Robert Herendeen estimated energy requirements based on input-output analysis and household expenditure data for the US economy (Herendeen and Tanaka, 1976; Herendeen *et al.*, 1981) and Norway (Herendeen, 1978). These studies examined the total energy cost of living for different types of household considering not only the direct demand for energy products, but also the indirect energy required to produce and distribute the commodities demanded by households. This methodology has subsequently been applied in other countries including the Federal Republic of Germany (Denton, 1975), New Zealand (Peet *et al.*, 1985), and the Netherlands (Vringer and Blok, 1995). Reinders *et al.* (2003) evaluated the average energy requirement of households in 11 member states of the European Union (EU), and Lenzen *et al.* (2006) analysed the relationship between income level and energy requirements for five countries, namely, Australia, Brazil, Denmark, India and Japan.

Nevertheless, research on CO_2 emissions associated with household energy requirements is much more recent. Lenzen (1998b) analyses CO_2 emissions for Australia; Weber and Perrels (2000) for West Germany, France, and the Netherlands; Munksgaard *et al.* (2000) and Wier *et al.* (2001) for; and Peters *et al.* (2004) for Norway. All these studies use energy input-output models that combine energy and household expenditure data, but none of them includes results for emissions other than CO_2[2]. Therefore, this is, we believe, the first study to consider other gas emissions generated by the consumption of different households[3].

The rest of the paper is organised as follows. In Section 2, we present the model used in evaluating total emissions embodied in household consumption. In Section 3, we describe the characteristics of Spanish data, the modifications required to correlate data from different sources, and the procedure adopted in estimating our model parameters. In Section 4, we present the results for Spanish households in 2000. In Section 5 we offer our conclusions. Finally, the Appendix to this paper includes more detailed information.

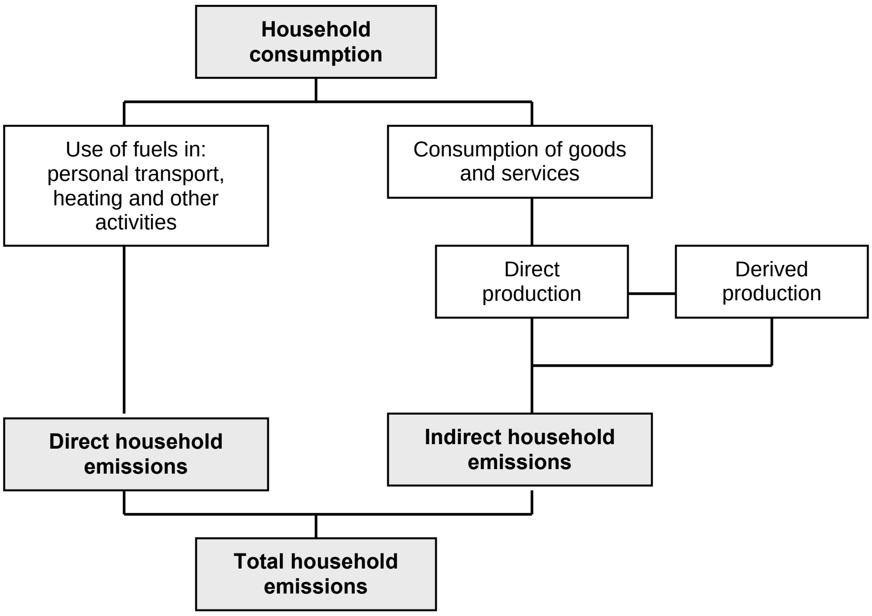
[2] A good review of different input-output methods can be found in Kok *et al.* (2006).

[3] Note that Lenzen (1998a), Peters and Hertwich (2006), and Sánchez-Chóliz *et al.* (2007) do in fact consider other gas emissions, while Nijdam *et al.* (2005) and Huppes *et al.* (2006) analyse other environmental impacts of private consumption, including acidification and eutrophication. However, these studies undertake aggregate analyses as they evaluate the emissions embodied in the total private consumption of the average household without differentiating different types of households.

2. Atmospheric emissions generated by households: the theoretical model

In our analysis of the total emissions generated by household consumption we consider both direct emissions, i.e., those generated directly by certain household activities, such as the use of fuels for personal transport or heating, and indirect emissions, i.e., those associated with the production of goods and services purchased by households, e.g., food, clothes, furniture, electricity, etc. (Figure 1). As such, indirect household emissions also include direct and indirect emissions generated by different economic sectors.

Figure 1: Direct and indirect emissions from household consumption



Source: own elaboration from Munksgaard *et al.* (2000).

Let k be atmospheric pollutants, h be households, and s be consumption purposes. Direct and indirect emissions generated by households are respectively $\mathbf{E}^{\mathbf{direct}}$ and $\mathbf{E}^{\mathbf{indirect}}$, which are two matrices of dimension kxh[4]:

$$\mathbf{E}^{\mathbf{direct}} = \mathbf{D}^{\mathbf{direct}}\mathbf{C} \qquad (1)$$

[4] Matrices are indicated by bold, upright capital letters; vectors by bold, upright lower case letters; and scalars by italicised lower case letters. Vectors are columns by definition.

$$\mathbf{E}^{\mathbf{indirect}} = \mathbf{D}^{\mathbf{indirect}}\mathbf{C} \quad (2)$$

Where $\mathbf{D}^{\mathbf{direct}}$ and $\mathbf{D}^{\mathbf{indirect}}$ are the kxs intensity matrices of direct and indirect household emissions whose respective elements d_{lp}^{direct} and $d_{lp}^{indirect}$ represent the direct indirect emissions of pollutant l measured in physical units associated with each monetary unit spent on a consumption purpose p. And $\mathbf{C}$ is an sxh matrix that indicates expenditure on different goods and services grouped according to consumption purposes carried out by each household.

Thus, total emissions associated with household consumption $\mathbf{E}^{\mathbf{household}}$ of dimension kxh can easily be calculated adding both expressions so that:

$$\mathbf{E}^{\mathbf{household}} = \mathbf{DC} \quad (3)$$

Where $\mathbf{D}$ is now the kxs intensity matrix of total household emissions that includes both direct and indirect household emission coefficients, i.e. $\mathbf{D} = \mathbf{D}^{\mathbf{direct}} + \mathbf{D}^{\mathbf{indirect}}$.

3. Atmospheric emissions generated by households in Spain: from theoretical model to empirical application

In order to estimate direct and indirect household emissions, the classifications and dimensions of all the matrices have to be compatible. However, the model presented in the previous section requires that data be combined from different sources and with different classifications. Thus, we first need to make some assumptions and prepare the data before the model can be computed.

Specifically, four main data sources were employed: the 2000 supply and use tables from the Spanish input-output framework base 1995 (INE, 2005); the

2000 Spanish environmental accounts for air emissions base 1995 (INE, 2006); Spanish Household Budget Continuous Survey (HBCS) for 2000 base 1997 (INE, 2004); and the Spanish transformation matrix that relates CPA and COICOP[5] groups for the year 1995 supplied by the Spanish national statistics institute (INE). These databases are described in detail in Appendix A. The rest of this section is devoted to explaining the procedures used to compute the model parameters.

Direct and indirect household emissions are determined by their corresponding intensity matrices of household emissions, i.e. $\mathbf{D}^{\mathbf{direct}}$ and $\mathbf{D}^{\mathbf{indirect}}$, and the household expenditure matrix $\mathbf{C}$, which can be derived directly from the 2000 Spanish HBCS. However, the two intensity matrices need to be estimated as they are not provided by any one specific statistical source. On one hand, we only have information concerning the aggregate of direct emissions for the total of Spanish households; and, on the other hand, from the above databases we are able to estimate the matrix of total emission intensity by economic products (or economic sectors) but not by expenditure purposes.

First, we estimate the intensity matrix of direct household emissions $\mathbf{D}^{\mathbf{direct}}$. Since direct emissions are only relatively important for CO_2 and NO_x[6], we only consider the direct emissions of these two gases. Given that CO_2 and NO_x emissions are closely linked to energy use, we share their emissions between 4.5 and 7.2 COICOP groups according to an expenditure criterion[7]. So,

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[5] CPA - Classification of Product by Activity; COICOP - Classification of Individual Consumption by Purpose.

[6] According to the 2000 Spanish NAMEA framework, the percentage of direct household emissions to total economy emissions stands at 19.1% for CO_2, 1.8% for CH_4, 6.9% for N_2O, 0.7% for synthetic greenhouse gases, 1.7% for SO_2, 20.7% for NO_x, and 1.2% for NH_3 (INE, 2006).

[7] We consider total expenditure on 4521 (natural gas), 4522 (liquefied gas), 4531 (liquid fuels), 4541 (solid fuels) and 7221 (fuels and lubricants). Note that this criterion implies the restrictive assumption that one monetary unit spent on any energy good of any of these groups generates the same direct emissions. The total expenditure of the economy is the mean expenditure of the HBCS sample multiplied by the number of official households in Spain in

we obtain a matrix $\mathbf{D}^{\mathbf{direct}}$ in which the elements for the remaining seven gases not considered and also for the other groups are zero.

Second, the intensity matrix of indirect household emissions $\mathbf{D}^{\mathbf{indirect}}$ is estimated from an environmentally extended input-output model. Our starting point is the open, static input-output model (see e.g. Bulmer-Thomas, 1982 or Miller and Blair, 1985 for an introduction), which is formally expressed as $\mathbf{x} = \mathbf{Ax} + \mathbf{y}$. For an economy of n sectors, $\mathbf{x}$ is the $nx1$ vector of gross output, $\mathbf{A}$ is the nxn matrix of total input coefficients, and $\mathbf{y}$ is the $nx1$ vector of final uses (including private and government consumption, private and government investments, inventory changes, and gross exports). The solution for the above input-output model is given by $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{Ly}$, where $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse and $\mathbf{I}$ is an nxn identity matrix. Assuming fixed input coefficients, the amount of domestic outputs $\tilde{\mathbf{x}}$ needed to satisfy any exogenously specified final uses vector $\tilde{\mathbf{y}}$ is determined by $\tilde{\mathbf{x}} = \mathbf{L}\tilde{\mathbf{y}}$, where the elements of $\mathbf{L}$ capture both the direct and indirect effects of any change in the exogenous vector of final uses.

The above input-output model can easily be extended to account for k atmospheric pollutants. So, let $\mathbf{V}$ be the kxn matrix of direct emission coefficients whose elements v_{lj} represent the emission of pollutant l generated per unit of sector j's output; the level of atmospheric emissions associated with a given vector of total outputs will be determined by $\mathbf{e} = \mathbf{Vx}$, where $\mathbf{e}$ is the $kx1$ vector of emissions generated by the production of this economy. These emissions can also be expressed as a function of final uses as $\mathbf{e} = \mathbf{V}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{Fy}$, where $\mathbf{F}$ is now the kxn matrix of total emission intensity. This expression can be used to analyse the emissions generated by the economy

the year 2000. According to the Spanish HBCS, the number of households in Spain was 13,086,197 and the effective size of the sample is 9,628. This information is available at http://www.ine.es.

as a whole or by each component of the aggregated final uses such as household consumption, exports, or investment. For instance, if we define the household consumption by the $nx1$ vector $\mathbf{c}$, the above expression would be expressed as $\mathbf{e} = \mathbf{V}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{c} = \mathbf{Fc}$.

However, matrix $\mathbf{F}$ expresses the atmospheric impact of one unit spent by households on the economic sectors' products classified according to CPA, whereas the expenditure household data from the HBCS is classified according to expenditure purposes, i.e. COICOP. So, we need to 'translate' the household expenditures classified by COICOP into household expenditures classified by CPA. To do so, we use an nxs matrix $\mathbf{T}$ that relates n CPA groups with s COICOP groups[8]. Thus, the intensity matrix of indirect household emissions $\mathbf{D}^{\mathbf{indirect}}$ is obtained as:

$$\mathbf{D}^{\mathbf{indirect}} = \mathbf{V}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{T} = \mathbf{FT} \qquad (4)$$

4. Empirical results

This section analyses total emissions generated in 2000 by Spanish households classified according to expenditure level. Given the specific aim of this paper, we only consider direct and indirect emissions associated with household consumption, ignoring those generated by other final uses (government expenditure, investment, exports, etc.) and the CH_4 associated with waste management. We compute the model in terms of nine atmospheric gases: the six greenhouse gases (CO_2, CH_4, N_2O, SF_6, HFCs, and PFCs) and three other

[8] The transformation matrix provided by INE converts 61 types of household expenditure classified by CPA into 47 classified by COICOP valued at purchasers' prices for the year 1995. However, we need a matrix for the year 2000 that converts 47 COICOP groups into 46 CPA groups valued at basic prices. Thus, taking into consideration all these characteristics, we estimate matrix $\mathbf{T}$ from the transformation matrix provided by INE.

gases (SO_2, NO_x, and NH_3)[9]; 9,628 households; 46 NACE sectors or CPA products; and 47 consumption purposes, i.e. goods and services classified by COICOP groups. First, we present a general overview of the most polluting consumption purposes; and then, we analyse the total emissions of different households classified by their level of expenditure.

4.1 Different pollutant intensities for different goods and services

Let us start our analysis by presenting total emission intensities for different COICOP commodities, i.e. direct and indirect emissions generated by one monetary unit of household expenditure classified by consumption purposes. We estimated pollutant intensities for 47 COICOP groups and the outcomes are presented in Appendix B. Generally, these groups are aggregated into 12 COICOP divisions; however, here for the sake of clarity and in order to highlight the most polluting commodities, we preferred to aggregate them into 14 categories (or 'pseudo-divisions' as we have called them). These 14 categories are the same 12 standard divisions but we split division 0.4 'Housing, water, electricity, gas and other fuels' and 0.7 'Transport' as shown in Figure 2[10].

Figure 2: Correspondence between COICOP pseudo-divisions and COICOP divisions

[9] We grouped the SF_6, HFCs, and PFCs gases into the so-called 'greenhouse synthetic gases' and we also present the total emissions of the six greenhouse gases. The aggregation of the different gases is carried out using CO_2 equivalent units in accordance with the global warming potentials established by the Intergovernmental Panel of Climate Change (IPCC, 1997). See Appendix A for more details.

[10] Pseudo-division IV.a 'Housing and water' includes all expenditures related to housing maintenance and water supply. Specifically, it includes: group 04.1 'Actual rentals for housing', group 04.2 'Imputing rentals for housing', group 04.3 'Maintenance and repair of the dwelling', and group 04.4 'Water supply and miscellaneous services relating to the dwelling'. Pseudo-division IV.b 'Electricity, gas, and other fuels' corresponds to the COICOP group 04.5. Further, pseudo-division VII.a 'Personal transport' includes group 07.1 'Purchase of vehicles', and all expenses associated with the use of a private vehicle such as the purchase of fuels and lubricants, i.e. group 07.2 'Operation of personal transport equipment'. Pseudo-division VII.b 'Transport services' is the group 07.3, which corresponds to non-private transport of persons and luggage by railway, road, air, and sea.

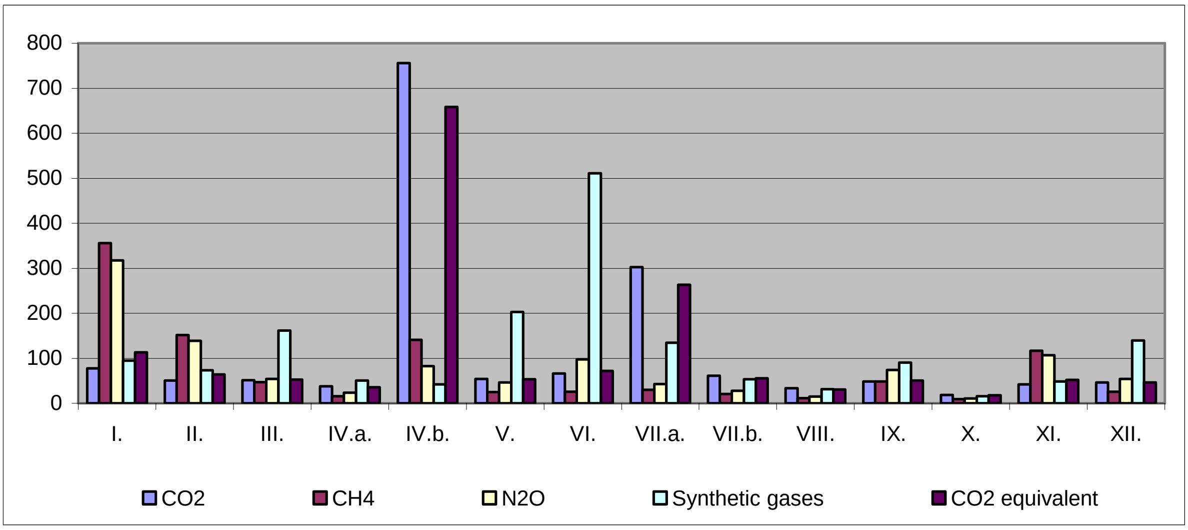
COICOP pseudo division codes	COICOP pseudo divisions	COICOP division codes
I.	Food and non-alcoholic beverages	01
II.	Alcoholic beverages, tobacco, and narcotics	02
III.	Clothing and footwear	03
IV.a.	Housing and water	04.1 – 04.4.
IV.b.	Electricity, gas, and other fuels	04.5.
V.	Furnishings, households equipment, and routine household maintenance	05
VI.	Health	06
VII.a.	Personal transport	07.1. – 07.2.
VII.b.	Transport services	07.3.
VIII.	Communication	08
IX.	Recreation and culture	09
X.	Education	10
XI.	Restaurants and hotels	11
XII.	Miscellaneous goods and services	12

Source: own elaboration from 2000 Spanish HBCS (INE, 2004).

Figures 3 and 4 present total emission intensities for the six greenhouse gases and the three other gases, respectively. These figures show how the expenditure of one monetary unit in the purchase of a range of different goods and services may have very different implications in terms of quantity and type of emissions.

Figure 3: Total emission intensities of greenhouse gases of COICOP pseudo-divisions, Spain 2000

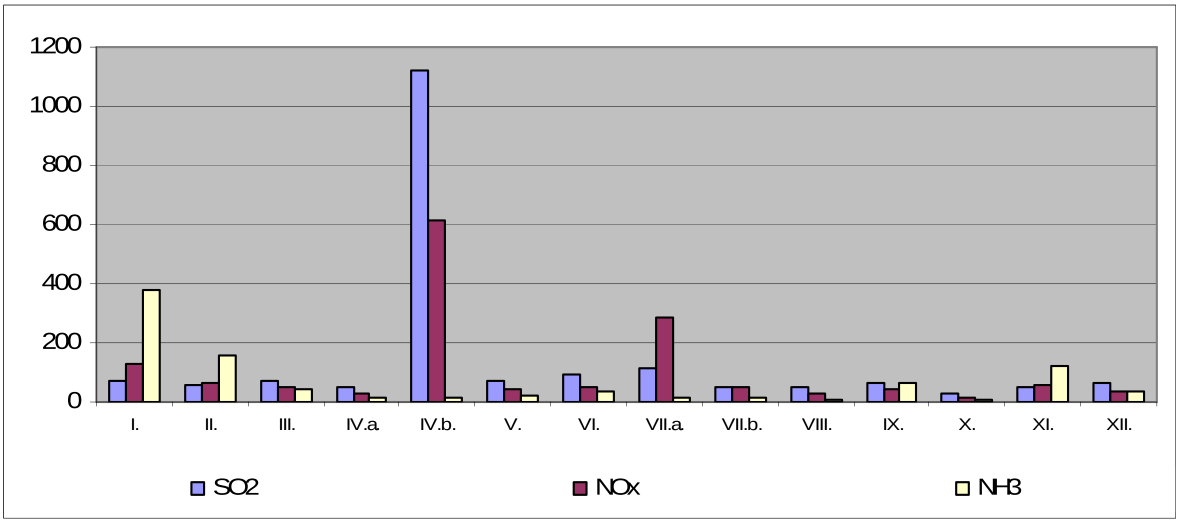
Units: index numbers, mean emissions of total expenditure of households 2000 base = 100.



Source: own elaboration.

Figure 4: Total emission intensities of other gases of COICOP pseudo-divisions, Spain 2000

Units: index numbers, mean emissions of total expenditure of households 2000 base = 100.



Source: own elaboration.

As these tables show, one euro spent on IV.b 'Electricity, gas, and other fuels', generates more than eleven times emissions of SO_2 than one euro spent on the average household consumption. Expenditure on this pseudo-division is also the most polluting in terms of CO_2 and NO_x. In the case of CO_2, SO_2, and NO_x, VII.a 'Personal transport', stands out as the second most polluting pseudo-division[11]. In contrast, the most polluting goods in terms of CH_4, N_2O, and NH_3 are those included in pseudo-divisions I 'Food and non-alcoholic beverages', II 'Alcoholic beverages, tobacco, and narcotics', and XI 'Restaurants and hotels', i.e. those groups related to agriculture and cattle raising CPA groups. In fact, the emission intensity of the most linked pseudo-division, 'Food and non-alcoholic beverages', is more than three times higher than the emission intensity of the average expenditure for these three gases. Finally, the synthetic greenhouse gases acquire relevance in pseudo-divisions VI 'Health' and V 'Furnishings, household equipment, and routine household maintenance'. The former caused mainly by group 6.1 'Medical products, appliances, and equipment'[12].

[11] Note that CO_2 and NO_x emissions include both direct and indirect household emissions, whereas the remaining gases include just indirect emissions.
[12] HBCS refers only to private expenditure on health; neither the consumption of public health nor subsidised medicines, which are usually consumed by lower expenditure quintiles, are considered. As a consequence, relative expenditure on the pseudo-division VI 'Health' can be

Therefore, we can conclude that not only the amount of expenditure but also its distribution across expenditure categories is highly relevant in explaining the emissions generated by different households.

4.2 The relationship between level of household expenditure and atmospheric emissions in Spain

As mentioned above, our aim is to analyse how emissions change when households reach a higher 'economic position'. Therefore, households need to be classified in line with this purpose. In this paper we classify them according to their level of expenditure rather than income for two reasons[13]. First, and much important, HBCS databases provide more complete and reliable data on expenditure than on income. Second, income levels are more variable over time than expenditure levels are. According to the permanent income hypothesis (Friedman, 1957), the choices consumers make regarding their consumption patterns are determined not by their current income but by their longer-term income expectations. So, consumers try to maintain their standard of living fairly constant although their income may vary over time. However, classifying households according to their level of expenditure also has its drawbacks. These limitations are mainly the result of the purchase criterion used to evaluate expenditure in the HBCS. This measure automatically means that those households that have bought durable goods in the current year will be classified in the highest percentile. This accounting criterion contrasts with the more technical perspective, according to which total expenditure on durable goods

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expected to be greater in the highest expenditure quintiles than in the lower quintiles. The same would also apply to expenditure on education.

[13] Clearly, income and expenditure are not the only important variables to classify households. In order to consider other factors influencing lifestyles, alternative perspectives have been adopted such as a multivariate econometric approach (Lenzen *et al.*, 2006), and/or household classifications compiled on the basis of several characteristics, e.g. Duchin (1998) classifies US households by using 40 "geo-demographic lifestyle clusters".

should be distributed over their shelf life. In this study, however, we are not able to measure the consumption of durable goods in economic terms since we do not have access to all the required data.

A further aspect concerning household classification is the question of how to deal with the fact that households differ in size and composition. In fact, several approaches are available to us and, because each has its own particular strengths and weaknesses, we decided to apply various. One alternative, and the most widely adopted, is to divide total household expenditure by the number of household members so that in fact what we analyse are per capita emissions and per capita emission intensities. A second alternative is to construct 'equivalent consumer units', weighting each household according to the number of members and their respective ages. In this case, various mathematical transformations can be applied, each yielding different 'equivalent consumer units'[14]. Among them, the scale recommended by EUROSTAT is the so-called modified OECD scale[15]. In this alternative we analyse emissions and emission intensities generated by the 'equivalent' expenditure of each household. This latter method has the advantage of being able to handle questions of household size and composition. However, it might well be argued that the choice of scale parameters is arbitrary unless supported by empirical evidence. Additionally, both methods propound different hypotheses on economies of scale in consumption and on necessities of monetary expenditure to meet the consumption needs of adults and children.

The third alternative involves grouping households according to their size and then performing the same analysis on each group. For instance, we analyse the emissions and emission intensities for one-member, two-member, three-member and four-member households, and households with five or more

[14] The first alternative (the 'per capita' expenditure) is, in fact, the simplest method for performing this mathematical transformation.
[15] Wier *et al.* (2001) applied this method. According to the modified OECD scale, the first person counts as 1, additional adults count for less than the first (0.5), and children count for less than adults (0.3).

members[16]. Finally, a fourth alternative is a ‘statistical’ method that explains household emissions performing a multivariate regression in which household characteristics are included as independent variables. In this study, we consider household expenditure and household size as our explanatory variables[17]. Both the ‘group-household’ method and the ‘statistical’ method have the advantage of the fact that they do not make any arbitrary assumptions about the importance of economies of scale despite their implicit assumption that household size is relevant while the age composition is not.

For reasons of clarity, in Section 4.2.1 we present – through graphical analysis– the results obtained from the first and second alternatives only. Since the results of the third alternative (the ‘group-household’ method) do not contribute new conclusions, and their interpretation is far from being synthetic, we have presented them graphically in Appendix C. Section 4.2.2 present the results from is the ‘statistical’ method. And finally, Section 4.2.3 presents complementary information for analysing the way in which the composition of different households’ consumption baskets explains different emission patterns.

4.2.1 Graphical analysis: average emissions and average emission intensities

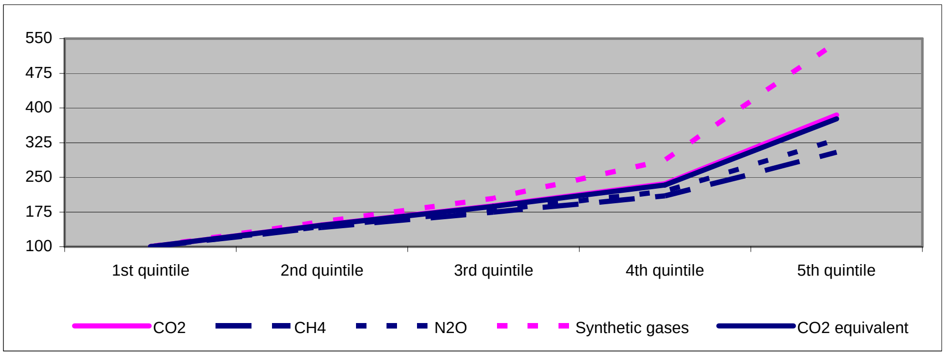
Figures 5 and 6 show the mean emissions of the greenhouse and the three other gases by per capita expenditure quintiles and equivalent expenditure quintiles. As these figures illustrate, emissions increased monotonically with household expenditure for all pollutants, confirming that the more households spent, the more emissions they generated. The marked increase, particularly in the case of the synthetic greenhouse gases, from the fourth to the fifth quintile might reflect the limitations of choosing expenditure as a classifying variable,

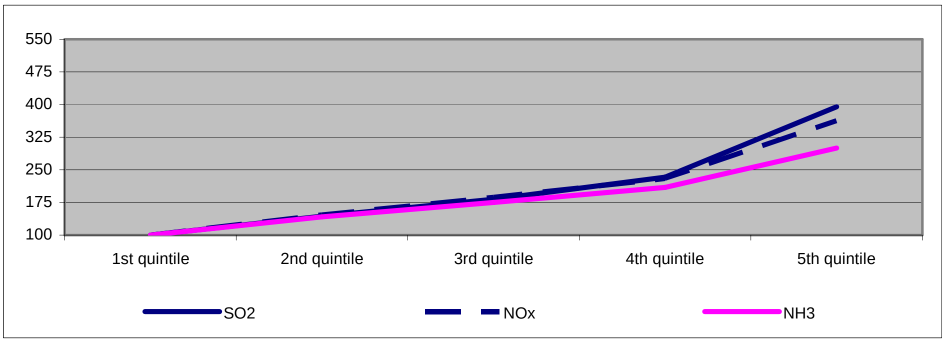
[16] This approach was applied by Herendeen and Tanaka (1978), Herendeen (1978), Herendeen *et al.* (1981), and Vringer and Blok (1995).
[17] Lenzen *et al.* (2006) carried out a multivariate regression considering seven variables.

i.e., the treatment of durable goods and the unreported consumption of subsidised goods and services such as public health.

Figure 5: Per-capita mean emissions of greenhouse gases and other gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.

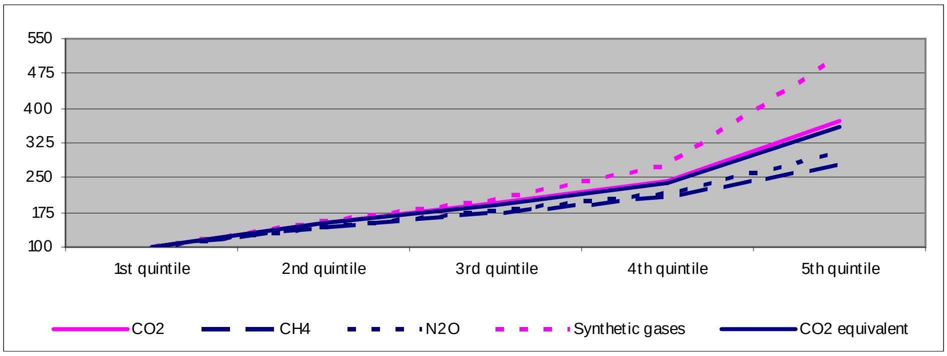


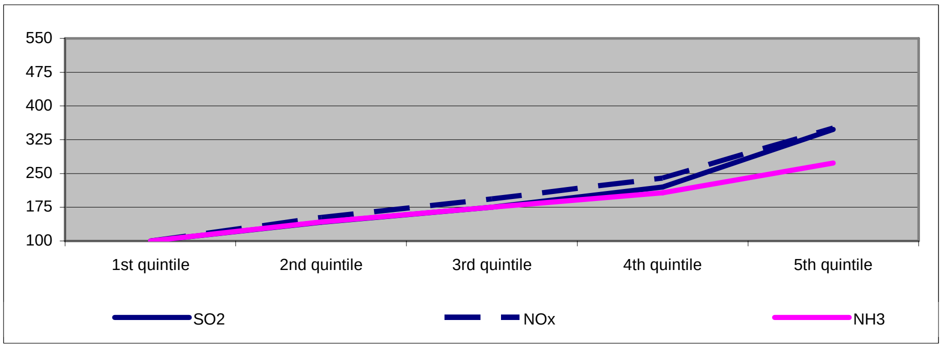


Source: own elaboration.

Figure 6: Equivalent mean emissions of greenhouse gases and other gases by quintiles of equivalent expenditure, Spain 2000

Units: first quintile base = 100.



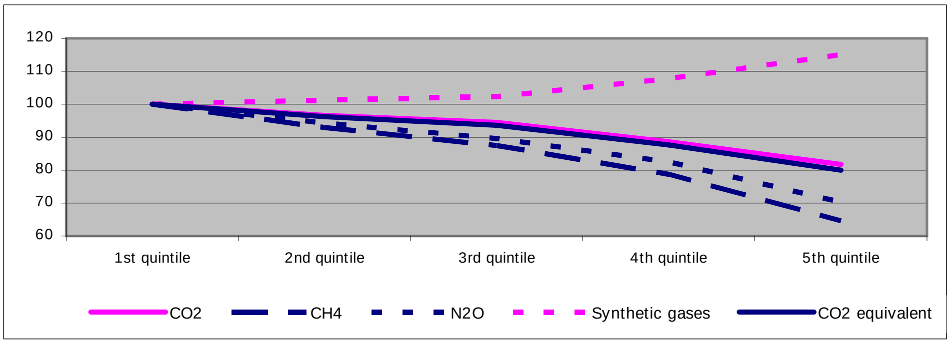


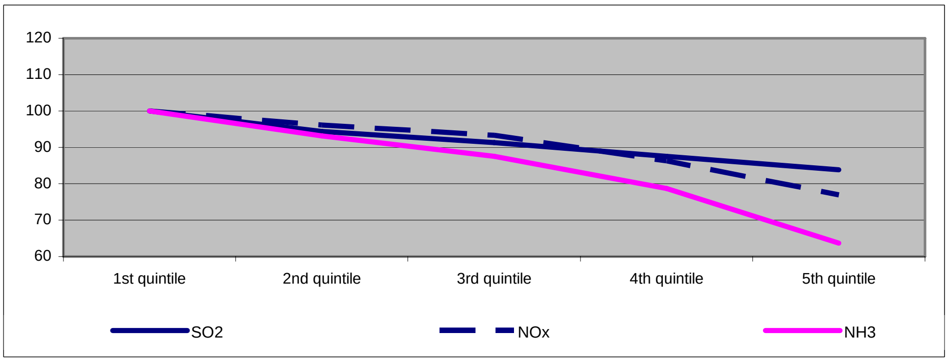
Source: own elaboration.

However, when analysing the evolution in emission intensities (Figures 7 and 8), we observe that the pollutants emitted per unit of household consumption generally decreased with the level of expenditure. In other words, the consumption patterns of the higher quintiles were less polluting than those of the lower quintiles. Exceptions to this were the synthetic greenhouse gases. The most significant, albeit also moderate, decrease was reported for those pollutants associated directly with food and indirectly with agriculture and cattle raising, i.e., CH_4, N_2O, and NH_3.

Figure 7: Per-capita mean intensities of greenhouse gases and other gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.

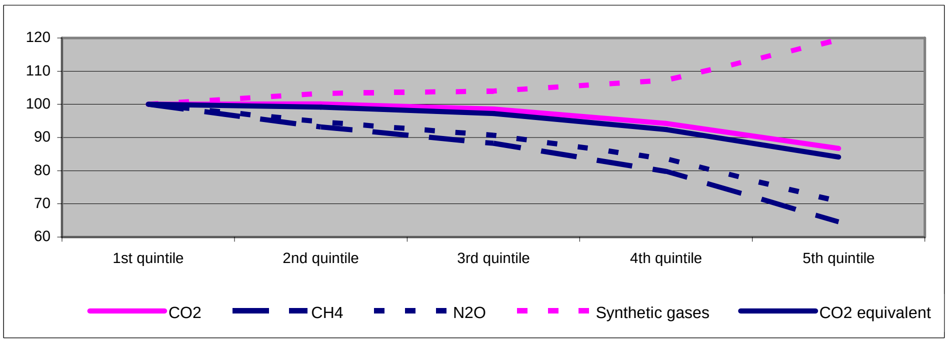


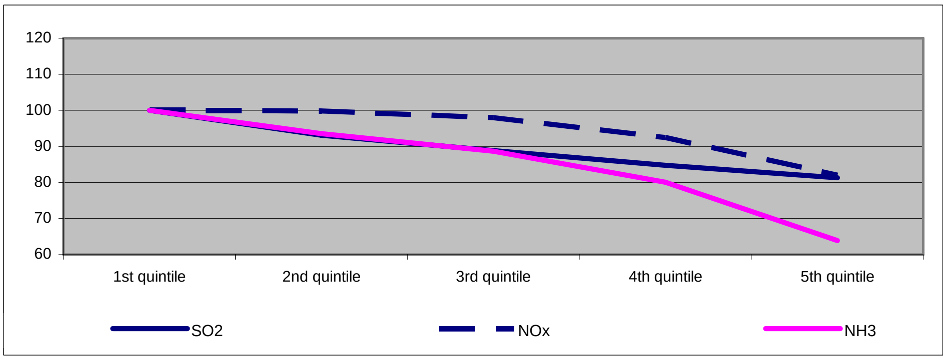


Source: own elaboration.

Figure 8: Equivalent mean intensities of greenhouse gases and other gases by quintiles of equivalent expenditure, Spain 2000

Units: first quintile base = 100.





Source: own elaboration.

Returning to the EKC debate, we found, in general, that as expenditure levels increase a change in the consumption structure could be expected, which may show a relative delinking between an increase in expenditure and emissions. However, there was not any decrease in absolute terms neither any turning point was recorded for any gas; thus, we cannot state the existence of an absolute delinking. The latter could only occur if the more polluting commodities were 'inferior goods', which would be supported by negative expenditure elasticity. However, there might well be other factors not considered in this study, such as technological improvements, that could account for an absolute delinking for some gases over time (see Roca and Serrano, 2007).

4.2.2 Statistical analysis: expenditure and size elasticity of emissions

As pointed out above, we also conducted a multivariate regression to analyse the relation between emissions and expenditure corrected for household size. We apply the same functional form as that used by Wier *et al.* (2001) and Lenzen *et al.* (2006) to analyse household energy requirements and/or the embodied emissions in other countries[18]:

$$E^{household} = \alpha C^{\beta_1} * \exp(\beta_2 N) \qquad (5)$$

Where α is a constant, $E^{household}$ are per capita household emissions, C is per capita household expenditure, and N the number of household members. This expression lends itself easily to linear regression analysis by taking the logarithm of both sides. Thus, we estimate the expenditure elasticity of emissions β_1 and the relationship between the variation in household size and

[18] Wier *et al.* (2001) showed that this functional form yields a better correlation than power, logarithmic, or polynomial functions.

emissions β_2 by performing a regression considering 9,628 different households. We apply the ordinary least-squares method to:

$$\ln E^{household} = z + \beta_1 \ln C + \beta_2 N \qquad (6)$$

The results of the regression are shown in Table 1. We find that the expenditure variable was significant for all gases[19].

Table 1: Expenditure elasticity and size elasticity of per capita emissions of nine gases, Spain 2000

	Expenditure			Size			
	β_1		|t|	β_2		|t|	R^2
CO_2	0.91	±0.005	175.028*	0.03	±0.002	16.551*	0.77
CH_4	0.72	±0.006	122.333*	0.00	±0.002	0.966	0.64
N_2O	0.78	±0.005	155.364*	0.00	±0.002	1.031	0.74
Synthetic gases**	1.11	±0.004	258.771*	0.03	±0.002	17.506*	0.88
Total in CO_2 equivalent	0.89	±0.005	194.363*	0.03	±0.002	15.336*	0.81
SO_2	0.86	±0.003	247.921*	-0.03	±0.001	25.061*	0.89
NO_x	0.87	±0.005	168.676*	0.04	±0.002	18.298*	0.76
NH_3	0.71	±0.006	109.721*	0.00	±0.003	0.907	0.58
Correlation coefficient							0.33
Variance Inflation Factor							1.13

* Significant variables at the 95% confidence level.
** Synthetic gases are total SF_6, HFCs and PFCs emissions measured in CO_2 equivalent units.
Source: own elaboration.

As expected, all gas emissions presented positive expenditure elasticity β_1 and for the synthetic greenhouse gases the results were higher than one. The elasticity values oscillated between 0.71 and 1.11. These results indicate that an increase in household expenditure generates in the most part of gases a less than proportional increase in emissions. The lowest values corresponded to those gases linked with food consumption, i.e., CH_4, N_2O, and NH_3. In the case of CH_4, N_2O, and NH_3, this can be explained by the fact that 'wealthier' households spend a smaller percentage of their budget on food (see Figures 7 and 8). The "energy" gases, i.e., CO_2, SO_2, and NO_x, presented high elasticity

[19] Given the specific purpose of this paper, we are not particularly interested in analysing the values of 'size elasticity' β_2, preferring to focus our attention on those related to 'expenditure elasticity' β_1. For this reason we have only analysed the outcomes of the latter. Moreover, the values of β_2 are particularly small and in some cases not statistically significant.

values but they were inferior to one. . This can be explained if higher quintile households purchased more commodities with low energy intensities. By contrast, the highest value ($\beta_1 = 1.11$) corresponded to synthetic greenhouse gases, i.e., when household expenditure increases by 1%, synthetic greenhouse gas emissions increase at a rate that is slightly more than proportional (i.e., 1.11%). In this instance, this might reflect the higher expenditure of 'wealthier' households on those COICOP categories with high emission intensity, such as medical products and/or furniture and other household equipment including air conditioning.

However, because of the aggregation level of the data, this approach does not allow us to test for specific consumer choices between different types of goods and services in the same category, such as high-quality versus low-quality products or hand-made versus manufactured goods. High-quality and hand-made commodities are usually priced higher; whereas the total emissions embodied in them do not necessarily increase by the same magnitude and they might even fall. Thus, for high-quality and hand-made goods we might expect lower emission intensities (Weber and Perrels, 2000). However, because of the input-output aggregation, here we assume that one euro spent on either a high-quality or a low-quality good will result in the same amount and type of pollutant. Consequently, the actual expenditure elasticity of emissions may be smaller than those reported in this study (Vringer and Blok, 1995).

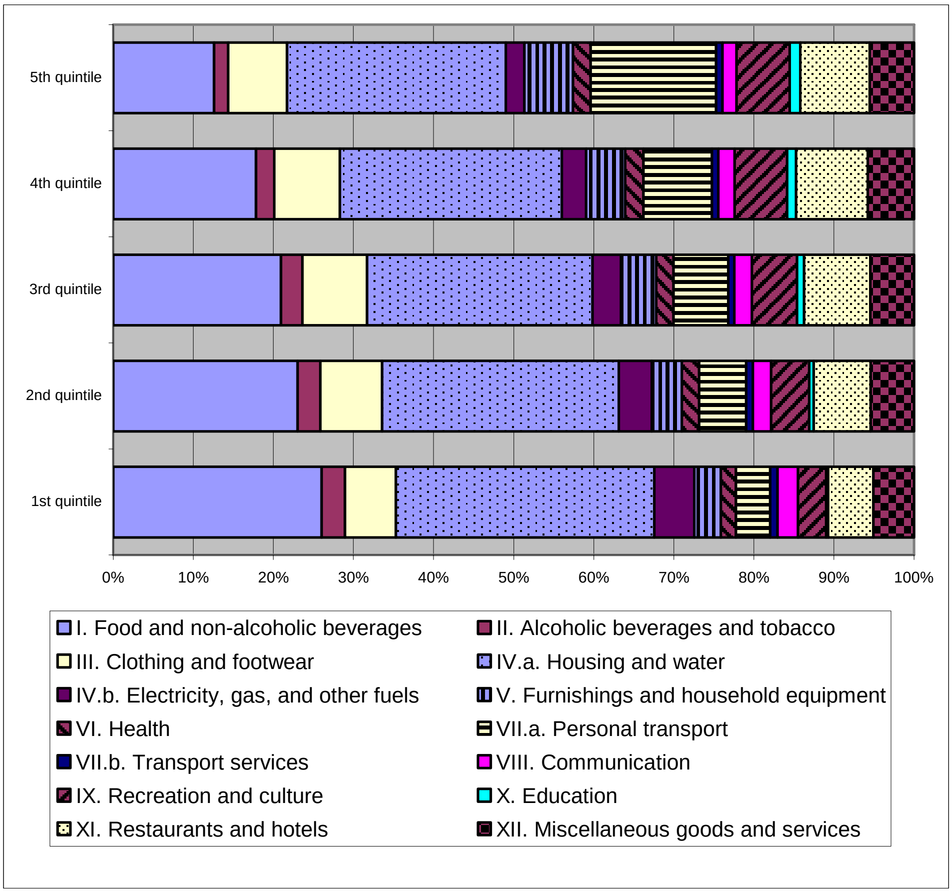
As discussed above, most studies have examined direct and indirect energy requirements for household consumption, while only a few have estimated the emissions embodied in this (primarily CO_2 emissions). Moreover, to the best of our knowledge, no studies have examined other types of atmospheric pollutants. However, given the strong relationship between energy requirements and associated CO_2 emissions we can compare our per capita expenditure elasticity for CO_2 emissions with the per capita expenditure elasticity of energy requirements reported elsewhere. Thus, our finding of a high elasticity with a value of less than one agrees with figures reported by other authors. Specifically, Lenzen *et al.* (2006) calculated the per capita expenditure elasticity of energy requirements for five countries. They report values that range from 0.64 in Japan to 1 in Brazil, with values of 0.78 for Australia, and 0.86 for Denmark and India. Although these results cannot be compared directly with our per capita expenditure elasticity for CO_2 emissions, our outcome $\left(\beta_1 = 0.91\right)$ lies within these values[20].

4.2.3 Analysis of the composition of households' consumption baskets

From the above results, it appears that as expenditure increases consumption patterns tend to move away from goods and services with high emission intensities towards those with lower emission intensities. This is the case for all gases, with the exception of synthetic greenhouse gases, where the opposite is true.

[20] Lenzen *et al.* (2006) carried out a multivariate regression considering seven variables, but only evaluated the per capita energy requirement and not the associated emissions.

Figure 9: Distribution of equivalent expenditure per quintiles of expenditure, Spain 2000



Source: own elaboration.

Figure 9 breaks household equivalent expenditure down into 14 COICOP pseudo-divisions, and confirms the previous statement. In other words, higher quintiles, on the one hand, were found to spend a higher proportion of their budgets on those categories with lower emission intensities such as X 'Education', while on the other hand, their percentage expenditure on more polluting categories was lower. This was so in I 'Food and non-alcoholic beverages', II 'Alcoholic beverages, tobacco, and narcotics', and IV.b 'Electricity, gas, and other fuels'. However, this hypothesis does not appear to hold true for two categories with relatively high emission intensities for some gases, i.e., VII.a 'Personal transport' and XI 'Restaurants and hotels'. In the case of synthetic greenhouse gases, the results are as expected: higher quintiles spent relatively more income on V 'Furnishings, household equipment, and routine household maintenance' and VI 'Health'.

However, the pseudo-divisions represented in Figure 9 group different goods and services, which at times present different patterns of behaviour. For instance VII.a 'Personal transport' includes the purchase of vehicles (group 7.1) but also expenditure on fuels and lubricants for vehicles (group 7.2). In Table 2, we show the percentage of total household expenditure in 47 COIOCP groups. Two criteria were used to select these commodities: first, the level of polluting intensity and, second, the relative weight of each COICOP group in the total expenditure.

Table 2: Equivalent expenditure in key commodities for emissions as percentage of total equivalent expenditure of each quintile, Spain 2000

Units: percentage of total expenditure.

	First quintile	Second quintile	Third quintile	Fourth quintile	Fifth quintile
CO_2, NO_x, and SO_2					
04.5. Electricity, gas, and other fuels	5.00	4.10	3.56	3.04	2.31
07.2. Operation of personal transport equipment	4.05	5.46	5.93	5.73	4.75
CH_4, N_2O, and NH_3					
01.1. Food	24.69	21.78	19.83	16.89	11.94
11.1. Catering services	5.51	6.79	7.81	8.39	7.94
Synthetic greenhouse gases					
06.1. Medical products, appliances, and equipment	1.35	1.38	1.25	1.22	1.05
12.1. Personal care	2.06	2.09	2.04	1.96	1.69
05.6. Goods and services for household maintenance	1.57	1.68	1.66	1.77	2.26
07.1. Purchase of vehicles	0.20	0.44	0.93	2.81	10.89
03.1. Clothing	4.74	5.98	6.41	6.59	6.04

Source: own elaboration.

Obviously, as well as confirming our previous results, this table also helps us to understand them better. For instance, from Table 2 it can be seen that the behaviour of VII.a 'Personal transport' is due in the main to group 7.1 'Purchase of vehicles'. As discussed above, the purchase of durable goods, such as vehicles, is concentrated in the highest quintile. Probably, the value of 10.89% recorded by the fifth quintile also accounts for the evolution in synthetic greenhouse gases. In the case of the COICOP groups linked with CH_4, N_2O, and NH_3 emissions, we see that expenditure on 01.1 'Food' decreases as the expenditure level increases; whereas 11.1 'Catering services', which includes expenditure on restaurants and the like, increased until the forth quintile and then fell gradually. However, if we consider the global expenditure in both groups, i.e., 01.1 and 11.1 together, we see that it fell as the level of expenditure increased.

5. Final remarks

In this paper we have applied an input-output approach to the analysis of a specific issue concerning the EKC hypothesis. It was not the intention of this paper to test for the existence of an EKC in Spain, but rather to study whether the consumption structure of 'wealthier' households might have a positive effect on the reduction in environmental pressures. With this aim in mind, we used the environmentally extended input-output model to analyse the impact on atmospheric pollution of the consumption of Spanish households in 2000. Combining information from different databases, we estimated the total emissions from household consumption of nine gases, namely, the six greenhouse gases (CO_2, CH_4, N_2O, SF_6, HFCs, and PFCs) and three other gases (SO_2, NO_x, and NH_3). Households were classified by quintiles of expenditure and we applied two approaches: first, we estimated per capita emissions and, second, the emissions associated with the expenditure of equivalent consumer units applying the modified OECD scale.

In relation to the EKC debate, we conclude that the more a household spends the more emissions it generates; however, the atmospheric pollution emitted per unit of household consumption decreased with the level of expenditure for the majority of gases. In fact, in 2000, Spanish households occupying a higher ‘economic position’ spent a lower proportion of their budgets on those categories that pollute most, i.e., on ‘Electricity, gas, and other fuels’ (CO_2, NO_x, and SO_2) and on ‘Food’ (CH_4, N_2O, and NH_3). By contrast, the percentage expenditure on ‘Furnishing, household equipment, and routine household maintenance’ was higher, which might explain the opposite trend taken by the synthetic greenhouse gases.

These outcomes were confirmed by the values of expenditure elasticity of emissions, which were estimated for all gas emissions by performing a multivariate regression. We found a positive elasticity, significantly lower than one, for almost all gases. The only exception to this was the synthetic greenhouse gases, which presented a positive elasticity higher than one, in keeping with the graphical analysis. These results could serve as arguments to justify a relative delinking between increasing consumption and emissions, but they are clearly insufficient to expect an absolute delinking. For the latter to be possible, we would need to have found negative expenditure elasticity, which could only occur if the more polluting commodities were ‘inferior goods’. Obviously, other factors not considered in this paper may account for an absolute delinking for some gases over time. One such factor is technological change, which either self-induced or induced by environmental policy, could act in the opposite direction.

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Appendix A. Spanish data and data preparation

A.1 The NAMEA framework

From the supply and use framework and environmental accounts for air emissions (INE, 2005, 2006) we estimate the Spanish environmentally extended input-output table for 2000 consistent with the National Accounting Matrix including Environmental Accounts (NAMEA) framework. According to the NAMEA system, environmental information is compiled consistently with the way economic activities are represented in national accounts (de Haan and Keuning, 1996; Keuning *et al.*, 1999). The Spanish NAMEA for air emissions is organised according to the supply and use table structure. Thus, the economic accounts cover 110 CPA products, 72 NACE sectors plus a fictitious sector 'Financial Intermediation Services Indirectly Measured' (FISIM), and 7 categories of final uses. Further, the environmental accounts collect information about direct emissions produced by 46 NACE sectors and by households. Air emissions are reported in physical units for different pollutants, amongst them the nine gases considered in this study.

Following the NAMEA principles air emissions related to incineration and decomposition of waste in landfills (mainly CO_2 and CH_4) are placed under NACE 90 'Sewage and refuse disposal services, sanitation, and similar services'. However, this sector is aggregated jointly with NACE 91 'Membership organisation services', NACE 92 'Recreational, cultural, and sporting services', and NACE 93 'Other services'. Due to the nature of these four sectors, one can logically infer that most CH_4 emissions and also a smaller amount of CO_2 emissions will be generated almost exclusively by NACE 90; however, this information remains hidden because of the above aggregation. Consequently, an increase in household expenditure on cultural or sporting services (NACE 92), for instance, should cause an increase in CH_4 emissions even though this sector only emitted a small amount of this gas. The consequences of this example will not be great if CH_4 emissions of the four-aggregated sector were relatively small compared with total CH_4 emissions, which was not the case (28.30% in 1995 and 31.28% in 2000). Therefore, following Keuning *et al.* (1999) we have assumed that all CH_4 emissions generated by this four-aggregated sector correspond to NACE 90 and we have reallocated them to a new category called 'other sources'.

Taking this into account, we estimate a 46x46 environmentally extended symmetrical input-output table according to the technology industry hypothesis. From which we obtain the total coefficient matrix $\mathbf{A}$ and the emission coefficient matrix $\mathbf{V}$.

Finally, the so-called synthetic greenhouse gases (SF_6, HFCs, and PFCs) and the six greenhouse gases have been aggregated in accordance with the global warming potential (GWP100) of each gas as established by the Intergovernmental Panel on Climate Change (IPCC, 1997). These conversion factors are: 1 for CO_2, 21 for CH_4, 310 for N_2O, and 23,900 for SF_6. For the group of HFCs and PFCs these values oscillate depending on each specific gas between 140 and 11,700 and 6,500 and 9,200, respectively. In this study we have calculated a warm potential for HFCs and PFCs groups based on the average weight of each group, hence the GWP100 for HFCs is 6,812.65 and for PFCs 6,728.51.

A.2 The Spanish household budget continuous survey

The Household Budget Continuous Survey (HBCS) informs mainly about the amount and structure of household expenditure. It also collects information on household incomes and other socio-economic characteristics regarding living standards such as household equipment, number of members, and level of studies and/or professional activity of breadwinner. The sample size of the 2000 Spanish HBCS is 9,631 representative households[21] and for each household the survey records expenditure on goods and services for final consumption classified by COICOP. These goods and services are arranged in 47 groups grouped into 12 main divisions. The expenditures are evaluated using the purchase criterion, i.e. they are recorded at the moment of availability of commodity by household regardless of whether it has been paid in cash or not. This criterion has important consequences for durable goods because by adhering to it the total amount of expenditure on goods, such as cars or appliances, is registered completely in the current year, although they will be consumed over a longer period than just one year.

A.3 The transformation matrix

Finally, we have used the matrix that relates products and consumption purposes. This matrix is essential for applying the model since the data sources described above use different criteria to classify products. That is, the input-output framework classifies goods and services by CPA, whereas HBCS classifies them by COICOP. Specifically, the 1995 Spanish transformation matrix is a coefficient matrix that converts household expenditure on 61 products classified by CPA into equivalent expenditure on 47 products classified by COICOP.

[21] In fact, we compute the model with 9,628 households because there were three households whose income register was zero in the original database. As it makes little sense to work with the expenditures of non-income households, we chose to eliminate them.

Appendix B. Total emission intensities of 47 COICOP groups

Figure B.1: COICOP divisions and groups

12 COICOP DIVISIONS	47 COICOP GROUPS
01. Food and non-alcoholic beverages	01.1. Food 01.2. Non-alcoholic beverages
02. Alcoholic beverages, tobacco, and narcotics	02.1. Alcoholic beverages 02.2. Tobacco 02.3. Narcotics
03. Clothing and footwear	03.1. Clothing 03.2. Footwear
04. Housing, water, electricity, gas, and other fuels	04.1. Actual rentals for housing 04.2. Imputed rentals for housing 04.3. Maintenance and repair of the dwelling 04.4. Water supply and miscellaneous services relating to the dwelling 04.5. Electricity, gas, and other fuels
05. Furnishings, household equipment, and routine household maintenance	05.1. Furniture and furnishings, carpets, and other floor coverings 05.2. Household textiles 05.3. Household appliances 05.4. Glassware, tableware, and household utensils 05.5. Tools and equipment for house and garden 05.6. Goods and services for routine household maintenance
06. Health	06.1. Medical products, appliances, and equipment 06.2. Outpatient services 06.3. Hospital services
07. Transport	07.1. Purchase of vehicles 07.2. Operation of personal transport equipment 07.3. Transport services
08. Communication	08.1. Postal services 08.2. Telephone and telefax equipment 08.3. Telephone and telefax services
09. Recreation and culture	09.1. Audio-visual, photographic, and information processing equipment 09.2. Other major durables for recreation and culture 09.3. Other recreational items and equipment, gardens, and pets 09.4. Recreational and cultural services 09.5. Newspapers, books, and stationery 09.6. Package holidays
10. Education	10.1. Pre-primary and primary education 10.2. Secondary education 10.3. Post-secondary non-tertiary education 10.4. Tertiary education 10.5. Education not definable by level
11. Restaurants and hotels	11.1. Catering services 11.2. Accommodation services
12. Miscellaneous goods and services	12.1. Personal care 12.2. Prostitution 12.3. Personal effects n.e.c. 12.4. Social protection 12.5. Insurance 12.6. Financial services n.e.c. 12.7. Other services n.e.c.

Source: own elaboration from INE (2004).
Note: n.e.c. means not elsewhere classified.

Table B.1: Total emission intensity of the greenhouse gases of different COICOP groups, Spain 2000

Units: Index numbers, mean emissions of total expenditure of households 2000 base = 100

CO_2		CH_4		N_2O		Synthetic gases		CO_2 equivalent	
COICOP codes	*Intensity*	*COICOP codes*	*Intensity*	*COICOP codes*	*Intensity*	*COICOP codes*	*Intensity*	*COICOP codes*	*Intensity*
04.5.	755.75	**01.1.**	358.07	**01.1.**	319.32	**06.1.**	823.71	**04.5.**	658.12
07.2.	512.19	**01.2.**	323.54	**01.2.**	289.60	**12.1.**	329.90	**07.2.**	440.99
05.4.	141.23	**02.1.**	227.62	**02.1.**	205.55	**05.6.**	306.35	**05.4.**	126.96
06.1.	94.34	**09.3.**	163.24	**09.3.**	160.95	**05.2.**	279.93	**01.1.**	113.50
04.3.	88.87	**04.5.**	140.96	**06.1.**	134.83	**07.1.**	213.10	**01.2.**	106.91
04.4.	80.19	**02.2.**	119.71	**12.1.**	113.00	**03.1.**	169.79	**06.1.**	102.88
07.1.	79.21	**11.1.**	116.70	**02.2.**	110.97	**05.5.**	163.40	**02.1.**	83.05
01.1.	77.51	**11.2.**	115.17	**11.1.**	106.72	**09.3.**	159.54	**04.3.**	82.21
01.2.	74.90	**05.2.**	67.97	**11.2.**	105.41	**05.4.**	130.48	**04.4.**	76.37
05.5.	67.17	**03.2.**	61.32	**09.4.**	102.04	**03.2.**	128.83	**07.1.**	75.06
05.2.	65.37	**04.4.**	45.74	**04.5.**	82.74	**09.2.**	127.33	**09.3.**	73.67
12.1.	63.82	**09.4.**	43.57	**05.2.**	81.16	**09.1.**	125.89	**05.2.**	69.66
02.1.	61.51	**03.1.**	43.48	**04.4.**	63.63	**04.3.**	125.26	**12.1.**	69.16
07.3.	60.91	**12.1.**	42.23	**03.2.**	56.17	**05.1.**	122.44	**05.5.**	63.58
08.2.	59.91	**09.2.**	36.76	**03.1.**	53.46	**06.3.**	118.12	**05.1.**	56.24
05.1.	58.68	**06.1.**	32.51	**12.7.**	52.81	**06.2.**	118.11	**02.2.**	56.08
09.3.	58.03	**07.2.**	32.50	**05.6.**	52.16	**12.4.**	117.91	**08.2.**	55.97
09.5.	57.04	**12.3.**	29.91	**12.4.**	50.98	**08.2.**	115.02	**07.3.**	55.73
05.3.	56.27	**04.3.**	29.37	**06.2.**	50.90	**12.3.**	109.32	**09.2.**	55.03
09.2.	56.15	**05.1.**	28.85	**06.3.**	50.90	**09.5.**	108.60	**09.5.**	54.47
12.3.	54.10	**05.4.**	28.29	**05.4.**	48.26	**05.3.**	105.63	**03.1.**	52.98
09.1.	53.79	**09.5.**	27.29	**09.2.**	44.49	**01.2.**	95.54	**05.3.**	52.85
09.6.	52.25	**07.1.**	26.98	**04.3.**	43.98	**01.1.**	94.28	**12.3.**	52.07
03.1.	51.78	**12.7.**	25.90	**07.1.**	43.28	**02.1.**	83.28	**09.1.**	51.99
03.2.	49.09	**05.5.**	25.60	**09.1.**	43.13	**09.6.**	70.70	**11.1.**	51.71
02.2.	46.31	**09.1.**	24.12	**07.2.**	42.23	**02.2.**	69.36	**03.2.**	51.59
11.1.	42.09	**09.6.**	23.84	**05.1.**	39.87	**04.4.**	63.18	**11.2.**	51.39
11.2.	41.94	**05.3.**	21.63	**09.5.**	38.96	**07.2.**	60.67	**09.6.**	48.90
12.5.	35.55	**07.3.**	20.37	**12.3.**	37.40	**07.3.**	53.55	**09.4.**	39.83
05.6.	35.50	**08.2.**	19.81	**05.5.**	36.44	**11.2.**	48.39	**05.6.**	38.85
12.6.	35.18	**12.4.**	16.93	**08.2.**	31.39	**11.1.**	48.26	**12.7.**	32.66
09.4.	34.85	**06.2.**	16.87	**05.3.**	30.87	**12.7.**	44.96	**12.5.**	32.55
08.1.	32.81	**06.3.**	16.87	**09.6.**	27.74	**09.4.**	43.84	**12.6.**	32.41
08.3.	32.70	**12.6.**	14.17	**07.3.**	27.43	**04.5.**	42.02	**12.4.**	32.36
12.7.	31.56	**05.6.**	13.66	**04.1.**	17.72	**04.2.**	40.25	**06.3.**	32.34
12.4.	30.87	**12.5.**	13.34	**04.2.**	17.65	**04.1.**	40.25	**06.2.**	32.34
06.3.	30.86	**08.3.**	11.47	**12.6.**	17.04	**08.3.**	28.98	**08.3.**	29.93
06.2.	30.85	**04.1.**	11.21	**12.5.**	16.12	**12.6.**	28.72	**08.1.**	29.61
04.1.	27.98	**04.2.**	11.13	**08.3.**	14.19	**12.5.**	25.13	**04.1.**	26.28
04.2.	27.97	**10.5.**	9.58	**08.1.**	11.80	**08.1.**	22.33	**04.2.**	26.26
10.5.	18.74	**10.2.**	9.58	**10.5.**	11.01	**10.5.**	15.71	**10.5.**	17.54
10.2.	18.74	**10.1.**	9.58	**10.2.**	11.01	**10.2.**	15.70	**10.2.**	17.54
10.1.	18.74	**10.4.**	9.58	**10.1.**	11.01	**10.1.**	15.70	**10.1.**	17.54
10.4.	18.74	**08.1.**	9.29	**10.4.**	11.01	**10.4.**	15.69	**10.4.**	17.54
02.3.	*	**02.3.**	*	**02.3.**	*	**02.3.**	*	**02.3.**	*
10.3.	**	**10.3.**	**	**10.3.**	**	**10.3.**	**	**10.3.**	**
12.2.	*	**12.2.**	*	**12.2.**	*	**12.2.**	*	**12.2.**	*

Source: own elaboration.

Notes: * data not available. Although HBCS gives information about 02.3. 'Narcotics' and 12.2. 'Prostitution', these activities are not included in National Accounts.

** in National Accounts estimation of 10.3. 'Post-secondary non-tertiary education' is included in group 10.4. 'Tertiary education'.

Table B.2: Total emission intensity of other gases of different COICOP groups, Spain 2000

Units: Index numbers,
mean emissions of total expenditure of households 2000 base = 100

SO_2		NO_x		NH_3	
COICOP codes	*Intensity*	*COICOP codes*	*Intensity*	*COICOP codes*	*Intensity*
04.5.	1124.62	**04.5.**	613.98	**01.1.**	381.44
05.4.	154.99	**07.2.**	502.96	**01.2.**	343.35
04.4.	142.41	**01.1.**	128.35	**02.1.**	240.06
06.1.	132.04	**01.2.**	111.99	**09.3.**	171.81
07.2.	119.67	**05.4.**	91.16	**02.2.**	123.88
07.1.	111.72	**02.1.**	86.65	**11.1.**	121.72
04.3.	98.96	**06.1.**	69.12	**11.2.**	120.06
05.2.	89.90	**09.3.**	67.99	**09.4.**	94.88
05.5.	89.81	**04.3.**	65.73	**12.1.**	76.96
12.1.	87.82	**04.4.**	60.40	**05.2.**	62.15
09.5.	81.76	**07.1.**	59.87	**06.1.**	52.98
08.2.	81.11	**05.2.**	59.34	**04.4.**	48.57
05.3.	73.55	**02.2.**	57.97	**03.2.**	46.60
09.1.	72.92	**09.6.**	55.73	**12.7.**	45.53
09.2.	72.91	**05.5.**	55.18	**03.1.**	39.12
01.2.	71.88	**11.1.**	53.99	**09.2.**	30.53
05.1.	70.92	**11.2.**	53.63	**09.1.**	25.48
01.1.	70.50	**05.1.**	53.08	**05.1.**	23.88
03.1.	70.26	**12.1.**	51.86	**12.3.**	23.40
09.3.	66.67	**07.3.**	51.43	**04.3.**	23.07
12.3.	66.11	**12.3.**	48.91	**05.6.**	21.77
03.2.	64.05	**09.2.**	48.19	**09.5.**	21.15
02.1.	62.07	**09.5.**	47.81	**12.4.**	18.04
12.5.	58.10	**08.2.**	46.73	**06.2.**	17.89
09.6.	56.82	**03.1.**	46.66	**06.3.**	17.88
12.6.	56.10	**03.2.**	46.06	**05.5.**	16.76
11.1.	52.58	**05.3.**	46.04	**07.1.**	16.62
11.2.	52.39	**09.1.**	44.11	**05.4.**	15.71
02.2.	50.88	**09.4.**	32.34	**07.3.**	15.54
05.6.	49.60	**12.7.**	27.82	**07.2.**	15.24
08.1.	48.39	**12.6.**	26.65	**09.6.**	14.92
07.3.	48.28	**05.6.**	26.42	**05.3.**	14.47
06.3.	47.68	**12.5.**	26.01	**08.2.**	12.83
06.2.	47.68	**08.3.**	25.30	**04.5.**	11.80
12.4.	47.67	**08.1.**	23.80	**04.1.**	10.38
08.3.	46.87	**12.4.**	23.20	**04.2.**	10.30
09.4.	46.35	**06.3.**	23.17	**12.6.**	9.41
12.7.	42.98	**06.2.**	23.17	**12.5.**	8.41
04.1.	40.66	**04.1.**	21.76	**08.3.**	6.98
04.2.	40.66	**04.2.**	21.74	**10.5.**	6.97
10.5.	31.98	**10.5.**	13.89	**10.2.**	6.97
10.2.	31.98	**10.2.**	13.89	**10.1.**	6.97
10.1.	31.98	**10.1.**	13.89	**10.4.**	6.97
10.4.	31.98	**10.4.**	13.88	**08.1.**	4.53
02.3.	*	**02.3.**	*	**02.3.**	*
10.3.	**	**10.3.**	**	**10.3.**	**
12.2.	*	**12.2.**	*	**12.2.**	*

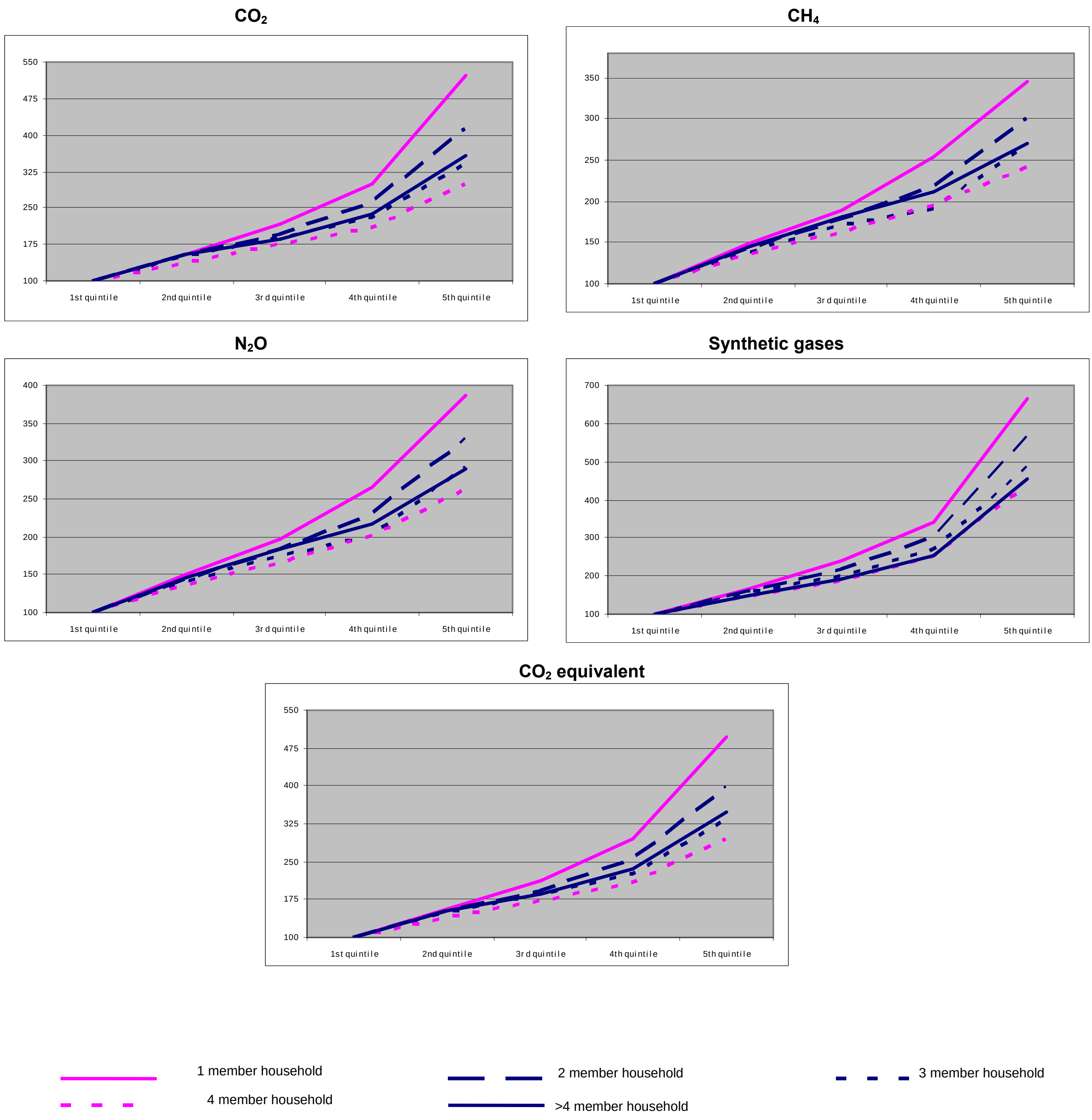
Source: own elaboration.

Notes: * data not available. Although HBCS gives information about 02.3. ‘Narcotics’ and 12.2. ‘Prostitution’, these activities are not included in National Accounts.
** in National Accounts estimation of 10.3. ‘Post-secondary non-tertiary education’ is included in group 10.4. ‘Tertiary education’.

Appendix C. Graphical analysis for different size households

Figure C.1: Member household mean emissions of greenhouse gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.

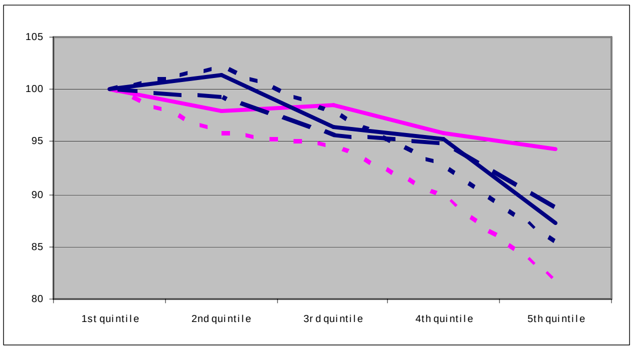


Source: own elaboration.

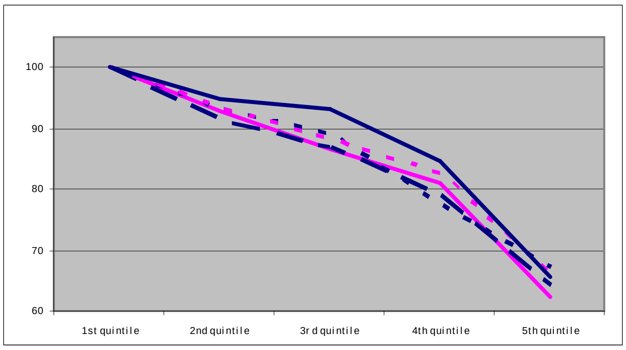
Figure C.2: Member household mean intensities of greenhouse gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.

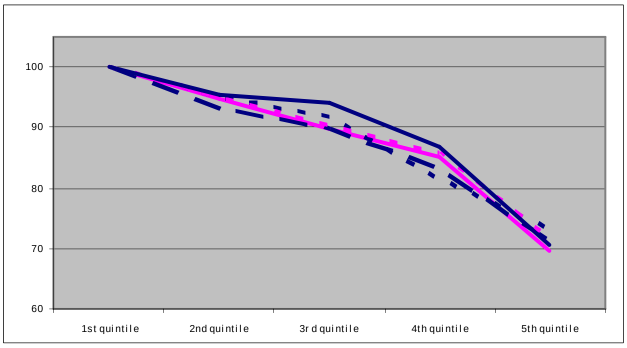
CO_2



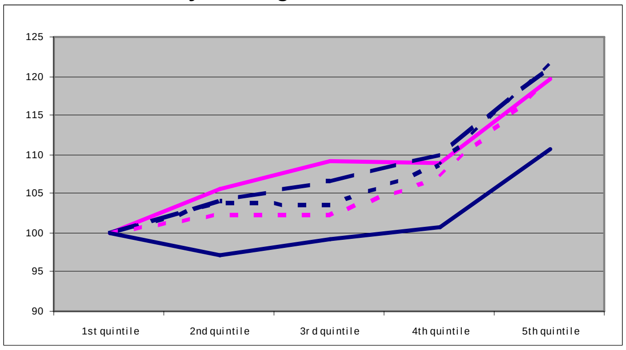
CH_4



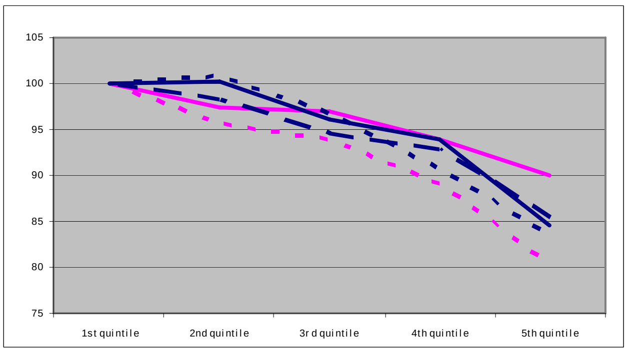
N_2O



Synthetic gases



CO_2 equivalent



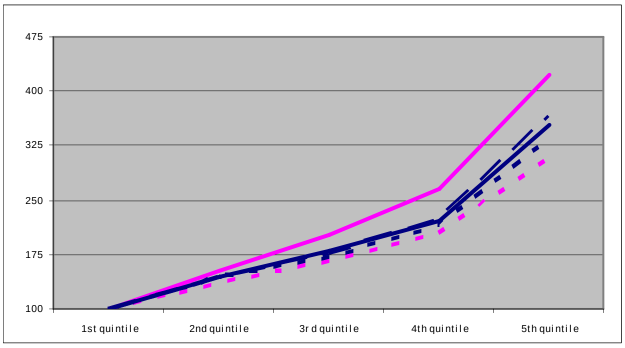
1 member household
2 member household
3 member household
4 member household
>4 member household

Source: own elaboration.

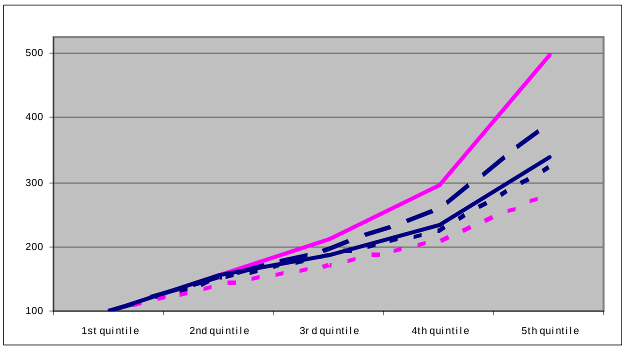
Figure C.3: Member household mean emissions of other gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.

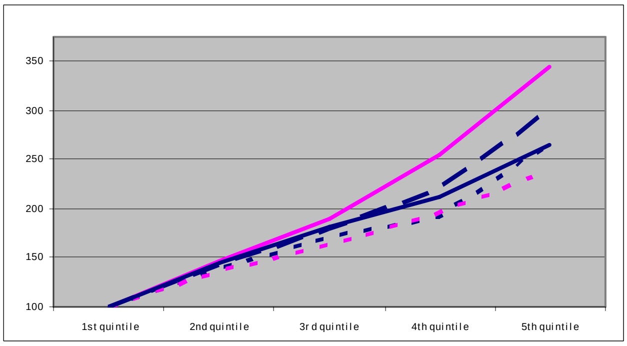
SO_2



NO_x



NH_3

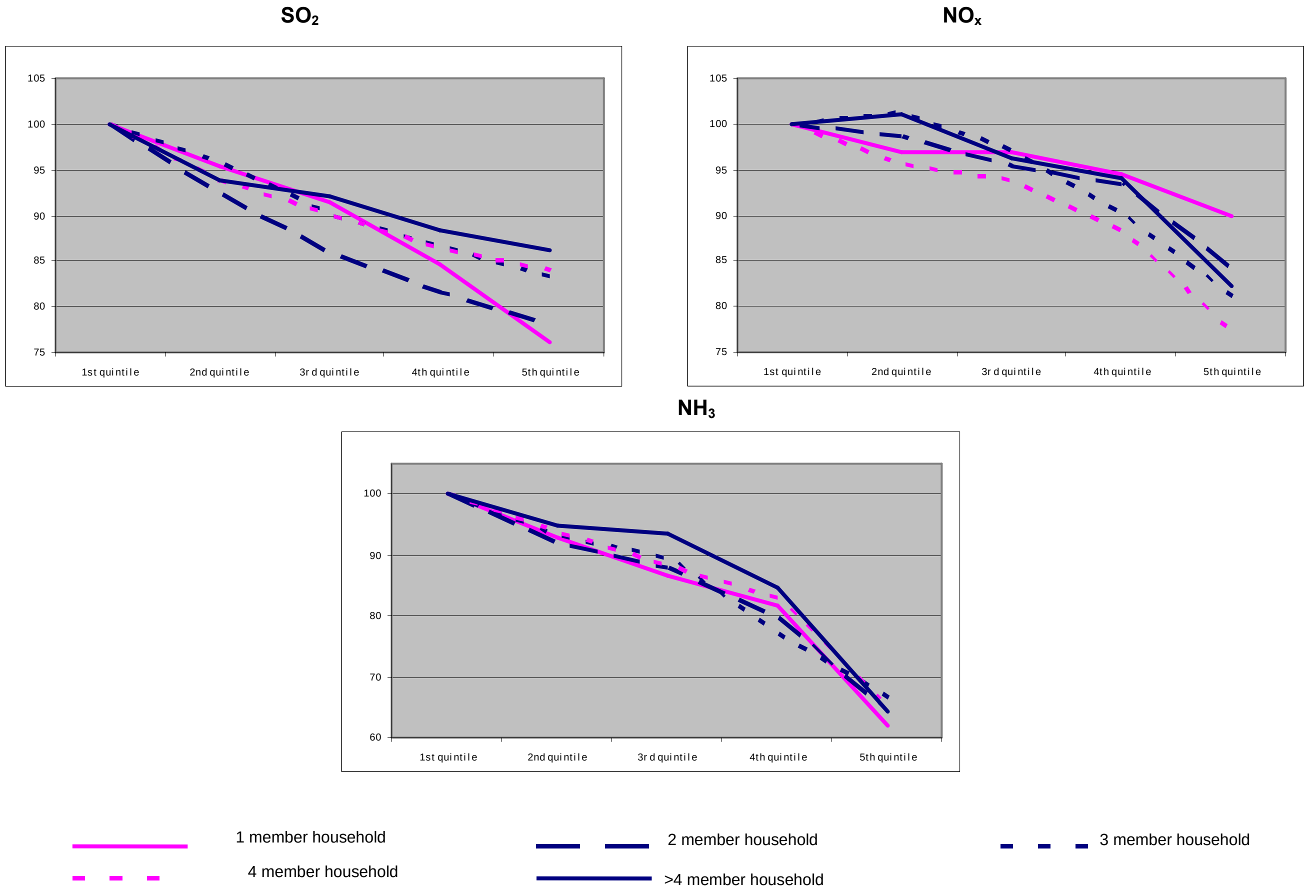


1 member household
2 member household
3 member household
4 member household
>4 member household

Source: own elaboration.

Figure C.4: Member household mean intensities of other gases by quintiles of expenditure, Spain 2000

Units: first quintile base = 100.



Source: own elaboration.