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Energy transition in the periphery

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Sofia Teives Henriques, *Energy transitions, economic growth and structural change: Portugal in a long-run comparative perspective*, Lund Studies in Economic History 54 (Lund: Lunds universitet 2011). 339 p.

Overview

Energy has been crucial to economic activity and to human welfare for millennia. In recent centuries this link has apparently become more critical than ever. The consumption of energy has accelerated, the bundle of energy types employed has changed remarkably, and the threat to global sustainability looms ever large.

This thesis by Sofia Teives Henriques focuses on a small instance of this enormous problematic, but an interesting and important one nevertheless. Taking Portugal as a case study, it deals with two major issues in Energy History. One is the role played by this resource in the long run growth of a poor economy which faced an important constraint in its energy supply. Attention is concentrated here especially on the energy transitions undergone and the evolution of energy intensity experienced in the course of this economy's development. The environmental consequences of this process constitute the second issue. They raise the question of whether sustainability can be ensured merely by the working of market forces, or, as appears to be the consensual view, requires active institutional intervention and coordination at different levels, including the supra national, in order to be achieved.

The thesis reaches two important findings. Portugal has faced perennial energy problems which stem from a severely inadequate endowment in this respect. As a consequence, for at least the first century of its modern economic growth, cheap and abundant energy was a major brake on its long-run economic development. It also shaped a persistent path of low-energy industrialization from which the country has departed only in the last few decades.

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A second major finding is that Portugal made its energy transition, from organic to fossil fuels, slowly and very late. It was only towards the end of its post war Golden Years, with the arrival of cheap oil, that it was finally freed from these shackles. The result was a rapid convergence to advanced levels of energy consumption and intensity, just when more developed countries were beginning to turn in the opposite direction and the world was waking up to the urgent need to curb that trend. Of particular importance in this context was the fact that by now it was the European Union which was going to shape Portuguese energy policies and try and align them with these preoccupations.

Chapter 1: introduction

This chapter lays out the three blocks of the background needed to make sense of the arguments which constitute the present thesis.

The first has to do with the vigorous controversy surrounding the importance of cheap energy to the onset of the Industrial Revolution in Britain and its spread to other advanced countries during the 19th century. For some authors, it was critical, for others, its role was dwarfed by more important determinants such as high wages or institutional and cultural factors which stimulated creativeness. A smaller and more specialized parallel debate exists concerning late and slow developers. It focuses on whether the latter were hampered in their progress by the lack of fossil fuels, at least up until the early 20th century. Portugal's considerable dependence on imports of mineral energy has thus to be borne in mind when trying to explain the late arrival of industrialization to its shores.

To study the history of energy in the context of economic growth we need also to know that the relation between output and the energy consumed to produce it is not time-invariant. To measure this, the ratio between the two variables is used. It is called the *Energy Intensity of Production* and is of fundamental importance in this thesis. Generally speaking, when an economy begins to develop, it tends to rise first, peak and then decline, in an inverted U-shaped curve, but not necessarily in every case. This depends on three factors: a) the structure of the economy, which may include larger or smaller high energy-consuming sectors; b) the efficiency of the technology used to produce and consume energy, which changes over time along with technology in general; and c) the type of energy carriers locally available and the stock of technology specifically for using it. Interestingly, the level of energy intensity peaks exhibits a declining time trend – Portugal's therefore peaked around 1910 at a lower level of intensity than Britain's did around 1870.

The third block provides the setting for the analysis of the environmental impact of energy use in Portugal. Energy production has always been excep-

tional in that its by-products are mostly airborne, very noxious in various ways and also very abundant. This flow, in the form mostly of CO₂ emissions, is a function of energy intensity, economic activity and the energy basket. It has come to represent a global climatic threat and to this extent, knowledge of individual country emissions is the starting point for the solution to this problem.

Chapter 2: energy quantities

This chapter provides the empirical backbone to the thesis. It represents the state of the art on Portugal and offers a detailed quantitative view of the evolution over 150 years of the Portuguese energy sector, both in terms of mix and of level of use. It enables us to grasp the speed at which Portugal changed from an organic to a non-organic economy and the smoothness of this transition.

This exercise consists of quantifying all relevant sources of energy consumed during this period – food, fodder, firewood, wind, water, fossil fuels and primary electricity – as well as their breakdown into sub categories such as renewable and non-renewable, and sums up their respective values to obtain an index of aggregate energy consumption in 1856–2006. A considerable number of assumptions have had to be made, since the knowledge gap is large and many of the sources are problematic. This is especially true for the period before 1950 and for the traditional energy carriers.

The effort required has been enormous. A great variety of sources has been drawn on for this purpose and some of them, although published, have never been used by historians before. They have been employed meticulously and imaginatively. The author has to be complimented for this thoroughly original piece of work and the valuable contribution to the international energy data collection effort that this chapter represents. There are probably many errors and omissions, although every reasonable effort has been made to avoid them. I would say that ultimately it is as good an estimate of overall and sectoral energy consumption as we shall ever possess.

Certain premises had to be specified and they seem on the whole plausible. Some of them are standard in this field and their choice was aimed at ensuring international comparability with other indices: a) only the energy obtained directly by human effort is counted – sunlight therefore is excluded; b) likewise, only primary energy is included – for example, firewood is used but not charcoal, which is produced from firewood; c) food and animal fodder were made part of the calculation. The justification is that they are used to produce muscular energy, an essential input to most activities, in particular during the early period of this account, when agriculture predominated and mechanization was still rare.

*Chapter 3: Long-run energy transitions and CO₂ emissions:
Portugal in comparative perspective*

Chapter 3 takes us into the heart of the thesis by examining Portugal's long term energy transition from organic to modern energy carriers. It does this in a comparative framework constituted by nine countries with different individual histories of development and of energy transition. The program for this chapter has four stages.

The first one specifies the principal factors of energy transition in the world, namely, population and its density, energy intensity, climate, level of development or of GDP per capita and natural resource endowment. A second stage establishes whether, on the basis of the information regarding these countries, there is something like a set of generalizations in which to place the Portuguese case. A third evaluates the speed at which this process occurred in Portugal and its determinants. The fourth shifts to the environmental consequences associated with the long term evolution of energy consumption and pursues the comparative analysis of the Portuguese experience in these terms also.

This chapter makes two important points. The first is that it does not make sense to discuss energy consumption and its impact on the environment in the long term without taking all forms of energy into consideration. This is contrary to much work which has been done already. The second is that there is a considerable dispersion in countries' energy histories around a number of common characteristics concerning what one might call a "mean" of energy transition. In other words the fit is reasonable for our nine countries and probably others as well, but the problem is very complex and the presence of heterogeneity is strongly felt.

The case of Portugal corresponds well to this last statement. It experienced significant shifts in quantities and types of energy carriers but its transition was late and slow, even compared to other economic laggards in Europe, such as Spain and Italy. In 1938, 70 per cent of total primary energy came from biomass, at a time when for developed countries the figure was below 30 per cent (p. 98). Much of this had to do with climate, relatively low levels of economic growth and of GDP per capita, an unfavourable resource endowment, and low energy intensity, as a result of a weak degree of technological development.

For a long time, just as it was a low consumer of energy, it was also a low emitter of CO₂, even when industrialization accelerated after 1950. This low energy path was abandoned, however, after 1973 and the country, somewhat paradoxically, began to converge rapidly to the levels of pollution of advanced economies.

Chapter 4: energy, natural resources and industrialization

This chapter focuses on the problem of the costs of the different kinds of energy available to Portugal – in particular its industry – as it went through the various stages of its economic development from the mid 19th century to the present time. The aim is to evaluate, at each of these stages, the penalty which this economy suffered as a result of two factors. One was the country's weak resource endowment, from the energy point of view. The other was the high needs for modern forms of energy imposed by the only industrial technologies which were successively available to Portugal at each historical moment – steam, electricity, oil and recently introduced renewables.

The chapter's program involves, to start with, a considerable and complex effort to gather information on cost conditions in different countries. It then uses them in the correct way so as to be able to determine how penalising it would have been, for example, to rely heavily on imported coal before the 20th century; or to harness Portugal's quite abundant but difficult sources of hydro power to the production of electricity as a replacement for coal.

As regards the manifestations in Portugal of the so-called First Industrial Revolution, the main finding is that the energy situation did not favour this country. It ended up failing to converge with the leaders and was forced by its endowment and the high cost of imported coal to specialize in a light and less advantageous industrialization. The advent of an electricity-based Second Industrial Revolution still did not confer a particular advantage on Portugal although its endowment in this respect was much better than in the case of coal. Electrification came late, had to depend on the impulse of the state, was probably poorly handled and soon ran into a supply constraint. The bottleneck was released by the coming of oil, however, so that Portugal was able to enjoy economic Golden Years between World War II and the 1970s and converge in GDP per capita to the richer nations. This better and cheaper energy mix nevertheless brought its problems too. While Portuguese industrial growth did not manage to shift the country away from its traditional low capital intensity pattern, it certainly converged to the higher levels of energy intensity and CO₂ emission of the rich countries, at a time when energy policy was moving into the EU sphere. This meant having to restrain energy consumption and possibly became part of the brake on economic growth which the country has been seriously experiencing for the last 15 years.

Chapter 5: energy intensity and the service transition

In this chapter the thesis takes a somewhat different direction from that followed in the preceding chapters. It broadens out from Portugal to encompass both OECD countries and Brazil and India. It turns its attention emphati-

cally towards the energy consequences of economic growth and structural change, and, in particular, it analyses the possibility of decoupling energy intensity from economic growth. It also reveals a preoccupation with policy prescription which was absent from chapters one to four.

The aim of this chapter is to find out if there is a justified hope that in future the threat posed by world economic expansion may not lead to global warming and escalating energy costs, as has been happening. The observation which encourages this expectation is that a shift has been recently occurring towards the service sector, which is characterised by a low intensity of production. This service transition should thus raise world GDP while reducing CO₂ emissions.

The program for this chapter is to mobilize data from several statistical bases and process the information they provide for energy consumption, value added, intensity, sector shares and so on as regards 13 countries. The methodology (LMDI) employed allows the decomposition of changes in energy intensity in response to structural factors and to intensity factors. In other words, it considers what was the effect of changes in sectoral distribution with intensity constant; and changing intensities keeping the structure of the economy constant.

The results of the analysis undertaken are rather discouraging. The evidence is first of all that in *real terms* services are growing at the expense of the primary, secondary and transport sectors, but much less so than in nominal ones. Moreover, a considerable share of service production consists of inputs for manufacturing and therefore stimulates additional energy consumption. In addition, the world economy is using transport both of people and goods increasingly, both as part of production and as final consumption. The balance of these effects is therefore that the much heralded service transition may not be bringing much relief to current environmental problems unless policies are devised to cut down on the energy intensity of all sectors. On the other hand, there has been a decline in intensity in both the developed countries and the emerging ones, with a remarkable degree of convergence between them. The exception is Portugal, where intensity increased by 35 per cent between 1971 and 2006, despite a very large service transition.

Conclusion

This study covers a large amount of ground and touches on a vast array of problems. Nevertheless, its findings can be grouped into two principal areas.

One of its main concerns is to provide an entirely new case study which tracks the long-run energy transitions in a low income and poorly endowed country on the periphery of Europe, from organic to fossil fuels and their associated CO₂ emissions. As a result of its problematic endowment in sources

of energy, Portugal was constantly delayed in acceding to coal usage and then to electricity. It adopted a low energy-intensive pattern of development and it became a late and slow industrialising nation. A large amount of data and meticulous calculations are used here to show that it was chronically disadvantaged by having to depend so much and until so late on biomass, an inelastic source resource with a price which significantly and damagingly exceeded that of imported coal. As a result, we are told, "energy costs played an important role in constraining industrial growth" (p. 249) until after World War II. They also kept Portugal firmly on a path of low energy industrialization which is still patent today. After a second "missed chance" with electricity, from the 1920s to the 1970s, caused in part by the poor quality and quantity of its hydro resources, Portugal was finally liberated from the consequences of its poor endowment. Thanks to cheap, abundant and adaptable oil, its energy consumption and intensity rapidly increased. It then began to converge to the more advanced economies in both respects, and went on doing so after they had started doing the opposite after the 1970s.

These findings represent a major contribution to Portuguese economic historiography and, with the assertion "that cheap energy was a necessary pre-condition for industrialization" (p. 254), a clear departure from mainstream views. They offer a refreshingly different perspective on the history of Portuguese industry, which is normally dominated by narratives based on tariffs, inadequate natural resources, human capital scarcity, deficient institutions, weak capital markets and so on. And they are sustained by means of an impressive empirical apparatus.

The second main thrust of this study pertains to the last few decades since the 1970s and the culmination of the transition to oil. Not surprisingly, Portugal raised its energy intensity dramatically – in itself perhaps not a problem, despite world resource scarcity, because it has such a small share of demand. The problem is that this was the period in which it also developed a vocation as a rising producer of CO₂ emissions, in sharp contrast to the trend followed by all the countries in the sample that we are following here and when this was becoming a serious international issue. Hypothetically, there was a non-political solution for this, in other words one driven essentially by market forces, rather than policy ones. This was the "service transition" which Portugal followed rapidly without, however, the positive consequences for CO₂ intensity and energy consumption which might have been expected. The thesis dissects the causality that brought about this unfortunate evolution and makes interesting suggestions regarding other, possibly better outcomes.