DIVERSIFICATION PATHS AND ENERGY TRANSITIONS IN EUROPE IN THE LONG-TERM

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Overview

The energy mix is crucial to determine important aspects of energy economics such as the energy efficiency, energy intensity or the carbon intensity of a country. The changes in the composition of the energy mix in the long run lead to energy transitions. Primary energy substitution models allow addressing these phenomena. However, the diversification paths of the energy mix of different countries in a long term compared perspective have not been studied in a synthetic form yet. We ignore when (or whether) the energy mixes become more diversified, whether the levels of diversification of the energy mix have converged overtime, whether all countries followed similar paths, and whether diversification of the energy mix took place at the same time everywhere.

There exists a general intuition about the energy mixes becoming more diversified in recent times. This tends to ignore the different traditional forms of energy available in the past (draft power, wind, water, firewood), which allowed a variety of energy mixes with large diversification of sources in previous centuries. The interaction between energy mix and successive energy transitions also requires further investigation.

In addition to addressing these issues in this paper, the approach of our research to the evolution of the diversification of energy mix over the long term may be also useful for shedding light into some other crucial questions such as whether it was easier to alter the energy mix in the past or in recent times. Last but not least, shall a country always prefer energy mix diversification to concentration?

Methods

This paper proposes an indicator, based on the Herfindahl-Hirschman Index, the Energy Mix Concentration Index (EMCI), to quantify the degree of diversification of the primary energy mix of eight European countries (i.e. Germany, France, England and Wales, Netherlands, Italy, Portugal, Spain and Sweden) over the last two centuries. The energy data for these eight countries consider the full set of energies –traditional and modern– and refers to primary energy supply. Widening the scope beyond commercial energy sources has proven to make important differences interpreting long term trends on most aspects of the relationships between the economy, the environment and the energy consumption.

Results

The results reveal that larger energy consumers (being also the early comers to the industrial revolutions) required a huge concentration of their energy mixes in the 19th century, however, the observed countries had converged to similar levels of diversification of their energy sources from the second half of the 20th century, and more crucially after the oil crises. None of the smaller energy consumers (latecomers to the industrial revolutions) reaches high concentration indices along the full period. On the contrary, they show medium and low concentration of their energy mixes, and particularly low in the Mediterranean countries until the sixties and now again in recent times. For some countries, today's degree of diversification is the largest in their energy histories, but it is not the case for all of them (like the Netherlands, Spain, Portugal and Italy).

Furthermore, our results show very different diversification paths of the energy baskets of European early comers versus latecomers. The early comers achieved the maximum level of concentration during their coal era somewhere on the first half of the 20th century. The latecomers reached the maximum concentration of their energy baskets in the early days of the oil dominance, right about the oil crisis of 1973. These two maximums are not only distant in time and predominant fuel, but also differ in their magnitude. Early comers maximum EMCI almost doubles the maximum EMCI of latecomers.

Conclusions

Our results confirm the general intuition that countries had converged to similar levels of diversification of their energy mixes only from the second half of the 20th century and more crucially after the oil crises of the 1970s. However, the process of reducing the energy mix concentration has been much more intense in the early comers (the larger energy consumers).

Our results suggest that size matters at the time of altering the level of concentration of the energy mix –it was more difficult for large consumers than for small consumers to achieve diversification. Therefore the small energy consuming countries would be able to achieve higher diversification, and therefore to do a faster transition to a low carbon economy, than the large energy consumers.

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