Energy demand and energy efficiency

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Workshop Economic Challenges for Energy
Fundación Ramón Areces
Madrid, 22-24 January 2014

Motivation (I)

- What we pursue (in this presentation) is how to contribute to a sustainable growth model for an economy (either for Spanish, any other country or globally). We basically will give empirical evidence for Spain
- But … we only focus on partial equilibrium models (particularly models for the domestic and transport sectors)
- We talk about energy efficiency only from a demand perspective in these sectors
- So, the basic task is to identify key variables which can contribute to energy efficiency

Motivation (II)

- Looking at any report on energy efficiency (particularly the report of IDAE, 2009), we can summarize several products contributing recently to energy efficiency (in order of importance of their contribution):
  - Insulating windows
  - Lights of low consumption
  - Domestic appliances of high energy efficiency (labels A, A+, A++)
  - Electrical engines and speed changers in electrical engines
  - Low emission vehicles
  - Other services
- Building (23%), domestic and office equipment (9%) and transport (23%) are the main contributors to energy efficiency in terms of value added (55% of total)

Motivation (III)

- Building (31%), domestic and office equipment (14%) and transport (34%) are the main contributors to the direct effects of energy efficiency in terms of employment (79% of total)
- Whether or not we make a choice for an impulse of energy efficiency, we have the possibility to think about a sector (the energy efficiency sector) which, in the medium term can represent up to 5.5% of the total production of the country (IDAE report)
- Of course, the correct incentives to energy efficiency has several benefits (energy savings, emission reductions, economic sustainability, energy dependence reduction, reduction of vulnerability, etc.)
- At some cost (it needs financing and some public expenditure devoted to introduce incentives, it needs information and consciousness, etc.)

Motivation (IV)

ESTIMATION

SIMULATION

- So we consider Y = f (X) and we are interested in estimating causal effects of X on Y
  - Y is energy (in the domestic case it could be electricity, natural gas, liquified petroleum, or any other energy source while in the transport sector it could be gasoline, diesel or any other source)
  - X contains all (possible) determinants of energy demand (the factors and their number are going to depend on data availability)
- Why (and how) could this approach be useful for energy efficiency considerations? Because once we adjust the causal effects (parameters) we can:
  - Calculate X for a tarjet Y
  - Change X (taxes, for instance) and see the effects on Y
  - Assume a counterfactual and calculate the impacts
  - …

Outline

- Energy demand. Estimation
- Energy demand. Simulation
- Estimation – simulation and energy efficiency
- Some results
- Conclusions

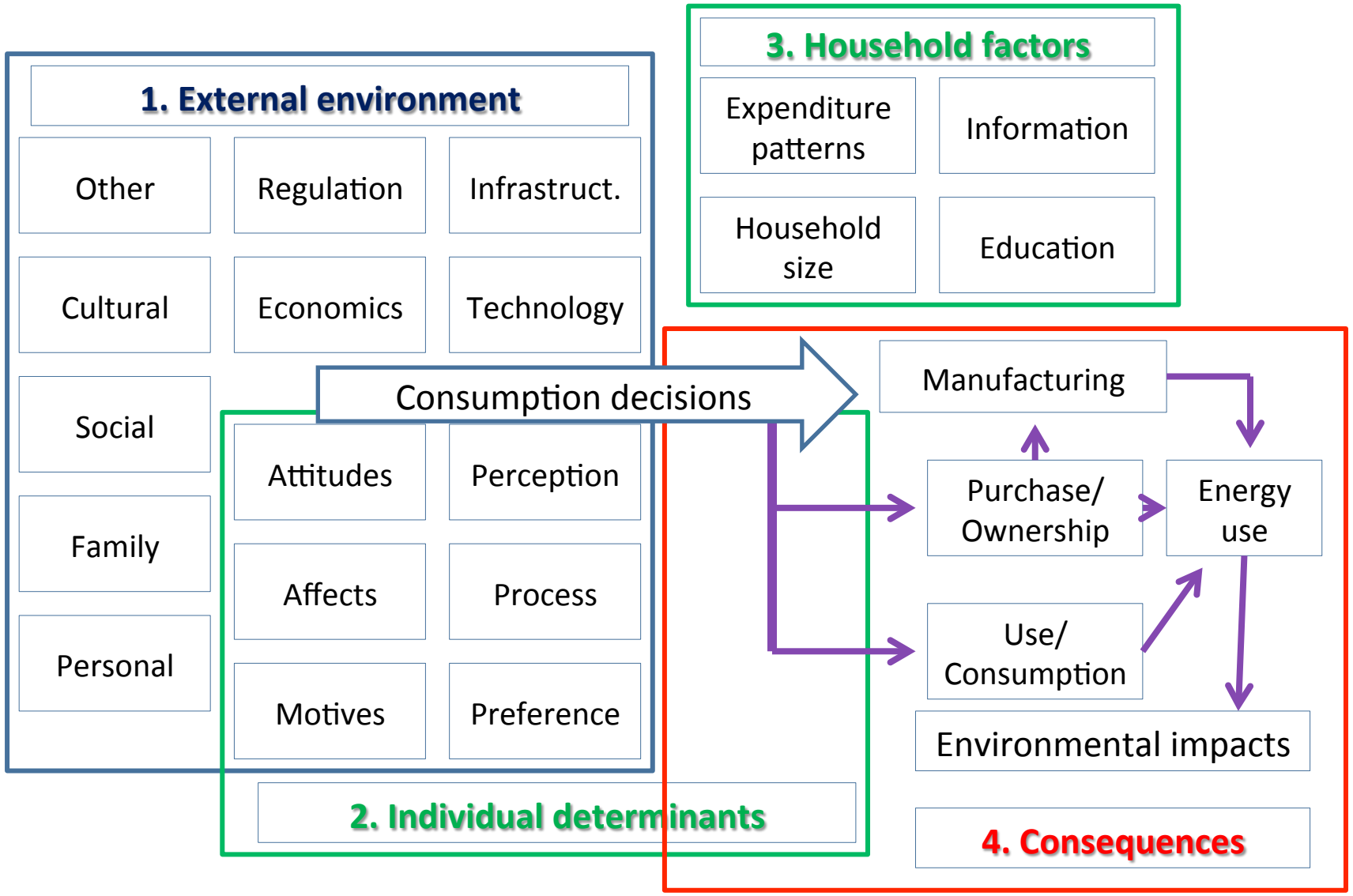
Energy demand. Estimation (I)

- How can we derive parameters to have causal effects of X (determinants) of Y (demand for energy)
  - Which is the data available?
  - Which variables do we have?

- Which data available?
  - Time series
  - Cross-sections
  - Combination of time series – cross-sections

- Which variable do we have?
  - Level of aggregation
  - Physical – monetary
  - Source of variables (administrative records, private records, survey data …)

Energy demand. Estimation (II)



Energy demand. Estimation (III)

- Extensive literature on energy demand (housing) in the last decades traced back to the 50's
  - Micro – macro models
  - Univariate – multivariate models
  - Single – simultaneous equations
- This literature has evolved due to many reasons:
  - Questions of interest
  - Theoretical development
  - And, basically, data availability
- I will present basically two examples and give information about more exercises of demand in the domestic and transport sectors

Energy demand. Estimation (IV)

- Example 1: Hanemann, Labandeira, Labeaga and López (2013)
- Survey. The Spanish Household Survey (*Encuesta de Presupuestos Familiares*), carried out by the Spanish National Institute for Statistics . Information on:
  - The amount and sources of households' incomes (**household factors**)
  - Their expenditures on goods and services (**household factors**)
  - Socio-demographic information (**individual determinants**)
  - Sources of energy used for heating, quantity demanded and expenditure (consumption decisions)
  - Physical characteristics of the household (**external environment**)
- Sample
  - Period: 2006-2008, number of observations: NT=63.053; T = 2 (balanced panel)

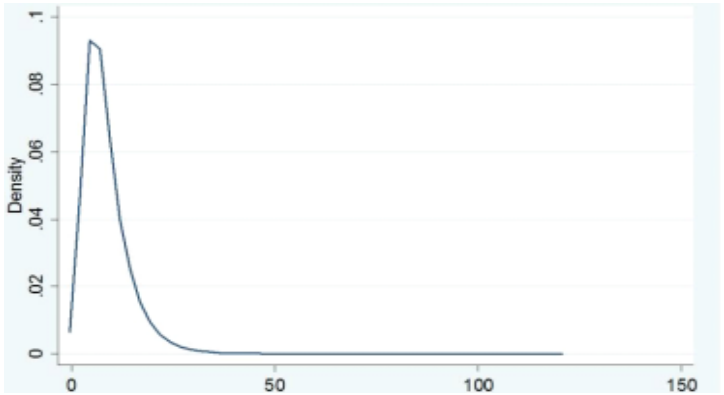
Energy demand. Estimation (V)

- Energy and heating in Spanish households

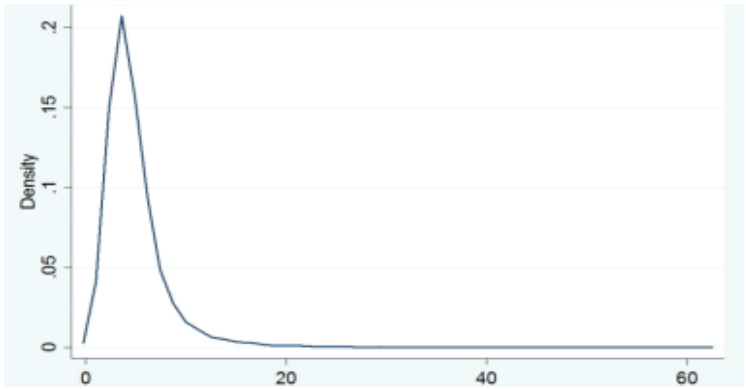
	2006	2007	2008
Average household energy consumption (€/m²)			
Total	8.39	8.32	8.55
Electricity	4.77	4.81	4.89
Natural gas	4.55	3.93	4.20
GLP	2.71	2.24	2.47
Liquid fuels	5.33	4.03	4.40
Solid fuels (coal, wood, etc.)	1.42	0.81	0.88
Heating availability			
Yes	59.64%	62.09%	63.75%
No	40.35%	37.91%	36.25%
Energy source for heating			
Electricity	20.90%	19.36%	20.71%
Natural gas	42.11%	43.74%	43.89%
GLP	6.23%	5.70%	5.53%
Other liquid fuels	27.89%	28.36%	27.34%
Solid fuels	2.87%	2.84%	2.49%
Solar energy	0.00%	0.00%	0.03%

Energy demand. Estimation (VI)

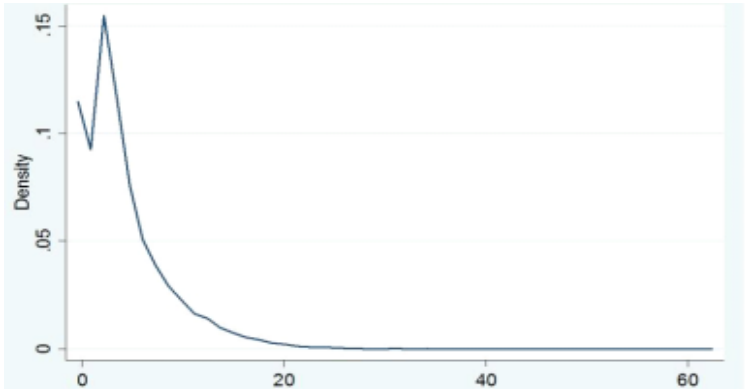
Figure 1. Energy expenditure density (€/m²)



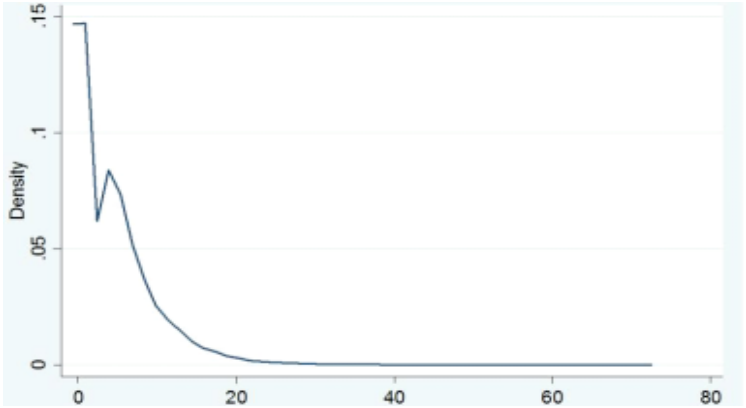
Total Energy



Electricity



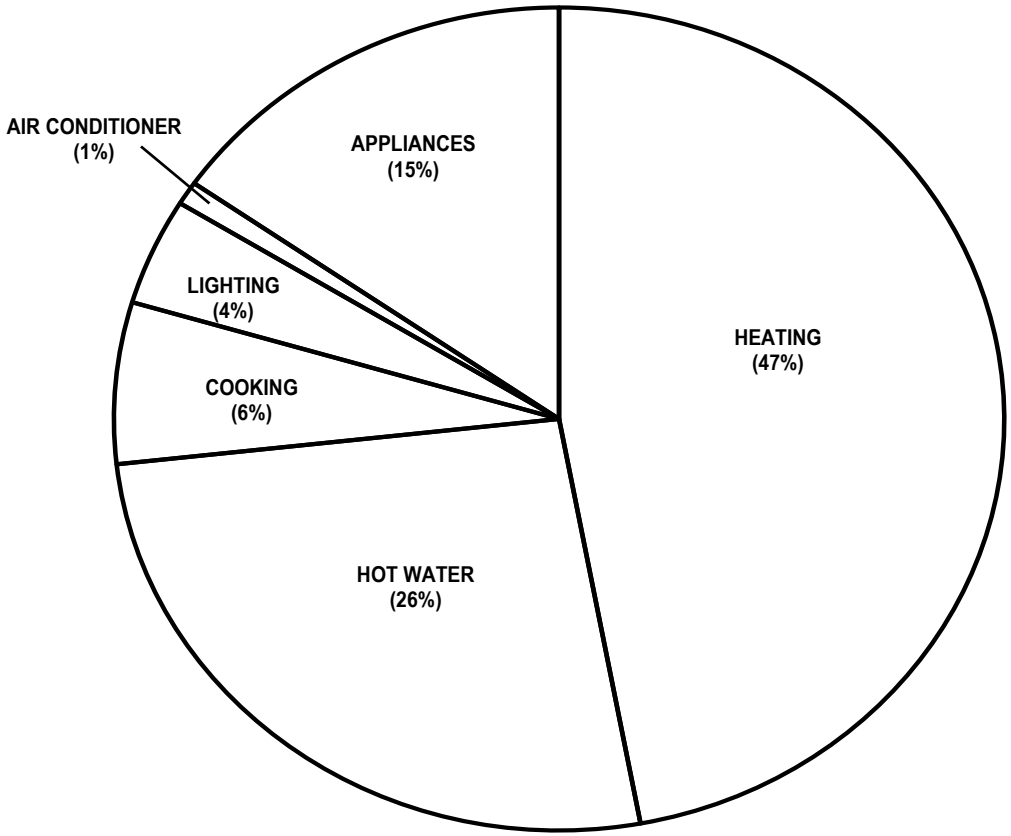
Natural gas



Liquid fuels

Energy demand. Estimation (VII)

- Distribution of final energy consumption by Spanish households 2008



Energy demand. Estimation (VIII)

- Main sources for heating and changes during the 2006-2008 (% and number of households)

2006 \ 2007	Electricity	Natural Gas	Liquid Fuels	Others
Electricity	92.59% (612)	4.39% (29)	1.97% (13)	1.06% (7)
Natural Gas	1.24% (22)	95.16% (1,690)	2.08% (37)	1.52% (27)
Liquid Fuels	1.25% (15)	3.57% (43)	92.77% (1,117)	2.41% (29)
2007 \ 2008	**Electricity**	**Natural Gas**	**Liquid Fuels**	**Others**
Electricity	94.38% (857)	1.87% (17)	2.31% (21)	1.43% (13)
Natural Gas	1.42% (32)	95.53% (2,158)	1.64% (37)	1.42% (32)
Liquid Fuels	0.72% (11)	2.87% (44)	94.91% (1,455)	1.50% (23)

Energy demand. Estimation (IX)

- Which is the main aim?
  - We use the high quality household survey described to estimate a microeconometric model that takes into account the real nature of energy demand (Figure), in this case a demand for services (heating) which is associated with the purchase of durable goods that consume energy to produce the services. The aim is to provide precise and accurate results regarding demand of household heating, both at the extensive and intensive margins. We also like to design (or propose) proper public policies and we would like to asses them

- Further issues in this field
  - Demand systems (Labandeira, Labeaga and Rodríguez, 2006)
  - Choice of appliances and demand (Galarraga, Abadie and Ansuategui, 2013)
  - Demand response integrated within the market (Jpchem and Fichtner, 2013, and Siano, 2014)
  - Demand side management (Xiong and Su, 2013)
  - DC versus LDC countries (Bakhat, Labandeira, Labeaga and Rosas-Flores, 2013)
  - Movements of population, energy demand and efficiency (Casado, 2014)

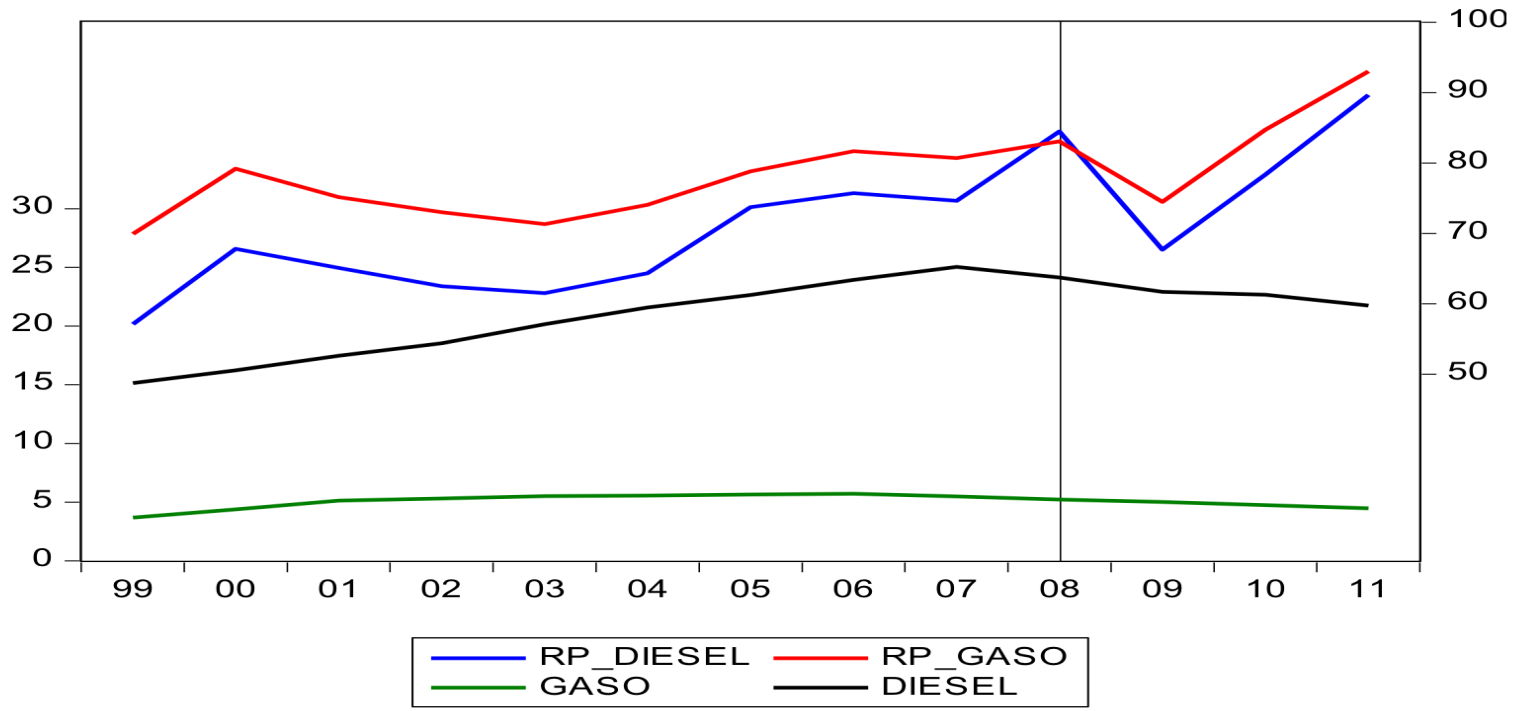
Energy demand. Estimation (X)

- Example 2: Bakhat Labandeira, Labeaga and López (2013)
- Data. Spanish regional data from several sources on:
  - Income (**household factors**)
  - Expenditure on diesel and gasoline and number of cars (consumption decisions)
  - Prices, infrastructures (**external environment**)
- Sample
  - Period: 1999-2011, number of regions: N=16; T = 13 (balanced panel, or in fact is it a panel?, or it is a data field)

Energy demand. Estimation (XI)

- So,we like to explain

Figure 1. Gasoline and diesel real prices (Euros/litres) and annual consumption (Million litres) in Spain (1999-2011)



Source: The authors with data from Ministry of Industry and CNE.

Energy demand. Estimation (XII)

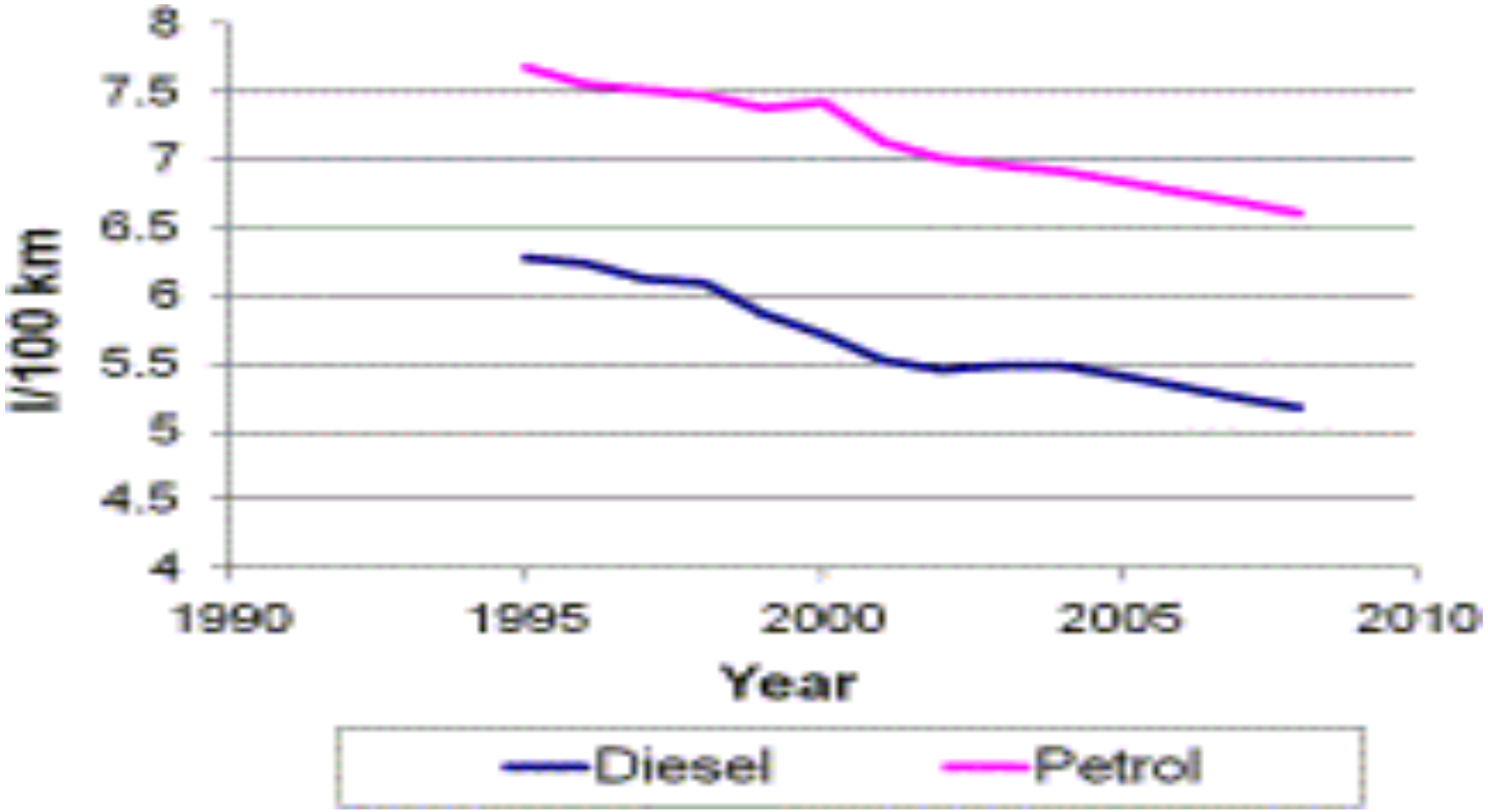
- The main aim in then
  - To provide an updates calculation of the price and income responsiveness of Spanish consumers of car fuels, and check the effect of the current crisis on the demand for these goods. This is just a technical paper but it gives evidence (attending to the income ranking of regions) of the potential impact of some tax policies

- Further issues in this field
  - Prices, labels and energy efficiency (Galarraga, Ramos, Lucas and Labandeira, 2013)
  - The role of information labels on energy efficient behaviour in the purchase of automobiles (Newell and Siikamaki, 2013)
  - Market structure, regulation, prices of energy (Houde, 2012 and Eckert, 2013)
  - Electric vehicles, regulation and the development of the market for charging (Schroeder and Traber, 2012)
  - Many more ….

Energy demand. Simulation

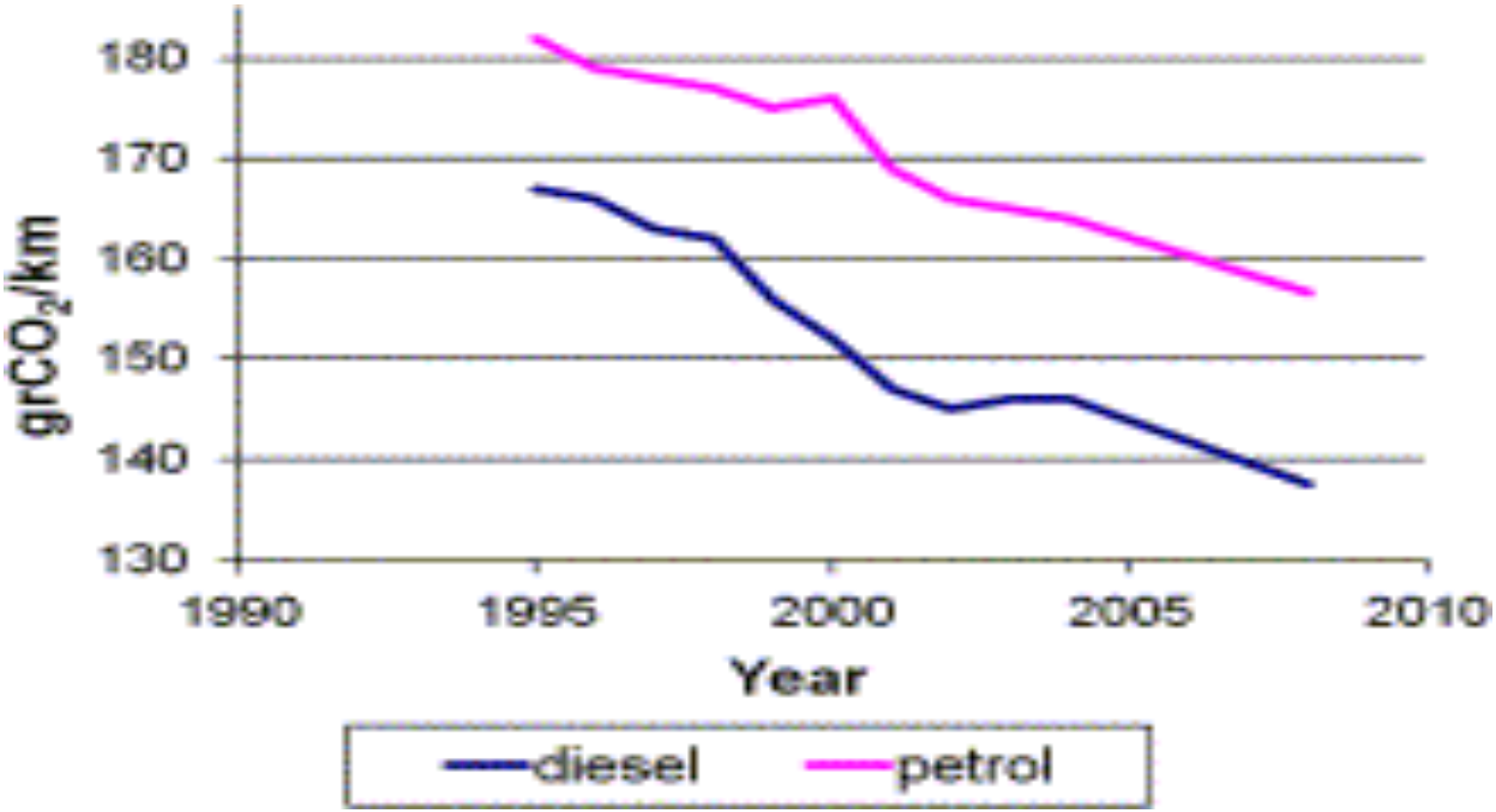
- We go back to Y = f (X) where the coefficients of X are going to be informative about policies related to energy use and, consequently, energy efficiency. We can use these coefficients in many different ways:
  - Calculate X for a tarjet Y
  - Change X (taxes, for instance) and see the effects on Y
  - Assume a counterfactual and calculate the impacts
  - …
- We can also make different exercises depending on the model used in estimation:
  - Single equations vs. complete demand systems. We can calculate in the second welfare measures when the system is estimated imposing theoretical restrictions but we cannot do it, normally, when adjusting single equations (ad hoc)
  - Individual vs. aggregated data. We can simulate different policies but we cannot conduct any exercise on redistribution or any other welfare analysis

Estimation – simulation and energy efficiency



Evolution of fuel consumption in new vehicles. Source: ACEA

Estimation – simulation and energy efficiency



Evolution of CO2 emissions in new vehicles. Source: ACEA

Estimation – simulation and energy efficiency

- Even with the evolution of efficiency of energy used for transport (diesel and petrol), the evolution of demand (quantity) has not followed the same pattern. Why?
  - We should look at determinants of demand. Economic determinants (prices / income), demographic determinants (population, movement of population, types of households, type of housing, labour market situation, socioeconomic conditions, location of the household, etc.). Which have been the drivers of demand for diesel and gasoline?

- Some data. From the mid 1990s to the outbreak of the crisis (2007-08), the demand of car fuels in Spain saw an impressive evolution: from 1999 to 2007 gasoline and diesel consumption grew at an average annual rate of 5.1% and 6.5% respectively. Prices were not determinants of demand (or technically there were non-linear effects of prices

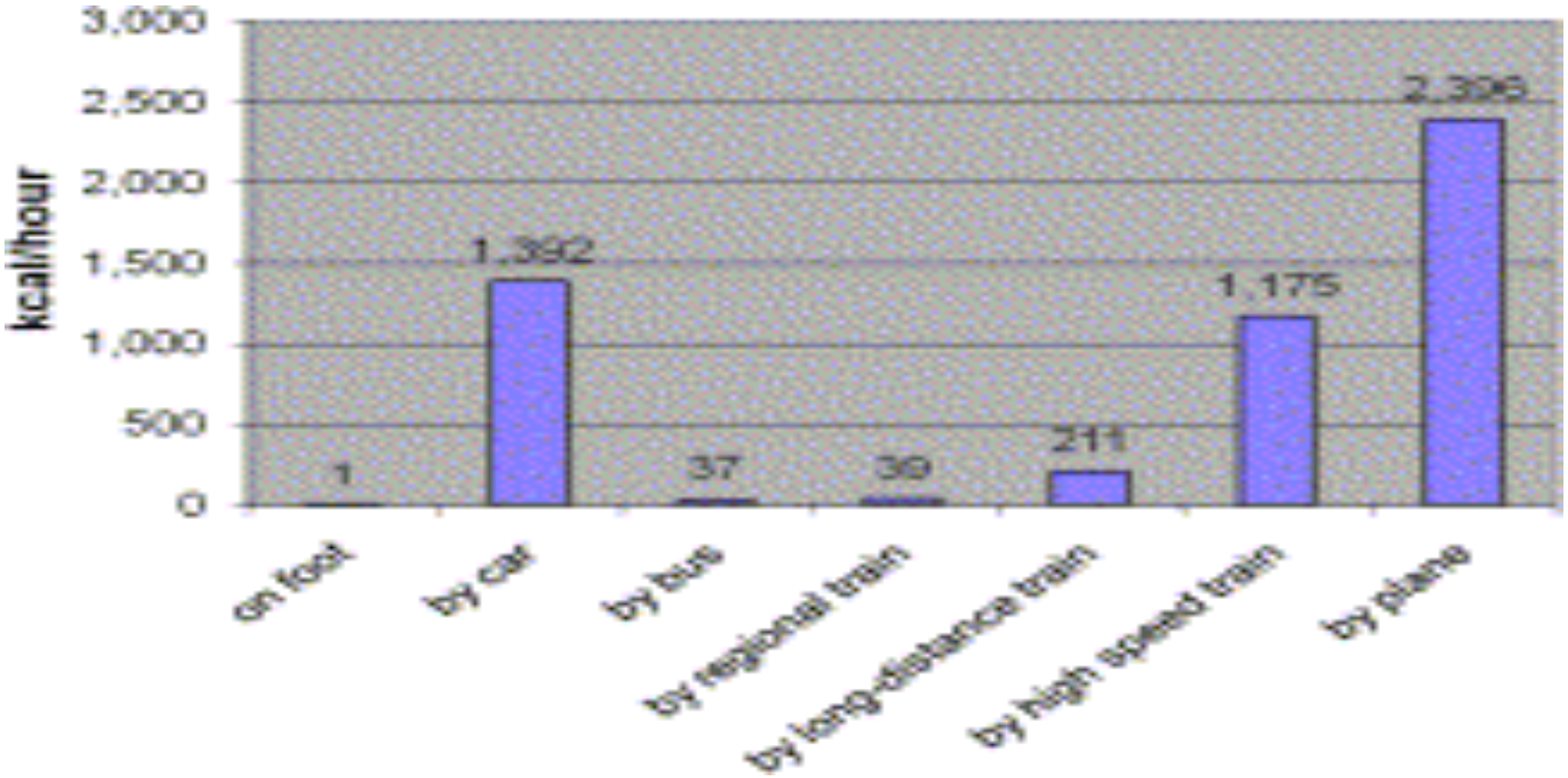
Estimation – simulation and energy efficiency

- In the years of deep crisis (2008-2011) gasoline and diesel demand fell at an annual rate of 2.4 and 1.8%, respectively whereas prices increase at annual rates of 3.6 and 4.6%, respectively. Despite this we can infer that diesel and gasoline consumption present strong inertia even at high price levels

- Consequences. With more efficient vehicles with strong reductions of CO2 emissions and even with a deep crisis emissions are far from expected from these figures. As a result we need:
  - To simulate using accurate figures for responses (elasticities)
  - To re-design the policies
  - To introduce new policies

Energy demand and efficiency

- Space for different policies at cities:



The relation between energy and invested time in journeys by different means of transport

Some results

- We go back to Y = f (X) where the coefficients of X are going to be informative about policies related to energy use and, consequently, energy efficiency
- Results 1. Estimation
- Results 2. Estimation
- Results 3. Simulation

Conclusions (I)

- Energy demand and energy efficiency are intimately related
- Energy demand decisions involve many interrelated factors from families and individuals but also from the environmental. Most of these factors are not exogenous to the consumption decisions and we should be careful in taking them into account to be able to derive proper policy parameters (causal effects)
- In addition to a suitable methodology, we need high quality data to answer policy relevant questions related to energy efficiency
- Finally, I also miss more multidisciplinary research in this area

- But, I am very sorry to say that I can only conclude (as Platón is attributed to say about Sócrates): "solo sé que no sé nada". This is a form of saying that after examining individual's behaviour, most of the decisions are taken because of what we technically name unobserved heterogeneity

Conclusions (II)

- First, a quote from Galarraga, Abadie and Ansuategui (2013): " …the current application of the Spanish *Renove* plan with rebates on the dishwasher market for energy efficient appliances generate some welfare losses, a rebound effect and a considerable deficit in public budgets". My questions are:
  - Did the policy makers worry about all these consequences (ex - ante) before implementing the program?
  - Are they going to evaluate the impacts of the policy ex – post?

- Second, a quote from Bakhat Labandeira, Labeaga and López (2013): " In a momento of pressing distributional constraints and changes in energy taxes, …, it is particularly important to have accurate estimates of the responsiveness of demand to price and income changes. Our findings suggest that strategies and policies related to car-fuel consumption need to be fully informed so that adaptation to a shifting socio-economic context can proceed in a swift, cost efficient and equitable manner

Many thanks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