

ENERGY PRODUCTION AND CONSUMPTION IN PORTUGAL: STYLIZED FACTS*

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1. INTRODUCTION

Energy is of vital importance in all economies. As a matter of fact, energy is a basic input in virtually all production processes and an important final consumption item for households. Therefore, structural characteristics in terms of energy production and consumption, as well as shocks in prices or quantities, have a strong impact in most economic variables. The literature on the impact of energy in economic activity is wide and regained interest in the last years due to the increase and high volatility of its prices. Some recent papers on the macroeconomic impact and drivers of oil price shocks are Blanchard and Gali (2008), Kilian (2009) and Hamilton (2009).

There are multiple and interrelated dimensions involved in the analysis of the impact of energy in economies, ranging from microeconomic regulatory issues to macroeconomic impacts on GDP, inflation and the current account. The analysis of energy issues has its own specificities, though energy markets share many of the basic characteristics of other markets in the economy. The supply of energy implies the transformation of primary energy sources into types of energy that can be later used as inputs or as final households' consumption. For example, hydroelectric power can be used to produce electricity and crude oil can be transformed into liquid fuel for road, maritime or air transport. The extraction of primary energy sources and their transformation into different types of energy products is an economic activity by itself and contributes to the total gross value added and employment.

The energy sectors are typically associated with network industries. The investments required in energy extraction, transformation and distribution are typically high, leading to markets dominated by a small number of firms, which interact with an inelastic energy demand curve. This gives rise to important competition issues that are typically settled by specific regulatory authorities, either at the national or at the European level (see, for example, EC (2009)). As in other markets, primary and secondary energy supply is not only a function of energy endowments but it is also affected by energy price levels. In addition, the structure of primary and secondary energy production depends on the relative cost of each production technology, which may include not only economic and financial costs, in their strict sense.

In macroeconomic terms, the significant share of energy in total production costs and in households' total expenditure turn supply induced energy price shocks into important drivers of economic fluctua-

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tions. Conversely, developments in international economic activity potentially affect energy prices through the demand of energy. Overall, energy shocks potentially affect producer costs, inflation and output, as well as external competitiveness and the terms of trade. The effect of energy shocks on the foreign account is naturally stronger for countries with higher energy dependence, i.e., those where domestic primary energy production covers a small share of final energy consumption. In these countries the current account balance is typically affected by swings in international energy prices through changes in the terms of trade, though in some cases a positive effect can emerge from a higher foreign demand by oil exporting countries. In addition, a high energy dependence exposes countries to episodes of severe energy shortages associated with political or military instability, with disrupting effects on economic activity.¹ Finally, environmental concerns have become stronger and emissions reducing policies have become important in the recent years, with direct consequences on energy production and consumption (see, for example, Tol (2008)). These issues will certainly shape energy policies and the energy sector over the next decades.

This article aims to characterize structural aspects in the Portuguese energy production and consumption patterns, taking a long term perspective and providing a comparison with other advanced countries. The data used in the article comes essentially from the International Energy Agency (IEA) database. We focus just on a set of aggregate stylized facts, including key indicators like energy dependence and energy intensity, but setting aside issues related with market structure and regulation, inflation and current account. Although very important, the later topics require autonomous and methodologically different papers. A broader analysis, including the characteristics of energy markets, regulatory issues and the impact of energy prices in activity and inflation in the euro area is presented in ECB (2010). In addition, taking a detailed and policy-oriented approach, AIE (2009) reviews recent energy developments in Portugal, including energy policies, sectoral analysis and energy technology. Neves and Esteves (2004) discuss the channels through which oil prices affect the economy and present estimates for the overall impact of an oil price increase on GDP and prices in the main developed countries and Portugal.

The article is organized as follows. In Section 2 we analyze the structure of primary energy production in Portugal and its foreign dependence. Section 3 presents the share of energy producing sectors in the Portuguese total gross value added and employment and describes the patterns of final energy production and consumption. Section 4 turns to the analysis of the links between economic activity and energy consumption (energy intensity). Section 5 concludes.

(1) For an extensive analysis of energy security issues see, for example, Bohi and Toman (1996).

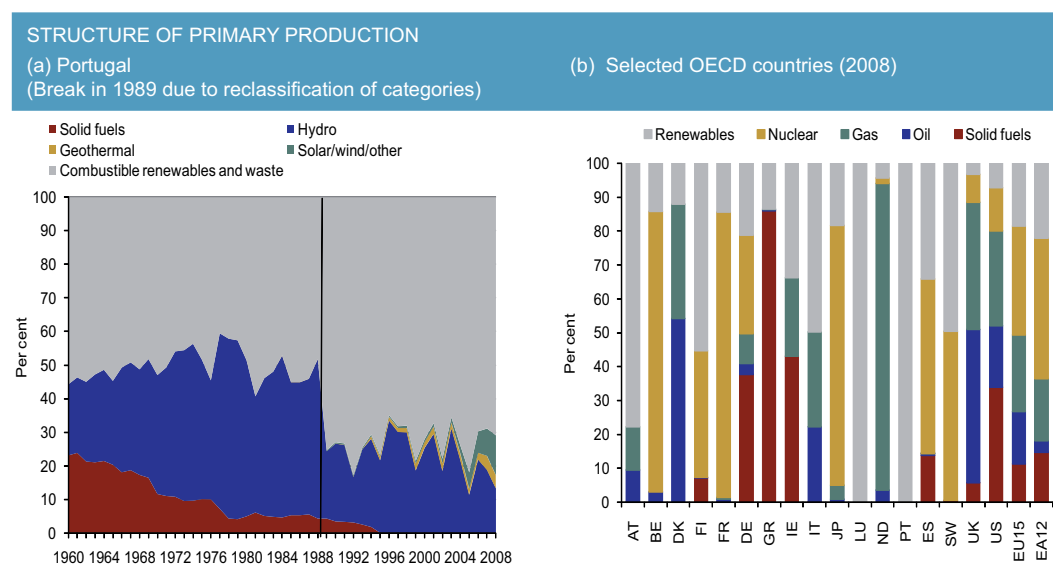
2. PRIMARY SOURCES OF ENERGY AND SUPPLIERS

2.1 Primary energy production

Primary energy production is the first stage in the energy production activity. The structure of primary energy production is very heterogeneous across countries and changes slowly along decades as it heavily depends on the endowment of natural resources and past investments in energy producing infrastructures such as dams or nuclear central facilities. The panel a) of Chart 1 presents the structure of primary energy production in Portugal from 1960 to 2008. “Combustible renewables and waste” represent the largest share of domestic energy production with a share of about 70 per cent in 2008.² Primary energy production based on hydro power plants is the second largest domestic source of primary energy, with an average share of about 20 per cent in the last decade. This component is substantially volatile as it depends on the yearly amount of rain.³ Solid fuels (coal and peat), represented around 20 per cent of primary energy production in Portugal in the beginning of the sixties, but recorded a declining trend and have virtually disappeared in the last decade. Renewable energies like the solar, wind and geothermal have significantly increased their importance, though they still represent a relatively small share in total domestic energy production (16 per cent in 2008).⁴

Panel b) of Chart 1 compares the structure of primary energy production in a set of advanced coun-

Chart 1



Sources: IEA (International Energy Agency) and author's calculations.

(2) According to the IEA methodology, combustible renewables and waste comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Biomass is defined as any plant matter used directly as fuel or converted into fuels (e.g. charcoal) or electricity and/or heat. Included here are wood, vegetal waste (including wood waste and crops used for energy production), ethanol, animal materials/wastes and sulphite lyes. Municipal waste comprises wastes produced by the residential, commercial and public service sectors that are collected by local authorities for disposal in a central location for the production of heat and/or power. Hospital waste is included in this category. Data under this heading are often based on incomplete information. Thus the data give only a broad impression of developments, and are not strictly comparable between countries. In some cases complete categories of vegetal fuel are omitted due to lack of information.

(3) Although other sources of energy can be used to partially refill dams, especially when there is low electricity demand (e.g. if wind power is being generated during hours of low electricity consumption - mix of primary energy sources), the yearly amount of rain clearly determines hydro electric production in the following periods.

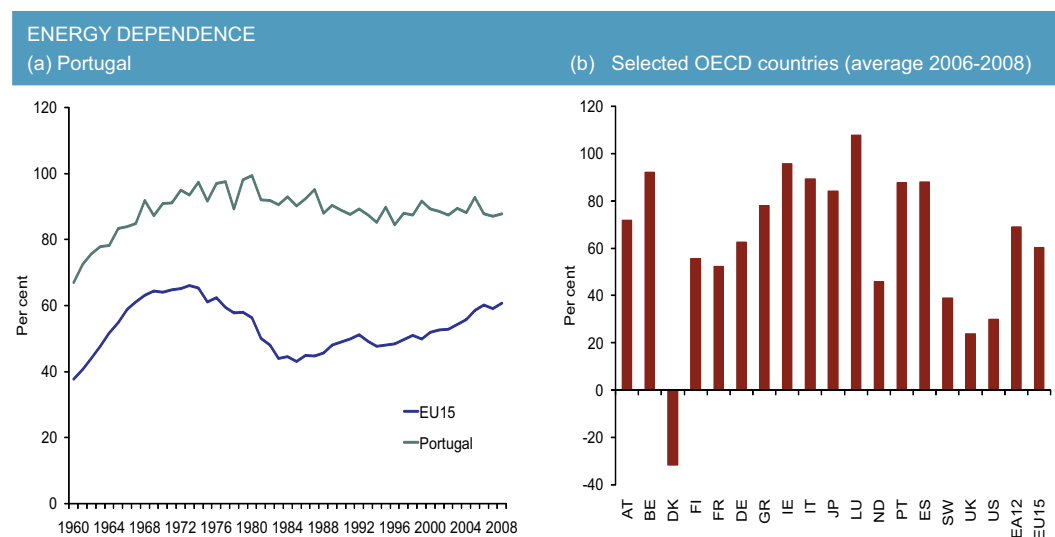
(4) Different sources of energy are converted into a common unit of measurement, tonnes of oil equivalent (toe).

tries in 2008. Portugal and Luxembourg are the only countries with primary energy production relying entirely on renewable energies. Other countries poorly endowed with primary energy sources like oil, gas or solid fuels have adopted nuclear energy. This is the case of Belgium, Finland, France, Japan, Spain and Sweden. Other economies like Germany, Netherlands, UK and US have also adopted nuclear energy, despite relevant endowments of other energy sources. The Netherlands stands out as a country with a significant share of gas, while Denmark and the UK present significant shares of both gas and oil.

The comparison between the level of domestic energy production and total primary energy supply sets the degree of energy dependence, i.e., the share of energy supplied to the economy that is imported. Chart 2 reports the evolution of this indicator for Portugal and the EU15 since the sixties and also a comparison across a set of advanced countries in the recent years. The degree of energy dependence in Portugal has always been substantially higher than that observed in the EU15, around 84 per cent in the last three decades. This is partly the reflex of the structure of primary energy production, which bases solely on renewables, and it is related to the broader issue of poor total energy endowments. Nevertheless, the degree of energy dependence in Portugal is similar to that of Spain in the period 2006-2008 (88 per cent) and lower than that of Luxembourg, Ireland, Belgium and Italy. Denmark is the only net exporter of energy in the set of countries presented.

Energy dependence by type of product depends on several aspects. Firstly, countries' endowments determine net imports. For example, there will be low imports of locally abundant energy sources. Secondly, some countries import primary energy as an input to produce final energy that is subsequently exported. This is basically the case of the oil refining industry. Thirdly, energy imports depend on the technological choices related with the production of final energy for consumption, notably for

Chart 2



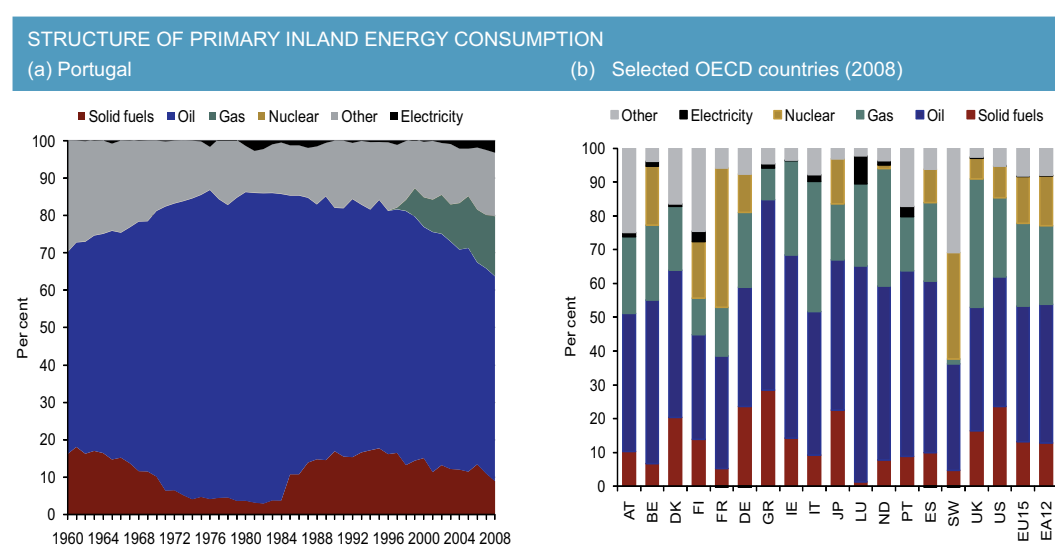
Sources: IEA (International Energy Agency) and author's calculations.

the production of electricity. More generally, the transformation of primary energy sources into energy for final consumption is dependent on the structural conditions, technological choices and countries' policies. It should be noted that, as in other markets, primary energy supply is not only a function of energy endowments but it is also affected by its prices. In addition, the structure of primary energy production also depends on the relative cost of each production technology, which may include not only economic and financial costs, in their strict sense. Moreover, primary energy production usually involves significant fixed costs, thus investment decisions in these markets typically consider a long-term horizon.

The structure of inland primary consumption, i.e. taking together the domestic primary production and the net energy imports, reveals that oil stands as the main source of primary energy consumed in the Portuguese economy (55 per cent in 2008) (see Chart 3).⁵ Energy sources referred in the chart as "other", mostly comprising renewables, account for 17 per cent of total. Gas, which became part of the domestic consumption of primary energy in 1997, stands as the third largest component, with a share of 16 per cent in 2008. The inclusion of gas in the Portuguese bundle of primary energy sources is undoubtedly one of the significant changes occurred in the last decades, largely substituting oil imports. Solid fuels, represented around 10 per cent of total inland consumption in the last years, recording a slight decreasing trend since the mid-nineties. Finally, there is a residual share for electricity that is imported directly, i.e., not the result of a secondary domestic production process.

The structure of inland primary energy consumption across countries is generally more homogeneous than that of primary energy production. Panel b) of Chart 3 compares some advanced countries along this dimension in 2008. Some regularity emerges from this comparison. The majority of countries rely on oil and gas for more than half of total primary energy consumption. In addition, solid

Chart 3



Sources: IEA (International Energy Agency) and author's calculations.

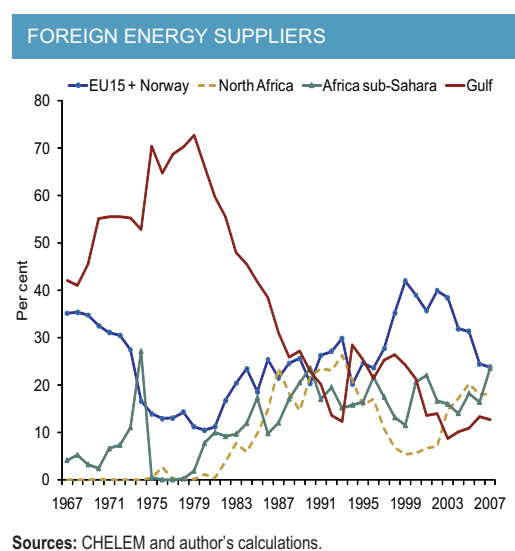
(5) Inland consumption differs from the final energy consumption due to international marine and aviation bunkers and stock changes.

fuels tend to represent less than 20 per cent of total primary consumption. Finally, nuclear energy naturally plays a larger role in countries which have a lower share of fossil fuels.

2.2 Foreign suppliers

The choice of foreign energy suppliers depends on geographical aspects, types of products imported and energy security considerations. Although energy security involves several dimensions, the reliability and accessibility of energy sources are key aspects.⁶ In this respect, in last decades Portugal has diversified the set of foreign energy suppliers, increasing overall energy security. Chart 4 plots the share of different regions in total energy imports in nominal terms from 1967 to 2008. The importance of the Gulf countries in Portuguese energy imports was very high during the seventies but dropped substantially afterwards and presently their weight is only slightly higher than 10 per cent. Conversely, European suppliers (EU15 plus Norway) increased their importance, with a peak of around 40 per cent in the late nineties. More recently, the North African and the sub-Saharan African regions significantly increased their importance, the former mainly as a supplier of gas.⁷ The standard deviation of the shares presented in Chart 4 decreased from a maximum of 34.5 in 1979 to a minimum of 1.4 in 1990, standing presently around 5 per cent. Apart from these regions, Brazil and Russia presently represent 10 per cent of total energy imports.

Chart 4



(6) Other dimensions of energy security include exposure to the volatility in prices and negotiating power, degree of electrical connectivity, etc. For a longer discussion of this issue and an energy security index for the euro area see Box 2 in ECB (2010).

(7) It should be noted that before February 2004, most gas imports from Nigeria arrived via the Huelva terminal in Spain, where they are regasified and sent by pipeline to Portugal. Since February 2004, gas imports arrive directly in Portugal at the Sines terminal.

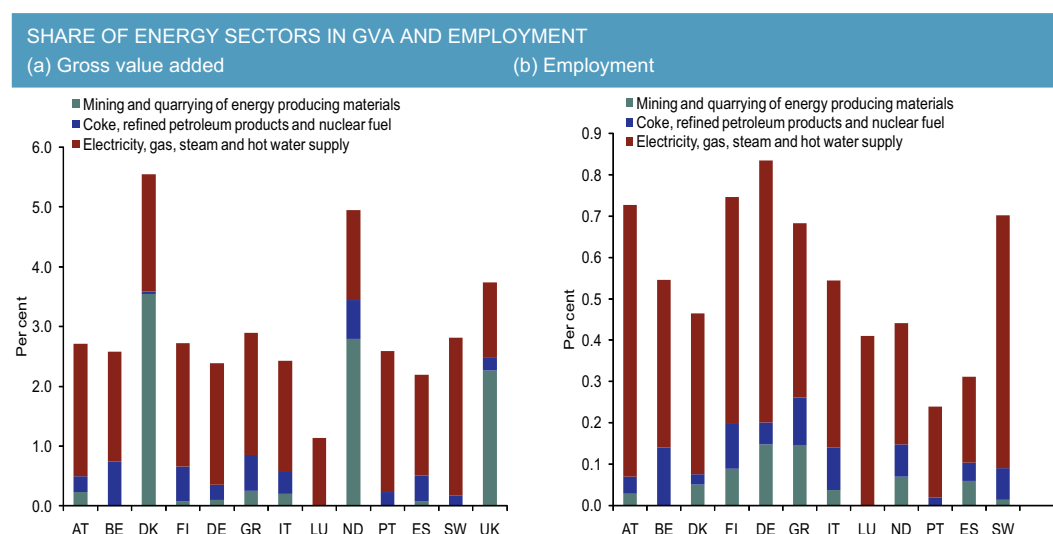
3. ENERGY INDUSTRIES AND CONSUMPTION PATTERNS

3.1 Gross value added and employment

Primary energy sources must be extracted and transformed into energy products suitable to be used as inputs in the production chain of firms or consumed by households. Therefore, the activities of extracting and transforming primary energy into final energy products are important in any economy. Nevertheless, figures for sectoral gross value added and employment are plagued by statistical problems, especially if a long period or a cross country comparison is required. The set of energy related industries comprises the sectors “mining and quarrying of energy producing materials”, “coke, refined petroleum products and nuclear fuel” and “electricity, gas, steam and hot water supply” of the International Standard Industrial Classification of economic activities, Revision 3 (ISIC Rev. 3).

Chart 5 presents the share of these sectors in gross value added (GVA) and employment in a set of advanced countries for the average of the period 2004-2006. The sector of “electricity, gas, steam and hot water supply” is typically the largest energy sector, except in countries that have significant primary energy endowments and thus significant “mining and quarrying of energy producing materials” activities (Denmark, Netherlands and UK). With the exception of these three countries, the share of energy related industries in total GVA is lower than 3 per cent. In what concerns the share of employment in energy related industries on total employment in the economy, values are small (lower than 1 per cent) and “electricity, gas, steam and hot water supply” plays the largest role. As for the Portuguese economy, the share of energy related activities in total GVA is near the average (2.6 per cent) but their share in total employment is the lowest of all countries represented (0.22 per cent), with a slight declining trend along the last decades.

Chart 5



Source: OECD (STAN).

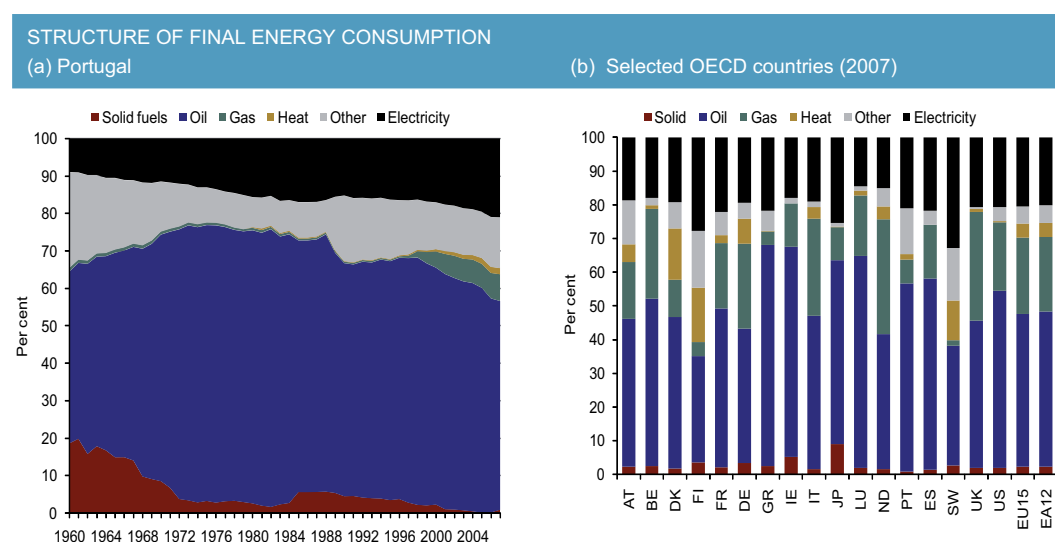
3.2 Patterns of energy consumption

Households and firms consume a set of energy products. The panel a) of Chart 6 presents the structure of final energy consumption in Portugal by type of product. Oil is the dominant final energy product consumed in Portugal, with a share above 55 per cent in 2008. Nevertheless, this share has been decreasing since the mid-nineties. Electricity represents about one fifth of total final energy consumption, while “other” (mostly combustible renewables) represents about 17 per cent. Finally, there is a progressive usage of gas, which presently represents about 7 per cent of final energy consumption. In international terms oil is the dominant final energy product in consumption.

The structure of final energy consumption by sector is, *inter alia*, the reflex of the structure of the economy and its level of development. This latter factor is related with the type of technologies used in production and the profile of households’ consumption. Since these are structural aspects in the economy, the sectoral structure of energy consumption evolves slowly along the decades. Panel a) of Chart 7 sector presents the evolution of this structure for the Portuguese economy since 1960. In the last two decades “industry” and “transport” represented each one third of total final energy consumption. The third largest consumption sector is “residential”, with a share of around 16 per cent. “Commerce and public services” have increased their share, representing presently more than 10 per cent of total energy consumption, while the reverse trend is observed in “agriculture, forestry and fishing”. The “non-specified” item is interpreted as a residual component.⁸ Panel b) of Chart 7 sector shows that the structure of energy consumption by sector is not very different across countries.

The large importance of the transport sector in final domestic energy consumption reflects not only

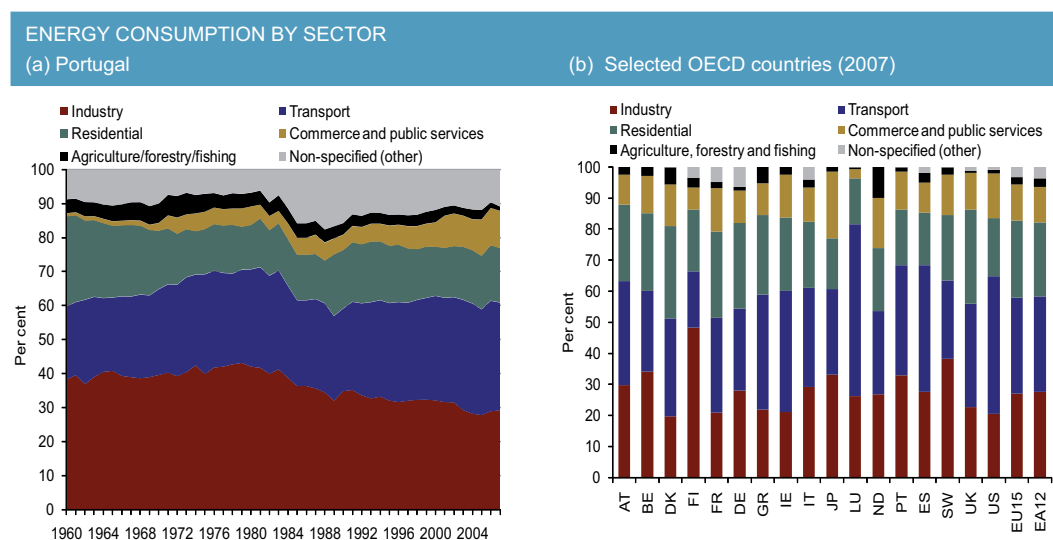
Chart 6



Sources: IEA (International Energy Agency) and author's calculations.

(8) This residual component includes: i) non-specified items, i.e., all fuel use not elsewhere specified as well as consumption in the above-designated categories for which separate figures have not been provided. Military fuel use for all mobile and stationary consumption is included here (e.g. ships, aircraft, road and energy used in living quarters) regardless of whether the fuel delivered is for the military of that country or for the military of another country; ii) non-energy use, which covers those fuels that are used as raw materials in the different sectors and are not consumed as a fuel or transformed into another fuel. These items are of difficult measurement and subject to reclassification, thus causing series breaks.

Chart 7

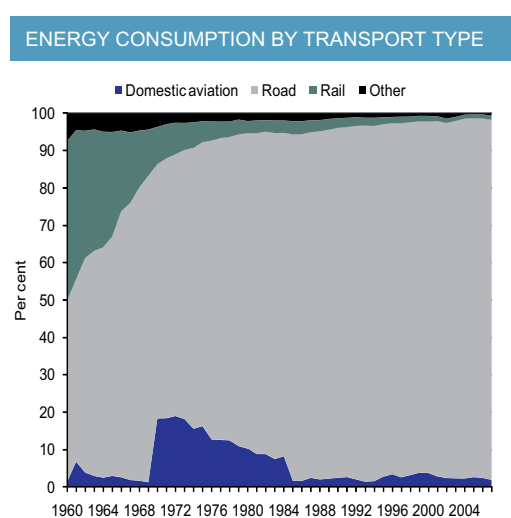


Sources: IEA (International Energy Agency) and author's calculations.

its share in the economy but mostly the fact that its underlying technology is energy-intensive. If this sector's energy consumption is broken down by type of transport further conclusions are drawn. Chart 8 reveals that the share of "road" in total domestic transport energy consumption is overwhelming in Portugal, with a share higher than 95 per cent.⁹ This pattern is similar to that observed in other countries and in the euro area (see ECB (2010), first chapter).

A complementary approach to analyze final energy consumption in Portugal is to describe the energy profile of residential and industry sectors. As regards households, it is important to note that the item "other", basically comprising "combustible renewables and waste", is dominant. As mentioned

Chart 8



Sources: IEA (International Energy Agency) and author's calculations.

(9) If "total aviation" is included in the transport sector (instead of just "domestic aviation"), the share of "road" drops to around 85 per cent.

above, this item is important in the structure of the domestic primary energy production, but this high share also reflects the existence of statistical problems as data under this heading are often based on incomplete information. Electricity plays an important role in the energy basket of households (35.5 per cent in the period 2004-2007). This item has been gaining importance in the last years, contrary to what is observed for oil products, whose share is presently slightly higher than 20 per cent. The consumption of gas is still small but it increased significantly in the last decade (see top panel of Table 1). This structure shows important differences relatively to the (non-weighted) average of the EU15. The share of electricity in the households' energy consumption bundle is lower in the EU15 (24.6 per cent in the period 2004-2007), while that of oil is relatively close. The largest difference concerns the share of gas, which is the largest household energy consumption item in many EU15 countries. In addition, the consumption of heat is non-negligible in the EU15 as it is in Portugal.¹⁰

In what concerns the energy profile of the industry sector, the lower panel of Table 1 reveals that electricity and oil play the leading roles, with shares in Portugal of 26 and 27 per cent in the period 2004-2007, respectively. Nevertheless the share of oil has been decreasing very substantially, having reached 41 per cent in the period 1992-1998. This has been compensated by the increase in the share of gas in industry energy consumption, which increased from a share of 0.7 per cent in 1992-98 to 16.9 per cent in 2004-07. Comparatively to the EU15 average, despite the recent developments, the Portuguese industrial energy consumption bundle has still a high share of oil and relatively lower shares of electricity and, mostly gas. As in the residential sector, the share of the item "other" is comparatively high in Portugal.

Table 1

PATTERNS OF CONSUMPTION OF RESIDENCIAL AND INDUSTRY SECTORS IN PORTUGAL AND THE EU15

Consumption profile of residential	Portugal			EU15		
	1992-98	1999-03	2004-07	1992-98	1999-03	2004-07
Electricity	26.1	31.5	35.5	21.3	22.7	24.6
Oil	27.1	24.2	21.3	25.6	22.9	19.8
Gas	1.8	4.1	6.3	35.5	39.6	42.9
Solid fuels	0.0	0.0	0.0	3.6	1.6	1.0
Heat	0.0	0.2	0.2	5.2	4.4	2.5
Other	45.0	40.0	36.7	8.8	8.8	9.3
Total	100	100	100	100	100	100
Consumption profile of industry	1992-98	1999-03	2004-07	1992-98	1999-03	2004-07
	1992-98	1999-03	2004-07	1992-98	1999-03	2004-07
Electricity	22.8	22.6	26.1	30.1	31.7	33.1
Oil	41.3	37.4	27.0	19.2	17.0	15.8
Gas	0.7	12.3	16.9	30.8	34.1	31.6
Solid fuels	10.4	4.3	1.3	13.1	9.0	8.3
Heat	0.9	2.5	5.2	1.3	2.6	5.1
Other	23.8	21.0	23.5	5.6	5.7	6.1
Total	100	100	100	100	100	100

Sources: IEA (International Energy Agency) and author's calculations.

Note: EU15 - Average non-weighted.

(10) Heat production includes all heat produced by main activity producer combined heat and power (CHP) and heat plants, as well as heat sold by autoproducer CHP and heat plants to third parties.

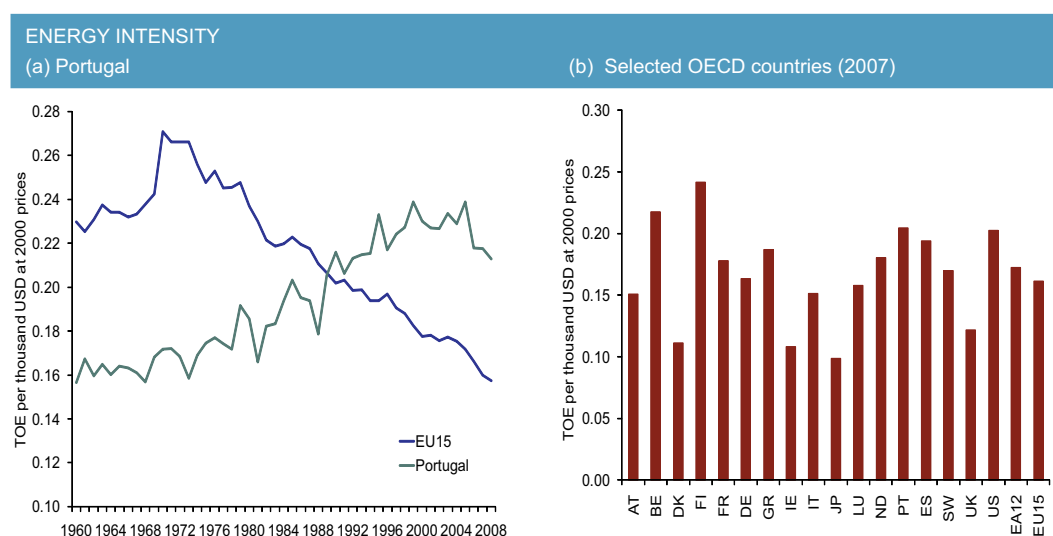
4. ENERGY INTENSITY

The ratio between energy consumption in an economy and its GDP level - the energy intensity - is a typical variable when energy stylized facts are analyzed. The economic literature refers that the path of energy intensity depends on a complex interaction between structural factors and cyclical developments. The list of factors affecting energy intensity over time is long and includes variables like the per capita GDP level, sectoral specialization of the economy, production technologies, average age of the capital stock, transportation patterns, climatic conditions and overall energy efficiency. Chima (2007) presents a list of references for the literature on the determinants of energy intensity and gives emphasis to the inverse U-shape relation between per capita GDP level and energy intensity. Less developed economies, with a high share of low-energy intensive activities and poor living conditions tend to show low energy intensity. The same reasoning explains that economies in catching up tend to show rising energy intensities and those more advanced, which make use of efficient production processes and energy saving technologies, may record declining energy intensities. Although many variables affect energy intensity, this indicator is often used as a proxy for energy efficiency, especially among similar countries.

Panel a) of Chart 9 plots the path of energy intensity in Portugal and in the EU15 from 1960 to 2008, measured in terms of toe per thousand USD 2000. Energy intensity in Portugal has recorded an ascending trend until the nineties, followed by a period of relative stabilization and then a decline in the latest years of the sample. The energy intensity in the EU15 showed a steady and significant declining trend since the mid-seventies. When compared with other advanced economies in the period 2006-08 (panel b) of Chart 9), Portugal shows a high energy intensity, equal to that of the USA but lower than that of Finland and Belgium.

An alternative way to look at energy intensity bases on the coefficients of the inverse Leontief matrix.

Chart 9



Sources: IEA (International Energy Agency) and author's calculations.

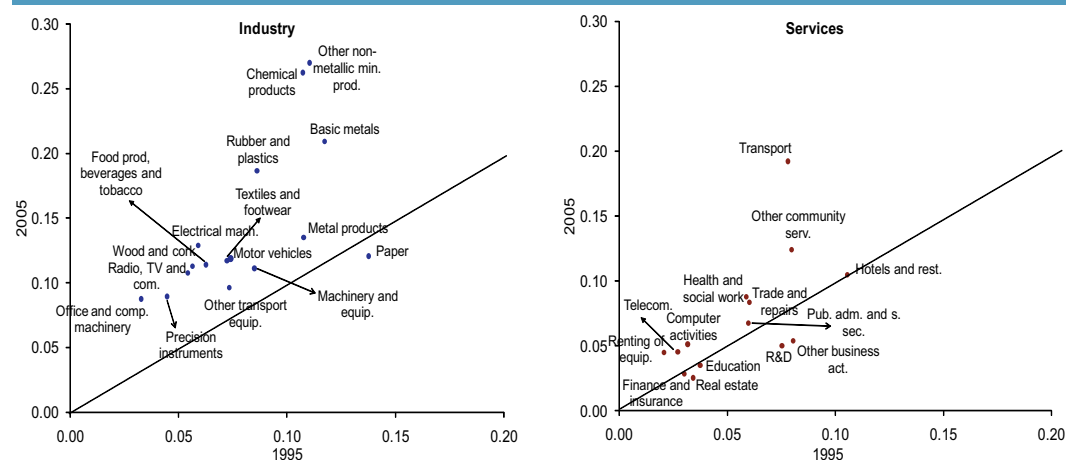
These coefficients provide information on the backward linkages of each sector, i.e., the response of the production in each sector to a unitary increase in demand of each of the other sectors, all of them in nominal terms. Chart 10 reports such responses from the part of final energy producing sectors, considered as “coke, refined petroleum products and nuclear fuel” and “electricity, gas and water supply”. Although this measure can be interpreted as a proxy for the energy intensity of the different sectors, it faces some drawbacks. Notably, it is a nominal measure, thus it is clearly affected by energy price developments. Chart 10 reveals that the response of the energy sector in Portugal to higher demand in most sectors increased from 1995 to 2005, which is a result strongly affected by energy price increases in this period. In particular, sectors like “chemicals and chemical products”, “rubber and plastics products”, “other non-metallic mineral products” and “transport and storage” have recorded significant increases in energy intensity. In addition, Chart 10 shows that, with the exception of “transport and storage”, the energy intensity in services sectors is typically lower than that observed in manufacturing industries.

Nevertheless, if these coefficients are compared across countries for the same year (i.e., taking the same international energy prices) they reveal the differences in the response of energy sectors to higher demand in the other sectors of the economy. Therefore, it is possible to perform a cross-country comparison of energy efficiency, which is a competitiveness factor in international markets, as energy is usually an important component of firm’s costs. Chart 11 reports the differences between the coefficients of the energy sector in the inverse Leontief matrix of Portugal relatively to those of, respectively, Germany, Spain and France in 2005. The coefficients in the Portuguese industries are typically higher than those of the other countries considered, though close to those observed in Spain. This also means that lower energy efficiency is broad based in terms of sectors.

The consumption of electricity per head is another stylized indicator, though with an interpretation that is more limited than energy intensity because, as previously mentioned, electricity presently repre-

Chart 10

EFFECT OF A NOMINAL UNIT INCREASE IN DEMAND OF THE DIFFERENT SECTORS ON THE NOMINAL PRODUCTION OF ENERGY SECTORS IN PORTUGAL

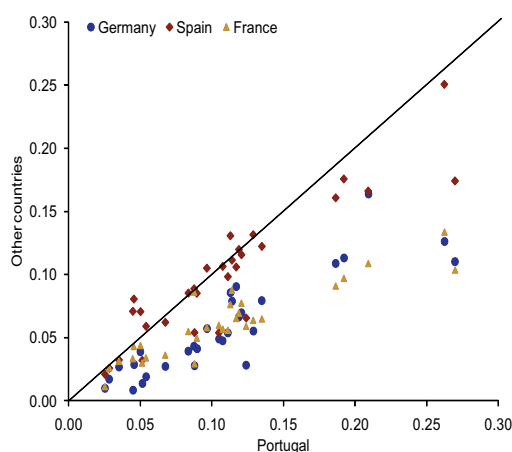


Source: OECD (STAN - ISIC Rev. 3).

Note: The calculations are based on the coefficients of the inverse Leontief matrix. These are nominal measures and thus affected by energy price developments.

Chart 11

EFFECT OF A NOMINAL UNIT INCREASE IN DEMAND OF THE DIFFERENT SECTORS ON THE NOMINAL PRODUCTION OF ENERGY SECTORS
Differences between Portugal and Germany, Spain and France



Source: OECD (STAN - ISIC Rev. 3).

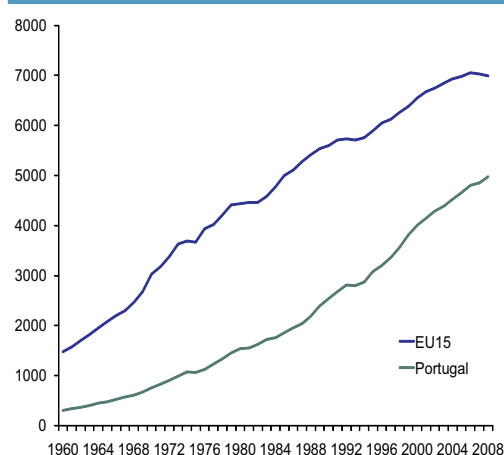
Note: The calculations are based on the coefficients of the inverse Leontief matrix. Final energy producing sectors (considered as "coke, refined petroleum products and nuclear fuel" and "electricity, gas and water supply") are not represented.

sents only about one fifth of total final energy consumption. Chart 12 shows the path of this indicator for Portugal and compares with a set of advanced economies. Electricity consumption per head has increased steadily in Portugal and in the EU15 since the sixties. At present, such consumption in Portugal is about 30 per cent lower than in the EU15. When compared with other countries separately, Portugal records low electricity consumption per head.¹¹

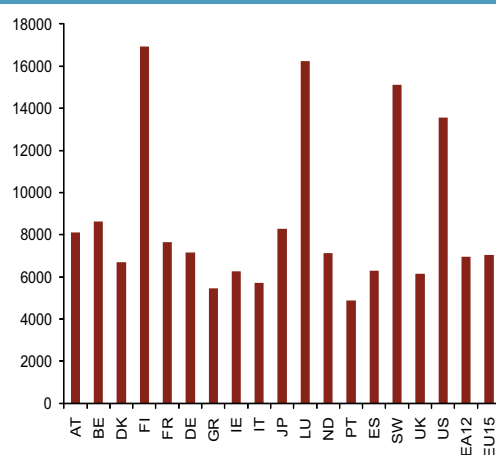
Chart 12

ELECTRICITY CONSUMPTION PER CAPITA (KWH PER CAPITA)

(a) Portugal



(b) Selected OECD countries (2007)



Sources: IEA (International Energy Agency) and author's calculations.

(11) The high values of electricity consumption per head observed for some countries may have specific explanations. For example the climatic conditions should play a significant role in the cases of Finland and Sweden and the significant number of commuters that work and consume electricity in Luxembourg but are not residents, affect the level of the indicator.

5. CONCLUDING REMARKS

This article presents a set of stylized facts regarding energy production and consumption in Portugal, taking a long term perspective and comparing with a set of advanced economies. The links between energy related issues, competition in the respective markets, consumer prices and the current account are not discussed.

Portugal is a country characterized by a small primary energy production, deriving from non-existent fossil energy resources and no nuclear energy production. Primary energy production is entirely associated with renewable energies. This structural situation naturally leads to a high level of energy dependence, which is a feature also shown by other EU15 economies. Nevertheless, such high energy dependence does not pose immediate concerns about energy security as there is evidence on the diversification of foreign energy suppliers. In what concerns energy consumption patterns, the general picture is not much different from that observed in other European countries, with industry and transport representing the bulk of total energy consumption. The largest difference regarding the energy consumption bundles of the residential and industry sectors is the still small role played by gas.

Energy intensity in Portugal has recorded an ascending trend until the nineties, followed by a period of relative stabilization and then a decline in the latest years of the sample. Over the same period, the energy intensity in the EU15 showed a steady and significant declining trend. The comparison with other countries reveals that Portugal records a relatively high energy intensity, which is broad based in terms of sectors. Such underlying structural conditions, together with international high and volatile energy prices, will continue to stand as determinants of the potential growth of the Portuguese economy in the future.

REFERENCES

- Blanchard, O. and Gali, J. (2008), "The macroeconomic effects of oil prices: Why are the 2000's so different from the 1970's?", *Working Paper* 13368, NBER.
- Bohi, D. and Toman, M. (1996), *The economics of energy security*, Kluwer Academic Publishers.
- Chima, C. (2007), "Intensity of energy use in the usa: 1949-2003", *Journal of Business and Economics Research* 5(11), 17–30.
- EC (2009), "Report on progress in creating the internal gas and electricity market", *Communication from the European Commission* (11.3.200, COM(2009).
- ECB (2010), "Energy markets and the macro-economy", *Occasional Paper Series* 113, Task Force of the Monetary Policy Committee of the European System of Central Banks, European Central Bank.
- Esteves, P. and Neves, P. (2004), "Oil prices and the economy", Banco de Portugal, *Economic Bulletin* - December.
- Hamilton, J. D. (2009), "Causes and consequences of the oil shock of 2007-08", *Working Paper* 15002, NBER.
- IEA (2009), "Energy Policies of IEA countries - Portugal" *2009 Review*, OECD/IEA.
- Kilian, L. (2009), "Not all oil price shocks are alike: disentangling demand and supply shocks in the crude oil market", *American Economic Review* 99(3), 1053–1069.
- Tol, R. (2008), "The economic effects of climate change", *Journal of Economic Perspectives* 23, 29–51.