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Estimating CO2 emissions from the combustion of petroleum derivatives. An AGE model for Spain: 2000 – 2010

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Abstract
The aim of this paper is to estimate the sectoral emission of CO_2 to the atmosphere caused by the combustion of six petroleum derivatives in Spain during the period 2000 – 2010. To do so, we use an energy-AGE (applied general equilibrium) input-output model, consider known information about petroleum derivatives and GDP up to 2007 and then assume a period of economic deceleration until the end of the period under analysis.
The novelty of our approach lies in (*i*) the sequential treatment of the dynamics of final demand and technical coefficients and (*ii*) the relation between CO_2 emissions and the total content of petroleum derivatives in final deliveries either consumed or invested in Spain.

Keywords: CO_2 emissions, input-output, Spain.

1. Introduction.

The aim of this paper is to estimate the sectoral emission of CO_2 to the atmosphere caused by the combustion of six petroleum derivatives in Spain during the period 2000 – 2010. In 2001, the consumption of petroleum amounted to 63% of final consumption of energy and 53.65% of primary energy consumption in Spain.[1] Additionally, CO_2 emissions amounted to 80.96% of total emissions in 2000.[2]

We do so using an energy AGE-model, as developed by Dejuán (2006, 2007).[3]

Its main features, for our purposes are:

- Output is not grounded on the notion of full employment, in contrast to neoclassical models, but on the Keynesian principle of effective demand.
- We have adopted the classical theory of value, as revived by Sraffa (1960).
- Sectoral production functions are not differentiable, nor are technical coefficients the outcome of a profit-maximization process. Substitutability amongst inputs is rather limited so that the influence of prices on the utilization of inputs is small. Therefore, technical coefficients are better understood as taken initially from the outside, and then influenced by technical change and (to a minor extent) by changes in relative prices.
- The structure of our model is that of the (symmetric) input-output tables with the one exception of households' consumption which has been endogenized (that is, it has been treated as one additional intermediate consumption). Simultaneously, a portion of value added has been shifted to the intermediate consumptions block.
- It is a dynamic-sequential model: we have projected the Spanish symmetric input-output table of 2000 forward to 2010, using econometric techniques (non-observable variables model) and calibrated coefficients taking into account information on: (*i*) the production, consumption, imports and exports of six petroleum derivatives; (*ii*) their corresponding prices; and (*iii*) the evolution of the GDP, with official data (although at a not very high disaggregation rate) until 2007.

Our methodology consists of computing the total content of six petroleum derivatives (gasoline, gas / diesel oil, kerosene, residual fuel, LPGs and naptha and other products) embodied in final (autonomous) demand and then, multiplying this outcome by the amount of carbon dioxide which one unit (one million euros of 2000) of each petroleum derivative emits to the atmosphere.[4] We do this for the period 2000 to 2010.

It should be noted that we aim to calculate the consumption of petroleum derivatives which takes place in Spain. This means that we do not consider as Spanish, emissions that are generated abroad, when commodities which, once they are produced are exported to Spain. Similarly, we exclude emissions of petroleum derivatives which are exported to other countries.

[1] See: Ministerio de Industria Comercio y Turismo (2007). The calculations are made in petroleum equivalent tonnes.

[2] See Ministerio de Medio Ambiente (2007, p. 7).

[3] AGE stands for Applied General Equilibrium.

[4] Thus, our methodology is akin to that suggested by Manresa *et al*. (1998).

2. Measuring emissions of CO_2 caused by the consumption of petroleum derivatives.

We intend measuring the sectoral amount of carbon dioxide emitted to the atmosphere caused by the combustion of petroleum derivatives in Spain during the period 2000 – 2010.

For each year we need two set of data: (*i*) the direct and indirect amounts of petroleum derivatives which have been used in Spain to produce goods and services either consumed or invested in Spain, and (*ii*) the amount of CO_2 emitted to the atmosphere by one unit of an energy source in each production process. Note that, contrary to the usual practice, we use CO_2 per unit of energy used and not CO_2 per unit of commodity produced.

The first set of data can be obtained from the following expression:

$$\mathbf{X} = \left[\left(\mathbf{I} + \mathbf{A^m}\right)\left(\mathbf{I} - \mathbf{A^d}\right)^{-1} \hat{\mathbf{y}}^{\mathbf{d}} + \hat{\mathbf{y}}^{\mathbf{m}} \right] - \hat{\mathbf{y}}^{\mathbf{x}} \qquad (1)$$

Where the 'hat' indicates a diagonal matrix; $\mathbf{y^d}$ stands for final demand of domestic production. $\mathbf{y^m}$ accounts for final demand of imports; $\mathbf{y^x}$ is export of manufactures. Matrix **X** has a 24 x 24 dimension and each element x_{ij} informs about the total amount of commodity i (either imported or domestically produced) required to produce y_j units of commodity j as final delivery which, once they have been produced, have been either consumed or invested in Spain. Nevertheless, from matrix **X** we only need the six upper rows: those informing about the total (direct and indirect) requirements of petroleum derivatives required to produce final deliveries either consumed or invested in Spain. Therefore, we shall use a matrix **X** with dimension (6 x 24).[5]

Regarding the second set of data, we require two sources of information: (*a*) the amount of CO_2 per unit of petroleum derivative which goes into the atmosphere, and (*b*) the amount of petroleum derivatives accounted for in one million euros of the base year. Hence we need a diagonal matrix $\hat{\mathbf{g}}$ (6 x 6) where each element g_{ii} accounts for the amount of CO_2 emitted to the atmosphere by one million euros of derivative *i*.[6]

Total emissions of CO_2 can be easily computed from the expression:

$$\mathbf{F} = \mathbf{i}\,\hat{\mathbf{g}}\,\mathbf{GX} \qquad (2)$$

Where **i** is a (row) vector of ones.

Within this model. we compute the direct and indirect sectoral emissions of CO_2 caused by the use of six petroleum derivatives.

Contrary to standard practice, we do not estimate the amount of CO_2 directly and indirectly embodied in final demand commodities, but emissions caused by energy use which take place in Spain. First, we calculate the *amount* of energy directly or indirectly required to produce final demand which is either consumed or invested in Spain and then multiply it by the amount of CO_2 which this amount of energy emits to the atmosphere. That is why, for instance, we compute as CO_2 emitted in Spain that which is caused by the production of exported commodities, though we remove from the

[5] The first six rows are those of petroleum derivatives.

[6] In the particular case of petroleum derivatives, the amount of CO_2 emitted to the atmosphere is always the same, independent from the process of production where they are used.

balance CO_2 embodied in these exports.[7] Similarly, we compute as CO_2 emitted in Spain that corresponding to the use of final demand of imports, though we leave aside emissions directly and indirectly generated within the process of its production..
Additionally, we do not take from the outside (usually from national statistics agencies) data about the sectoral emissions' intensity (that is, the direct emissions of CO_2 per million currency of output) but we have preferred to build up such information. Here, we have computed the amount of petroleum derivatives required to produce output. Obviously, this leads to a downward biased content of CO_2 per output, since it does not account for other sources of CO_2. Yet, within this methodology we can track any one of the sources of emissions. Moreover, within this assumption, we get rid of the problem regarding emissions caused during the production of imported commodities.

3. Dynamizing the model.
As time goes on, elements $\mathbf{A^m}$, $\mathbf{A^d}$, $\mathbf{y^d}$, $\mathbf{y^m}$, and $\mathbf{y^x}$ change.
<u>Changes in technical coefficients.</u>
For the sake of simplicity, and the problems related to lack of data, non-energy technical coefficients in matrix $\mathbf{A^T}$ which is obtained by adding up matrices $\mathbf{A^d}$ and $\mathbf{A^m}$, will be assumed as constant for the whole period 2000 – 2010. Energy technical coefficients in $\mathbf{A^T}$ change for two reasons. Firstly, there is an inherent, long term trend to save energy (because of the increasing efficiency of production processes) and to replace one source of energy for another one (e.g. diesel oil for gasoline in transport, or natural gas for gas oil in heating systems) and which we represent as follows:

$$a_{ji}(t) = a_{ji}(t-1)(1+\tau_{ij}) \qquad (3)$$

With:

$$\tau_{ij} = \frac{\Delta a_{ij}}{a_{ij}} \qquad (4)$$

And secondly, these energy coefficients may also change due to changes in relative prices.[8] Although this is related to the concepts of elasticity and substitutability, we should not forget that, by and large, we face clear ratchet effects here. So, we believe that this price effect might be better understood as a factor accelerating technical change. Therefore, if after a sudden energy price change its requirements are altered, even if the price returns to its initial level, the new requirement does not return to its previous level but remains at the new level.
If we define the price effect with the symbol ε as:

[7] For instance, refined petroleum requires refined petroleum as an intermediate input. Thus, we account for CO_2 emitted within the combustion of this used refined petroleum. However, in the Spanish case, a high proportion of gasoline obtained during the refining process is exported. The CO_2 that these exports are going to emit to the atmosphere when they are used should be imputed to the country where its combustion is going to take place. This idea, which is quite simple, cannot be put into practice when using sectoral emissions intensity.
[8] Here we mean 'physical' amounts of inputs per unit of 'physical' output that change because of changes in relative prices and not changes in nominal technical coefficients due to changes in relative prices.

$$\varepsilon_{ij} = \frac{\Delta a_{ij} / a_{ij}}{\Delta p_i / p_i} \qquad (5)$$

Additionally, energy coefficients in matrix $\mathbf{A^T}$ change because of changes in the propensities to import. We define $\mathbf{A^m}$ as $\mathbf{A^T} \cdot \mathbf{M}$. with **M** being a matrix of propensities to import. We shall assume that the effect of changes in import prices on propensities to import is negligible, although elements in **M** can change under certain circumstances: (*i*) when demand grows far more than productive capacity (more than 3.5%),[9] and when national prices greatly diverge from import prices[10] (irrelevant for electricity and gas, because imports of these energy sources are almost nil and similarly irrelevant for petroleum derivatives since national and international prices are similar).
Then, the whole change in energy technical coefficients can be approximated by:

$$a_{ij}{}^{T}(t) = a_{ij}{}^{d}(t-1)\left(1+\left(\tau_{ij}+\varepsilon_{ij}\left(\frac{\Delta p_i}{p_i}\right)\right)\right)+a_{ij}{}^{T}(t-1)\cdot m_{ij}\left(1+\mu_{ij}+\varepsilon^{m}\left(\frac{\Delta\left(p_i{}^{m}/p_i{}^{d}\right)}{\left(p_i{}^{m}/p_i{}^{d}\right)}\right)\right) \qquad (6)$$

Regarding the matrix of τ-elements we have obtained through calibration and by using econometric methods –non-observable components– a (9 x 5) matrix: 6 petroleum derivatives plus gas, electricity and coal x 5 groups of industries: energy, manufacture, transport, other services and households. Additionally, we have obtained a matrix of elasticities, ε, with a dimension (6 x 2), distinguishing firms and households. Finally, we have a vector of changes in propensities to import ($\mu+\varepsilon^m$) dimension (6 x 1).
The following table shows the average yearly rate of change of technical coefficients. encapsulating all these effects:

<Insert table 1 here>

The relevant trends underlying table 1 are the following:

- There has been a general decline in the technical coefficients related to the demand of gasoline during the whole period, though for households this decline stops in 2007. Since then, and up to the end of the period under analysis, it remains flat.
- Regarding gas / diesel oil, technical coefficients are relatively stable during this period. However, household demand per unit of output follows a pattern which runs contrary to that of gasoline: it rises until 2006 and then declines. Hence, there is an upward tendency for households to reduce the demand of gas / diesel oil and to increase (relatively) the demand for gasoline.
- Kerosene remains stable.

[9] In this case, the corresponding *coefficient* μ_{ij} adopts positive values; otherwise it is nil.
[10] This effect is encapsulated within the term ε^m.

- The same holds for fuel. Nevertheless, it should be noted that fuel demand required for the generation of electricity is assumed to fall.[11]
- LPGs coefficients experience a massive fall in all sectors and during the whole period.
- Naphta and other residuals are required by the energy and manufacturing sectors (chemicals in particular). Their demand rises but not significantly.
- The demand for gas increases substantially in all sectors especially in manufacture and increases as well in households, though at a lower pace.
- Demand for electricity per unit of output increases in all industries, but falls in households. This can be interpreted as households replacing gas for electricity.
- Finally, the rate of growth of demand for coal per unit of output is surprisingly large. In manufacture and other services, the base year technical coefficient is almost zero. The only sector demanding relevant amounts of coal is electricity. where the coefficient remains stable.

Lastly, the "socio-technical" coefficients in matrix $\mathbf{A}^{\mathbf{T}}$ are assumed to change as well for two reasons. Firstly, because as households' disposable income rises some petroleum derivatives are replaced by other sources of energy. And secondly, because the average decisions of consumption change across the period of analysis.[12]

<u>Changes in elements of vectors of final demand.</u>
Regarding final demand, vectors $\mathbf{y}^{\mathbf{d}}$, $\mathbf{y}^{\mathbf{m}}$, and $\mathbf{y}^{\mathbf{x}}$ domestic demand, imported final demand and exports, respectively, change as well as was pointed out above. The reader should note that these vectors account for autonomous demand i.e. public consumption, gross investment and exports. For each year between 2000 and 2006 the *Banco de España* provides information about the evolution of the final demand for gross investment, public spending, exports and imports, despite the level of disaggregation being much lower than required by our IOT (four types of commodities while our table is disaggregated in 24 sectors). The following figure illustrates the rate of growth assumed for the whole period.

<Insert figure 1 here>

The total demand for petroleum derivatives for the period 2000 – 2007 is shown in figure 2. There we see that it grows until 2005 and then remains stable. At the aggregate level, our model has overestimated the total consumption of petroleum.[13] Real consumption in 2007 is 11.24 % higher than in 2000, whilst the estimate for 2007 is 12.92%: 1.7 percentage points higher. The total consumption of petroleum derivatives in 2010 is 13.83% higher than that of 2000.

<Insert figure 2 here>

The output of our model, and real data regarding the consumption of petroleum derivatives are represented in the following figure:

[11] The average rate of fall for the demand of fuel for electricity generation is -7.35%.
[12] For instance, Keynesian uncertainty affects consumption decissions.
[13] Obviously, total consumed petroleum is total domestic production, plus imports minus exports.

<Insert figure 3 here>

In figure 3 the prediction that our model yields is acceptable for gasoline, gas / diesel oil, kerosene, fuel and LPGs. For naphta and other products the model captures the trend, though estimates diverge slightly from real data.

<u>A matrix of emissions of CO_2 per unit of output</u>
The construction of this matrix requires certains sets of data:

- We take from the IPCC, 2006, data regarding default emission factors for stationary combustion of some petroleum derivatives. Units are measured in tons of CO_2 per terajoule.[14]

<Insert table 2 here>

Next, we should measure the default emission factor *DEF* in tons of CO_2 per million euros of petroleum derivatives. To do so, we need to convert terajoules into kilotonnes of petroleum derivatives. Again. IPCC. 2006 provides information for this conversion.[15]

<Insert table 3 here>

Now we have to multiply elements in table 2 by elements in table 3.

<Insert table 4 here>

- Next we need average prices for petroleum derivatives in order to compute how many kilo tonnes of each one are included in one million euros. The CNE (Spanish National Commission for Energy dependent on the Ministry of Industry) has provided us with data for seven petroleum derivatives at set dates in 2000. The average prices for these derivatives and year 2000 are offered in the following table:

<Insert table 5 here>

Now we have to *reduce* the number of petroleum derivatives in tabl 4 to those in table 5.

<Insert table 6 here>

Thus we obtain a table of tonnes of CO_2 per million euros of year 2000. The RHS column informs about the price of one kilogramme of petroleum derivative.

<Insert table 7 here>

- Finally, we should take into account the portion of carbon stored in other products and not emitted to the atmosphere. Here, for the sake of simplcity, we have assumed

[14] For more details see IPCC (2006, volume 2, chapter 2).
[15] See IPCC (2006, volume 2, chapter 1, table 1.2, p. 1.18).

that all naphtas are used as intermediate inputs not for energy but for the obtention of other products (refining, plastics and chemical). We have assumed that 80% of carbon content is stored.

4. Main results.

In this section we provide a summary of the main results obtained from expression (2). More detailed results will be found in the Annex.

The following table shows the evolution of emissions of CO_2 caused by the consumption of petroleum derivatives during the period 2000 – 2010 for seven large sectors, in vertically integrated terms.[16]

<Insert table 8 here>

The total amount of emissions runs parallel to the consumption of petroleum derivatives. Two sectors: manufacture (including chemicals, Intermediate, capital and consumer goods) and other services (hotels and restaurants, other marketed and non-marketed services) account for roughly 65% of total emissions. Construction increases emissions from 2000 to 2006 and then declines. The refined petroleum industry increases its emissions more than 33%. And the sector 'other energy sources' (electricity, gas, coal and nuclear fuels) generates very low and falling emissions of CO_2.

Taking 2000 as the base year:

<Insert table 9 here>

And in relative weights:

<Insert table 10 here>

This stands in direct contrast to information regarding directly observable sectors.[17]

<Insert table 11 here>

If we take 2000 as the base year, we can see the sectoral evolution and make direct comparisons with vertically integrated sectors.

<Insert table 12 here>

And regarding the relative weight of each sector's emissions of CO2:

<Insert table 13 here>

[16] Data in table 8 are obtained from expression: $\left(\mathbf{I} + \mathbf{A^m}\right)\left(\mathbf{I} - \mathbf{A^d}\right)^{-1}\left(\hat{\mathbf{y}}^{\mathbf{d}} + \hat{\mathbf{y}}^{\mathbf{m}} - \hat{\mathbf{y}}^{\mathbf{x}}\right)$.

[17] Now data is obtained from expression $\mathbf{A^T}\,\hat{\mathbf{x}}^{\mathbf{d}}$ and then manipulated to work with index numbers.

We see that transport plus households add up to more than 40% of all emissions. Refining and other energy sources represent nearly one fourth.
It is interesting to consider the emissions of CO^2 per one million euros of output (10^3 tonnes, vertically integrated sectors). This is shown in the following table.

<Insert table 14 here>

Here we can see that the larger reduction in emissions per one million euros of output takes place in the households sector amd 'other energy sources' (more than 23%), followed by other services (17.78%). On the other hand, emissions in petroleum derivatives per million euros of output remain stable.[18] From this table, we conclude that if socio-technical coefficients fall, whilst total emissions rise, this is caused by the rise in autonomous demand.
If, alternatively, we take into consideration direct coefficients, this information is provided in table 15. Here, we see that the sectors whose emissions per unit of total output show a greater fall are the same as above. However, we find that construction and agriculture now increase emissions per unit of output. Also, the reduction in other services is much lower than within vertical integration.

<Insert table 15 here>

5. Summary of the main results.
We now draw the following conclusions from our results.

- At the aggregate level, the consumption of petroleum derivatives rises in the period 2000 to 2005 and then remains relatively stable because the consumption of petroleum derivatives runs almost parallel to the consumption of petroleum.
- In vertically integrated terms, emissions per unit of output fall in all trades. In directly observable sectors this does not happen in agriculture and construction. The larger savings per unit of output occur in households, manufacture and 'other energy sources' (particularly electricity generation).
- Sectors emitting more carbon dioxide, in directly observable terms, are households, transport and other energy sources. In vertically integrated terms, the more intensive sectors in CO_2 are other services (hotels and restaurants, other marketed and non-marketed services), and manufacture.
- Sectors increasing emissions of CO_2 are, in directly observable terms, construction and agriculture. In vertically integrated terms, they are refining and construction.

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[18] Until 2006, the larger reduction occurs in other energy sources and manufactures (roughly 14%). In other energy sources we have assumed that the amount of fuel used for the generation of one million euros of electricity falls (although this may be compensated by a greater use of coal), and in manufacture we have implicitly assumed that petroleum derivatives have been replaced by gas.

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STATISTICAL ANNEX.

Table A 1: Rate of growth of GDP.

	Model	Observed
2001	4.05%	3.65%
2002	2.66%	2.70%
2003	3.03%	3.10%
2004	3.22%	3.27%
2005	3.64%	3.62%
2006	4.02%	3.86%
2007	3.54%	3.50%
2008	2.12%	
2009	1.68%	
2010	3.20%	

Table A 2: Consumption of petroleum. Base year: 2000 = 100

	Model	Observed
2000	100.00	100.00
2001	105.69	104.12
2002	107.46	105.02
2003	108.54	107.61
2004	111.52	109.77
2005	114.00	111.65
2006	112.35	110.54
2007	112.92	111.24
2008	112.07	
2009	112.61	
2010	113.83	

Table A 3: Real consumption of petroleum derivatives in Spain. Base year: 2000 = 100

	Gasoline	Gas / Diesel oil	Kerosene	Fuel	LPGs	Naphta and others
2000	100	100	100	100	100	100
2001	99.49	107.75	102.17	104.04	93.67	104.15
2002	96.44	110.96	97.82	111.33	93.67	99.65
2003	94.41	119.65	103.26	102.42	92.40	104.84
2004	90.35	127.03	114.13	96.35	93.67	105.53
2005	85.27	132.70	121.73	100	91.13	103.46
2006	81.21	135.91	127.17	91.09	83.54	102.42
2007	77.15	139.69	131.52	89.06	81.01	103.11

Table A 4: Estimates of consumption of petroleum derivatives. Base year: 2000 = 100

	Gasoline	Gas / Diesel oil	Kerosene	Fuel	LGP	Naphta and others
2000	100	100	100	100	100	100
2001	100.16	108.17	106.07	107.44	99.96	104.87
2002	96.61	112.42	110.46	111.11	95.93	104.83
2003	95.81	117.50	114.41	101.31	95.02	108.78
2004	92.27	127.08	119.13	98.46	93.31	109.88
2005	88.71	133.29	124.64	102.34	90.78	108.86
2006	83.16	138.24	130.21	96.52	86.23	99.83
2007	78.83	141.65	136.27	94.56	82.48	100.15
2008	76.08	141.22	140.07	92.99	82.20	98.75
2009	74.47	142.21	144.52	91.93	79.85	100.89
2010	73.13	144.13	150.10	91.91	79.26	102.72

Table A 5: CO_2 emissions. Rate of change: 2005 / 2000. Vertically integrated sectors.

% 05 - 00	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others	Total CO_2
Gasoline	-11,27%	35,03%	28,26%	5,37%	-10,41%	20,33%	10,34%
Gas / Diesel	-22,73%	25,54%	10,85%	-11,33%	-22,32%	4,32%	16,59%
Kerosene	-18,32%	21,86%	16,56%	-11,10%	-18,06%	10,02%	-4,61%
Fuel	-33,08%	0,58%	-4,00%	-27,14%	-32,73%	-9,66%	-21,46%
LPGs	20,49%	86,14%	75,66%	29,37%	25,78%	63,99%	29,22%
Naphta and others	-38,47%	-9,47%	-12,74%	-37,29%	-38,50%	-17,47%	-31,41%
Gas	-8,39%	39,14%	36,29%	32,05%	-6,41%	25,93%	29,14%
Electricity	-24,49%	8,06%	11,32%	-25,26%	-21,69%	-18,95%	-16,72%
Coal	3,62%	47,93%	52,70%	29,11%	5,74%	35,44%	38,86%
Nuclear fuel	-12,39%	22,97%	27,20%	13,83%	-10,57%	17,75%	18,36%
Agriculture	-22,03%	19,31%	16,16%	-6,41%	-19,65%	4,08%	8,38%
Chemical	-20,81%	16,64%	13,16%	-7,73%	-19,21%	0,60%	2,83%
Intermediate goods	-20,80%	17,57%	13,98%	-5,62%	-20,07%	0,82%	5,04%
Capital goods	-21,63%	20,03%	13,62%	-5,84%	-20,28%	1,79%	5,38%
Construction	5,10%	54,83%	47,72%	20,90%	2,27%	33,08%	36,44%
Consumer goods	-20,28%	20,73%	16,27%	-4,71%	-19,17%	3,25%	7,27%
Railway transports	-11,62%	30,16%	30,29%	14,51%	-9,20%	15,90%	20,13%
Road transport	-7,82%	16,87%	27,31%	-0,79%	-12,11%	3,69%	7,58%
Maritime transport	-13,72%	13,88%	25,51%	1,89%	-9,77%	-4,30%	11,03%
Air transport	-13,25%	34,14%	23,40%	-15,81%	-11,88%	-3,44%	19,50%
Hotels & Restaurants	-14,42%	34,59%	27,62%	5,47%	-16,75%	14,34%	17,41%
Marketed Services	-11,68%	39,19%	29,68%	10,21%	-10,19%	17,80%	20,91%
Non-marketed services	-13,78%	37,17%	27,63%	6,07%	-12,44%	15,80%	18,43%

Table A 6: CO_2 emissions. Relative weights. 2005. Vertically integrated sectors.

	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others
Gasoline	2,08%	9,58%	0,31%	64,84%	0,49%	22,71%
Gas / Diesel	0,44%	78,99%	0,07%	14,99%	0,09%	5,42%
Kerosene	1,81%	8,12%	0,27%	64,77%	0,36%	24,67%
Fuel	2,02%	9,08%	0,30%	63,01%	0,43%	25,16%
LPGs	0,69%	3,07%	0,09%	14,19%	76,48%	5,49%
Naphta and others	1,63%	7,36%	0,27%	64,33%	0,30%	26,11%
Gas	9,11%	57,66%	1,15%	26,97%	2,65%	2,47%
Electricity	2,63%	32,34%	0,35%	62,49%	0,89%	1,30%
Coal	5,71%	66,89%	0,73%	21,56%	1,61%	3,51%
Nuclear fuel	4,63%	71,98%	1,01%	17,75%	1,28%	3,35%
Agriculture	8,46%	71,36%	0,98%	12,99%	3,24%	2,97%
Chemical	4,92%	42,73%	1,06%	21,65%	2,18%	27,47%
Intermediate goods	10,43%	61,58%	1,35%	19,80%	2,73%	4,11%
Capital goods	11,29%	59,86%	1,92%	19,50%	3,38%	4,06%
Construction	14,34%	61,60%	1,50%	15,86%	3,09%	3,61%
Consumer goods	11,44%	63,84%	1,38%	16,60%	3,22%	3,52%
Railway transports	7,94%	62,28%	1,13%	23,96%	2,40%	2,29%
Road transport	25,14%	63,94%	0,47%	7,82%	1,08%	1,55%
Maritime transport	3,13%	84,63%	0,51%	9,42%	0,94%	1,37%
Air transport	2,35%	7,73%	83,04%	4,88%	0,54%	1,46%
Hotels & Restaurants	12,46%	63,07%	1,27%	15,74%	4,02%	3,43%
Marketed Services	14,08%	60,49%	2,06%	17,21%	3,31%	2,86%
Non-marketed services	13,92%	60,88%	1,91%	17,03%	3,41%	2,84%

Table A 7: CO_2 emissions. Rate of change: 2010 / 2005. Vertically integrated sectors.

% var 10 - 05	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others	Total CO_2
Gasoline	-3,97%	24,40%	33,83%	48,35%	-5,13%	43,54%	43,57%
Gas / Diesel	-13,09%	22,43%	20,70%	25,33%	-15,18%	27,86%	22,97%
Kerosene	-17,23%	6,80%	14,30%	22,75%	-19,55%	20,93%	20,11%
Fuel	-22,70%	-0,30%	7,36%	16,65%	-24,55%	13,73%	13,37%
LPGs	-4,01%	23,54%	32,41%	49,11%	42,35%	44,87%	42,54%
Naphta and others	15,10%	48,64%	59,89%	71,77%	11,14%	65,88%	67,39%
Gas	-6,59%	26,02%	28,32%	34,86%	-4,79%	19,39%	24,48%
Electricity	-26,89%	3,40%	0,98%	-30,40%	-22,99%	-21,96%	-19,09%
Coal	3,24%	44,73%	41,77%	26,70%	4,85%	30,82%	37,32%
Nuclear fuel	-9,37%	28,48%	31,59%	23,36%	-8,07%	22,17%	25,17%
Agriculture	-21,82%	12,23%	6,01%	-12,42%	-17,39%	-4,02%	4,65%
Chemical	-23,10%	8,17%	9,28%	-9,02%	-19,21%	-17,88%	-4,83%
Intermediate goods	-17,69%	11,40%	12,66%	-7,79%	-17,30%	-9,27%	2,95%
Capital goods	-19,68%	7,83%	13,32%	-12,04%	-18,02%	-8,88%	-0,60%
Construction	-13,57%	8,43%	11,34%	-12,44%	-18,65%	-5,53%	0,67%
Consumer goods	-19,84%	8,00%	9,26%	-13,02%	-18,87%	-8,78%	-0,11%
Railway transports	-18,58%	11,83%	13,19%	-1,68%	-15,93%	-1,96%	5,21%
Road transport	-8,57%	9,53%	9,55%	-3,94%	-18,71%	5,11%	3,55%
Maritime transport	-18,54%	10,44%	14,96%	7,04%	-13,96%	3,26%	8,91%
Air transport	-17,95%	1,60%	24,55%	-14,49%	-17,62%	-12,67%	19,10%
Hotels & Restaurants	-18,40%	11,35%	10,05%	-9,24%	-19,36%	-4,48%	2,61%
Marketed Services	-18,96%	6,79%	14,39%	-17,91%	-19,19%	-7,05%	-2,19%
Non-marketed services	-20,57%	5,92%	12,10%	-19,57%	-20,45%	-7,89%	-3,28%

Table A 8: CO_2 emissions. Rate of change: 2005 / 2000. Directly observable sectors.

% var 05 - 00	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others	Total CO_2
Gasoline	0,00%	0,00%	0,00%	-11,72%	0,00%	0,20%	-8,73%
Gas / Diesel	0,00%	0,00%	0,00%	8,44%	0,00%	27,23%	13,15%
Kerosene	0,00%	0,00%	0,00%	-13,59%	0,00%	7,30%	-8,35%
Fuel	0,00%	0,00%	0,00%	-39,27%	0,00%	-24,29%	-35,52%
LPGs	0,00%	0,00%	0,00%	-13,74%	0,00%	10,29%	-7,72%
Naphta and others	0,00%	0,00%	0,00%	-21,55%	0,00%	4,33%	-15,06%
Gas	0,00%	141,82%	0,00%	202,34%	0,00%	153,60%	167,54%
Electricity	0,00%	47,06%	0,00%	7,41%	21,16%	54,20%	15,30%
Coal	0,00%	51,35%	0,00%	95,18%	0,00%	59,71%	54,58%
Nuclear fuel	0,00%	26,03%	0,00%	62,52%	0,00%	35,73%	28,75%
Agriculture	0,00%	23,75%	0,00%	0,00%	-10,21%	0,00%	22,72%
Chemical	0,00%	20,10%	0,00%	7,11%	-12,85%	7,20%	11,07%
Intermediate goods	0,00%	25,56%	0,00%	11,97%	-8,89%	21,96%	22,76%
Capital goods	0,00%	19,42%	0,00%	6,50%	-13,35%	21,76%	15,86%
Construction	24,19%	42,87%	0,00%	0,00%	3,67%	45,19%	37,51%
Consumer goods	0,00%	24,80%	0,00%	11,30%	-9,44%	27,41%	21,72%
Railway transports	0,00%	13,65%	0,00%	0,00%	9,16%	0,00%	13,63%
Road transport	-4,75%	12,88%	0,00%	0,00%	8,42%	0,00%	6,68%
Maritime transport	0,00%	11,27%	0,00%	27,37%	6,87%	0,00%	11,86%
Air transport	-5,82%	0,00%	24,64%	0,00%	7,20%	0,00%	24,33%
Hotels & Restaurants	-12,33%	34,13%	0,00%	13,79%	-27,53%	0,00%	20,17%
Marketed Services	-12,06%	34,53%	0,00%	14,13%	-27,32%	0,00%	19,72%
Non-marketed services	-15,29%	29,59%	0,00%	9,94%	-29,98%	0,00%	15,47%
Households	-17,77%	48,39%	0,00%	0,00%	-10,75%	0,00%	23,66%

Table A 9: CO2 emissions. Relative weights. 2005. Directly observable sectors.

	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others
Gasoline	0,00%	0,00%	0,00%	72,49%	0,00%	27,51%
Gas / Diesel	0,00%	0,00%	0,00%	71,82%	0,00%	28,18%
Kerosene	0,00%	0,00%	0,00%	70,66%	0,00%	29,34%
Fuel	0,00%	0,00%	0,00%	70,58%	0,00%	29,42%
LPGs	0,00%	0,00%	0,00%	70,05%	0,00%	29,95%
Naphta and others	0,00%	0,00%	0,00%	69,22%	0,00%	30,78%
Gas	0,00%	50,72%	0,00%	47,65%	0,00%	1,62%
Electricity	0,00%	24,93%	0,00%	74,54%	0,20%	0,33%
Coal	0,00%	89,62%	0,00%	8,95%	0,00%	1,42%
Nuclear fuel	0,00%	89,60%	0,00%	8,95%	0,00%	1,45%
Agriculture	0,00%	97,78%	0,00%	0,00%	2,22%	0,00%
Chemical	0,00%	36,46%	0,00%	17,67%	1,81%	44,07%
Intermediate goods	0,00%	84,75%	0,00%	11,15%	2,31%	1,79%
Capital goods	0,00%	85,94%	0,00%	5,61%	6,44%	2,01%
Construction	26,02%	72,51%	0,00%	0,00%	0,01%	1,47%
Consumer goods	0,00%	86,73%	0,00%	8,69%	3,95%	0,63%
Railway transports	0,00%	99,74%	0,00%	0,00%	0,26%	0,00%
Road transport	31,37%	68,62%	0,00%	0,00%	0,02%	0,00%
Maritime transport	0,00%	95,53%	0,00%	4,25%	0,22%	0,00%
Air transport	0,74%	0,00%	99,19%	0,00%	0,07%	0,00%
Hotels & Restaurants	11,41%	79,55%	0,00%	3,15%	5,89%	0,00%
Marketed Services	21,66%	75,05%	0,00%	2,83%	0,46%	0,00%
Non-marketed services	20,45%	75,54%	0,00%	2,99%	1,01%	0,00%
Households	18,14%	73,70%	0,00%	0,00%	8,16%	0,00%

Table A 10: CO_2 emissions. Rate of change: 2010 / 2005. Directly observable sectors.

% var 10 - 05	Gasoline	Gas / diesel	Kerosene	Fuel	LPG	Naphta others	Total CO_2
Gasoline	2,10%	5,38%	7,67%	16,00%	-12,21%	11,02%	14,63%
Gas / Diesel	0,04%	3,25%	5,50%	7,08%	-13,98%	8,78%	7,56%
Kerosene	3,26%	6,58%	8,90%	14,90%	-11,21%	12,29%	14,14%
Fuel	-20,07%	-17,50%	-15,70%	-9,34%	-31,27%	-13,08%	-10,44%
LPGs	-2,33%	0,80%	3,00%	11,07%	-16,02%	6,21%	9,62%
Naphta and others	-2,42%	0,71%	2,90%	10,96%	-16,10%	6,11%	9,47%
Gas	110,28%	117,03%	121,76%	154,80%	80,82%	134,63%	135,32%
Electricity	12,75%	16,37%	18,90%	-25,50%	-3,05%	22,06%	-14,86%
Coal	25,13%	29,15%	31,97%	67,84%	7,60%	34,44%	32,69%
Nuclear fuel	27,74%	31,84%	34,72%	71,74%	9,84%	36,90%	35,49%
Agriculture	4,77%	20,78%	15,05%	9,42%	-10,97%	34,80%	20,08%
Chemical	2,77%	18,47%	12,85%	-0,30%	-12,68%	-16,53%	-0,83%
Intermediate goods	5,62%	21,75%	15,98%	10,51%	-10,26%	-17,66%	19,06%
Capital goods	6,31%	22,55%	16,74%	11,25%	-9,67%	21,34%	19,82%
Construction	7,87%	24,35%	18,45%	12,65%	-8,34%	23,21%	20,04%
Consumer goods	4,10%	20,01%	14,32%	9,08%	-11,54%	18,80%	17,81%
Railway transports	-10,04%	6,85%	18,87%	24,29%	4,29%	8,62%	6,84%
Road transport	-10,09%	6,79%	18,80%	24,22%	4,23%	8,56%	1,49%
Maritime transport	-8,06%	9,20%	21,48%	26,69%	6,58%	11,01%	9,93%
Air transport	-9,94%	6,97%	20,43%	24,44%	4,41%	8,75%	20,19%
Hotels & Restaurants	-23,29%	17,73%	9,41%	1,47%	-35,39%	12,72%	9,41%
Marketed Services	-22,15%	19,48%	11,04%	3,03%	-34,43%	14,39%	9,75%
Non-marketed services	-16,35%	28,38%	19,31%	10,72%	-29,55%	22,92%	18,12%
Households	-24,55%	-8,96%	15,31%	14,74%	-19,32%	16,00%	-12,63%

TABLES TO BE INSERTED IN THE TEXT

Table 1: Average yearly rate of change of technical coefficients. Spain: 2000 – 2010

	Energy	Manufacture	Transport	Other services	Households
Gasoline	-0.86%	-1.68%	-4.00%	-6.68%	-7.69%
Gas / Diesel oil	-0.35%	1.14%	-1.36%	1.64%	-0.16%
Kerosene	0	0	0.92%	0	0
Fuels	-0.04%	-1.16%	1.48%	-1.49%	0
LPGs	0	-5.00%	-2.00%	-10.00%	-6.35%
Naphta and others	0.56%	-0.45%	0	0	0
Gas	6.10%	20.00%	7.00%	14.24%	3.60%
Electricity	2.45%	4.00%	7.00%	4.84%	-4.72%
Coal	0.00%	5.00%	0.00%	20.00%	1.60%

Table 2

	Default emission factor tCO_2/ TJ
Motor gasoline	69.3
Aviation gasoline	70.0
Jet gasoline	70.0
Jet kerosene	71.5
Other kerosene	71.9
Gas / diesel oil	74.1
Residual fuel oil	77.4
LPG	63.1
Naphta	73.3
Bitumen	80.7
Lubricants	73.3
Petroleum coke	97.5
Refinery feedstocks	73.3
Other petroleum products	73.3

Source: IPCC.

Table 3

	Net caloric value (TJ / 10^3 tonnes)
Motor gasoline	44.3
Aviation gasoline	44.3
Jet gasoline	44.3
Jet kerosene	44.1
Other kerosene	43.8
Gas / diesel oil	43.0
Residual fuel oil	40.4
LPG	47.3
Naphta	44.5
Bitumen	40.2
Lubricants	40.2
Petroleum coke	32.5
Refinery feedstocks	43.0
Other petroleum products	40.2

Source: IPCC.

Table 4

	Default emission factor tonnes CO2 / 10^3 tonnes
Motor gasoline	3069.99
Aviation gasoline	3101.00
Jet gasoline	3101.00
Jet kerosene	3153.15
Other kerosene	3149.22
Gas / diesel oil	3186.3
Residual fuel oil	3126.96
LPGs	2984.63
Naphta	3261.85
Bitumen	3244.14
Lubricants	2946.66
Petroleum coke	3168.75
Refinery feedstocks	3151.9
Other petroleum products	2946.66

Source: IPCC and authors’ calculations.

Table 5: Petroleum derivatives. Euros per kilogramme.

Gasoline	0.450
Gas / Diesel oil	0.387
Kerosene	0.357
Residual Fuel	0.245
LPGs	0.523
Naphta	0.282
Other products	0.106

Source: CNE and authors' calculations.

Table 6

Motor gasoline		Gasoline
Aviation gasoline	Irrelevant	
Jet gasoline	Irrelevant	
Jet kerosene		Kerosene
Other kerosene	Irrelevant	
Gas / diesel oil		Gas / diesel oil
Residual fuel oil		Residual Fuel
LPGs		LPGs
Naphta		Naphta (and other products)
Bitumen	Irrelevant	
Lubricants	Irrelevant	
Petroleum coke		
Refinery feedstocks		
Other petroleum products		

Table 7: Petroleum derivatives. Tonnes of CO2 per million euros of 2000.

Gasoline	7109.51	0.45 € / Kg
Jet Kerosene	8297.31	0.357€ / Kg
Gas / Diesel Oil	8114.69	0.387€ / Kg
Residual Fuel Oil	12880.13	0.245€ / Kg
LPGs	5913.11	0.523€ / Kg
Naphtha	11514.40	0.280€ / Kg

Source: CNE and authors' calculations.

Table 8: Kt CO2 emitted by consumption of petroleum derivatives. Vertically integrated sectors.

	Refining	Other energy sources	Agricul-ture	Manufac-ture	Construc-tion	Transport	Other services	Total
2000	6.402,83	190,68	3.786,68	45.613,61	26.430,89	12.906,80	62.782,02	158.113,51
2001	6.135,62	196,17	3.950,20	47.466,21	28.871,41	13.529,64	67.668,03	167.817,27
2002	6.251,00	196,26	3.924,29	47.174,32	30.428,84	13.988,22	69.524,79	171.487,71
2003	6.108,72	165,99	3.864,87	46.189,97	31.841,89	14.140,09	70.498,95	172.810,49
2004	6.268,65	157,68	3.951,12	46.772,93	34.040,32	14.422,43	73.365,10	178.978,23
2005	6.558,40	153,79	4.103,86	47.999,25	36.061,01	14.629,92	74.873,50	184.379,72
2006	7.129,50	135,98	4.158,14	47.129,75	36.829,11	14.766,11	74.356,09	184.504,68
2007	7.511,56	124,63	4.214,46	47.766,69	36.562,06	15.497,47	74.009,93	185.686,78
2008	7.918,77	121,04	4.179,50	46.980,32	36.322,13	15.781,44	73.018,40	184.321,60
2009	8.241,45	119,80	4.232,37	47.155,27	36.003,02	15.972,50	72.939,22	184.663,64
2010	8.529,64	118,90	4.294,60	47.665,64	36.301,75	16.279,04	73.125,84	186.315,42

Source: Authors' calculations.

Table 9: Evolution of CO_2 emissions. Base year: 2000 = 100. Vertically integrated sectors.

	Refining	Other energy sources	Agricul-ture	Manufac-ture	Construc-tion	Transport	Other services
2000	100,00	100,00	100,00	100,00	100,00	100,00	100,00
2001	95,83	102,88	104,32	104,06	109,23	104,83	107,78
2002	97,63	102,92	103,63	103,42	115,13	108,38	110,74
2003	95,41	87,05	102,06	101,26	120,47	109,56	112,29
2004	97,90	82,69	104,34	102,54	128,79	111,74	116,86
2005	102,43	80,65	108,38	105,23	136,44	113,35	119,26
2006	111,35	71,31	109,81	103,32	139,34	114,41	118,44
2007	117,32	65,36	111,30	104,72	138,33	120,07	117,88
2008	123,68	63,48	110,37	103,00	137,42	122,27	116,30
2009	128,72	62,83	111,77	103,38	136,22	123,75	116,18
2010	133,22	62,35	113,41	104,50	137,35	126,13	116,48

Source: Authors' calculations.

Table 10: Relative weights. Vertically integrated sectors.

	Refining	Other energy sources	Agricul-ture	Manufac-ture	Construc-tion	Transport	Other services
2000	4,05%	0,12%	2,39%	28,85%	16,72%	8,16%	39,71%
2001	3,66%	0,12%	2,35%	28,28%	17,20%	8,06%	40,32%
2002	3,65%	0,11%	2,29%	27,51%	17,74%	8,16%	40,54%
2003	3,53%	0,10%	2,24%	26,73%	18,43%	8,18%	40,80%
2004	3,50%	0,09%	2,21%	26,13%	19,02%	8,06%	40,99%
2005	3,56%	0,08%	2,23%	26,03%	19,56%	7,93%	40,61%
2006	3,86%	0,07%	2,25%	25,54%	19,96%	8,00%	40,30%
2007	4,05%	0,07%	2,27%	25,72%	19,69%	8,35%	39,86%
2008	4,30%	0,07%	2,27%	25,49%	19,71%	8,56%	39,61%
2009	4,46%	0,06%	2,29%	25,54%	19,50%	8,65%	39,50%
2010	4,58%	0,06%	2,31%	25,58%	19,48%	8,74%	39,25%

Source: Authors' calculations.

Table 11: Kt CO2 emitted by consumption of petroleum derivatives. Directly observable sectors.

	Refining	Other energy sources	Agric-ulture	Manufac-ture	Constru-ction	Trans-port	Other services	House-holds	Total
2000	14.321	21.704	5.029	19.926	3.479	28.972	21.596	41722	156.753
2001	14.515	24.457	5.307	20.765	3.704	30.276	22.926	44471	166.425
2002	14.729	25.502	5.402	21.086	3.929	30.331	23.034	45988	170.004
2003	14.194	23.362	5.631	21.926	4.206	30.985	24.180	46742	171.231
2004	13.536	23.779	5.867	22.458	4.502	31.597	24.902	50621	177.264
2005	13.623	25.401	6.171	23.098	4.784	32.207	25.672	51592	182.552
2006	13.970	23.807	6.448	22.726	5.036	32.687	26.322	51488	182.488
2007	14.416	23.128	6.737	23.457	5.252	33.560	27.159	49886	183.599
2008	14.380	22.875	6.858	23.728	5.452	33.345	27.230	48148	182.019
2009	14.534	22.571	7.051	24.321	5.548	33.767	27.491	46926	182.211
2010	14.760	22.539	7.411	25.189	5.743	34.433	28.611	45077	183.766

Source: Authors' calculations.

Table 12: Evolution of CO_2 emissions. Base year: 2000 = 100. Directly observable sectors.

	Refining	Other energy sources	Agric-ulture	Manufac-ture	Construc-tion	Trans-port	Other services	House-holds
2000	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00
2001	101,35	112,68	105,53	104,21	106,48	104,50	106,16	106,59
2002	102,85	117,50	107,41	105,82	112,93	104,69	106,66	110,22
2003	99,11	107,64	111,97	110,03	120,90	106,95	111,97	112,03
2004	94,52	109,56	116,65	112,70	129,39	109,06	115,31	121,33
2005	95,12	117,03	122,72	115,92	137,51	111,16	118,88	123,66
2006	97,55	109,69	128,21	114,05	144,74	112,82	121,88	123,41
2007	100,66	106,56	133,97	117,72	150,94	115,84	125,76	119,57
2008	100,41	105,39	136,37	119,08	156,70	115,09	126,09	115,40
2009	101,49	104,00	140,20	122,05	159,45	116,55	127,29	112,47
2010	103,06	103,85	147,35	126,41	165,07	118,85	132,48	108,04

Source: Authors' calculations.

Table 13: Directly observable sectors. Relative weight.

	Refining	Other energy sources	Agric-ulture	Manufac-ture	Construc-tion	Trans-port	Other services	House-holds
2000	9,14%	13,85%	3,21%	12,71%	2,22%	18,48%	13,78%	26,62%
2001	8,72%	14,70%	3,19%	12,48%	2,23%	18,19%	13,78%	26,72%
2002	8,66%	15,00%	3,18%	12,40%	2,31%	17,84%	13,55%	27,05%
2003	8,29%	13,64%	3,29%	12,81%	2,46%	18,10%	14,12%	27,30%
2004	7,64%	13,41%	3,31%	12,67%	2,54%	17,83%	14,05%	28,56%
2005	7,46%	13,91%	3,38%	12,65%	2,62%	17,64%	14,06%	28,26%
2006	7,66%	13,05%	3,53%	12,45%	2,76%	17,91%	14,42%	28,21%
2007	7,85%	12,60%	3,67%	12,78%	2,86%	18,28%	14,79%	27,17%
2008	7,90%	12,57%	3,77%	13,04%	3,00%	18,32%	14,96%	26,45%
2009	7,98%	12,39%	3,87%	13,35%	3,04%	18,53%	15,09%	25,75%
2010	8,03%	12,27%	4,03%	13,71%	3,13%	18,74%	15,57%	24,53%

Source: Authors' calculations.

Table 14: 10^3 CO_2 per one million euros of output. Vertically integrated sectors.

	Refining	Other energy sources	Agricul-ture	Manufac-ture	Construc-tion	Trans-ort	Other services	House-holds
2000	58,62	3,21	0,45	1,61	0,33	4,18	1,04	0,42
2001	58,62	3,29	0,46	1,65	0,35	4,21	1,08	0,44
2002	58,70	3,32	0,46	1,65	0,34	4,19	1,07	0,43
2003	58,49	3,07	0,46	1,63	0,34	4,14	1,05	0,42
2004	58,08	2,99	0,46	1,63	0,34	4,12	1,05	0,42
2005	58,02	2,95	0,46	1,60	0,33	4,06	1,04	0,42
2006	58,06	2,76	0,44	1,52	0,32	3,97	1,00	0,40
2007	58,14	2,64	0,43	1,47	0,31	3,91	0,95	0,37
2008	58,08	2,56	0,41	1,42	0,29	3,84	0,90	0,34
2009	58,08	2,51	0,41	1,40	0,29	3,80	0,88	0,33
2010	58,08	2,46	0,40	1,38	0,28	3,76	0,85	0,32
% var	-0,93%	-23,39%	-10,38%	-14,16%	-15,96%	-9,95%	-17,78%	-23,42%

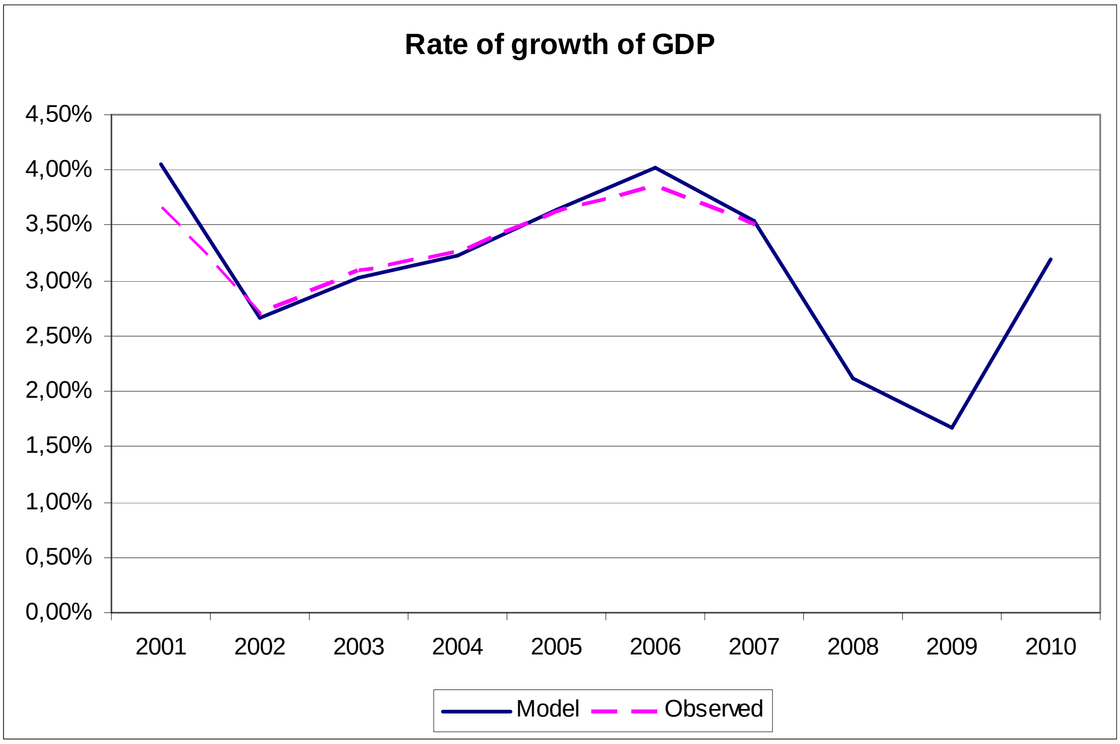
Source: Authors' calculations.

Table 15: 10^3 CO_2 per one million euros of output. Directly observable sectors.

	Refining	Other energy sources	Agricul-ture	Manufac-ture	Construc-tion	Trans-port	Other services	House-holds
2000	3,97	1,82	0,13	0,43	0,03	2,89	0,13	0,11
2001	3,96	1,84	0,13	0,43	0,03	2,88	0,13	0,11
2002	4,04	1,86	0,13	0,44	0,03	2,87	0,13	0,12
2003	3,87	1,68	0,13	0,45	0,03	2,86	0,13	0,11
2004	3,51	1,62	0,14	0,44	0,03	2,85	0,13	0,12
2005	3,47	1,59	0,14	0,43	0,03	2,82	0,13	0,11
2006	3,54	1,47	0,14	0,40	0,03	2,79	0,12	0,11
2007	3,65	1,41	0,14	0,40	0,03	2,78	0,12	0,10
2008	3,62	1,39	0,14	0,39	0,03	2,76	0,12	0,10
2009	3,64	1,38	0,14	0,39	0,03	2,74	0,12	0,09
2010	3,65	1,36	0,14	0,39	0,03	2,72	0,13	0,09
% var	-8,04%	-25,29%	10,36%	-8,89%	4,02%	-5,83%	-3,07%	-22,49%

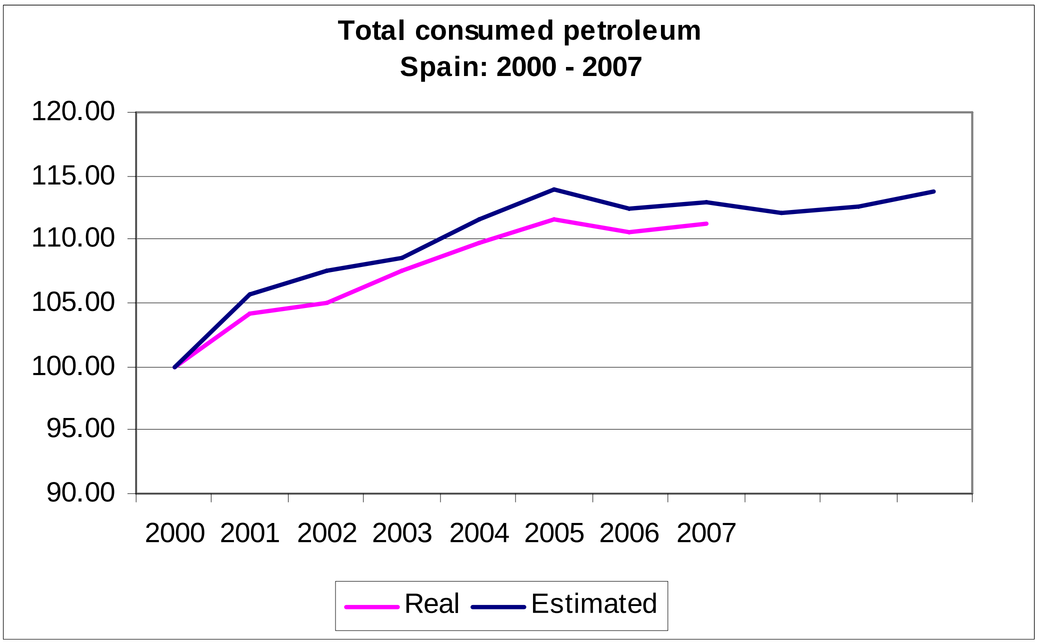
Source: Authors' calculations.

Figure 1: rate of growth of GDP



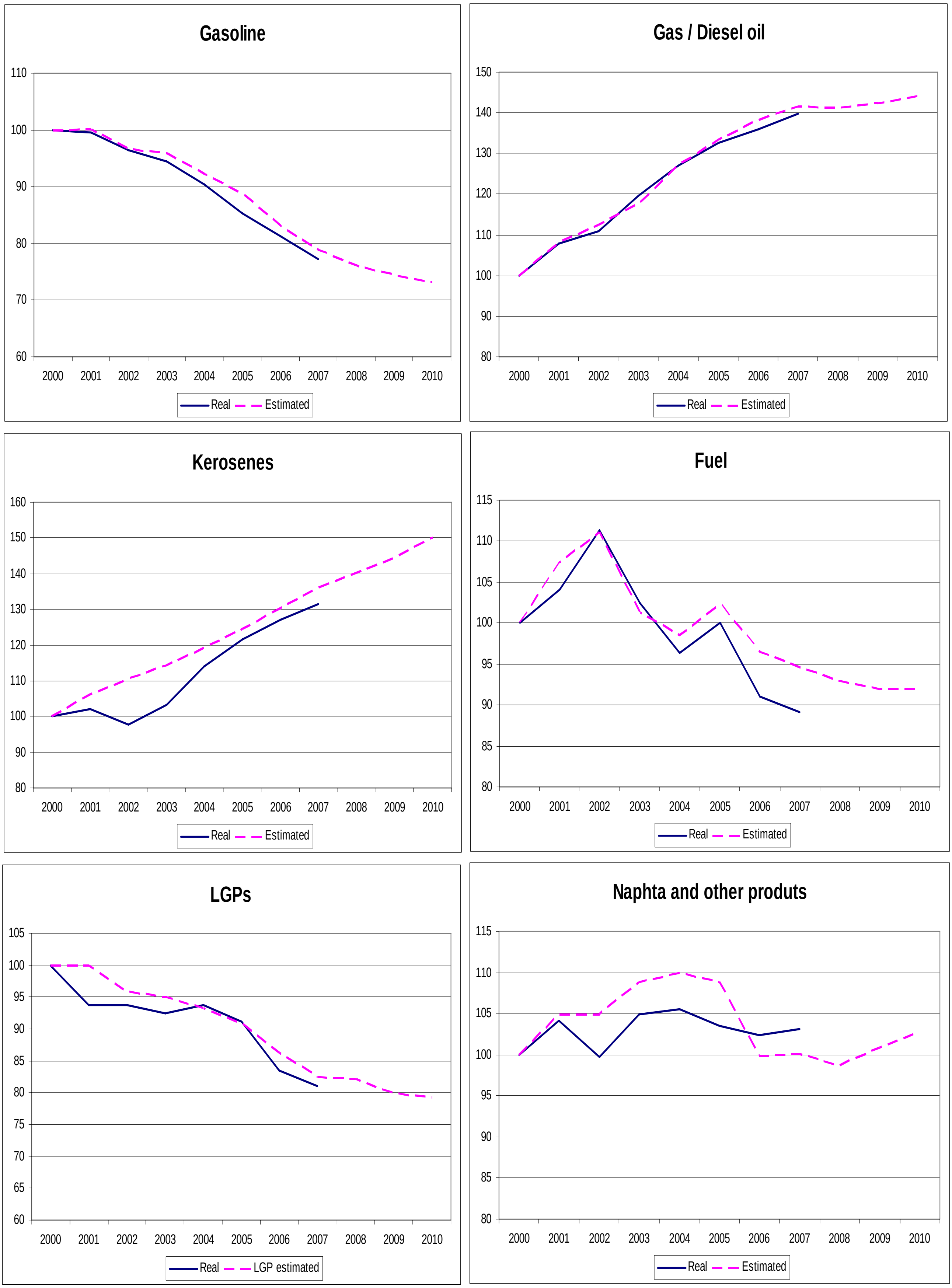
Source: INE and authors' calculations.

Figure 2: Petroleum consumed in Spain. Base Year: 2000 = 100.



Source: CNE and authors' calculations.

Figure 3: Petroleum derivatives consumed in Spain. Real and estimates. Base year: 2000 = 100



Source: CNE and authors' calculations.