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A spatial shift-share decomposition of electricity consumption changes across Italian regions

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ABSTRACT

This paper explores the changes in regional electricity consumption at the NUTS 3 level in Italy over the period 2000–2013. The analysis of regional electricity consumption changes is carried out by introducing a spatial shift-share decomposition measuring the neighbourhood effect on regional energy efficiency change. Our findings show that a shift toward less electricity-intensive activity sectors has occurred in almost all regions, reducing regional electricity consumption. A fall in economic activity has contributed to reducing electricity consumption in many regions, especially in Southern Italy. Notwithstanding the negative contributions of changes in industry-mix and economic activity, electricity consumption has increased in most regions due to the increase in electricity intensity. The increase in electricity intensity in Southern and North-Eastern regions has been enhanced by a neighbourhood disadvantage in energy efficiency. Electricity intensity has decreased in most NUTS 3 regions in Sardinia, an Italian region at the NUTS 2 level, due to both regional and neighbourhood advantages in energy efficiency.

1. Introduction

Reducing energy consumption is a primary target for all EU member states to guarantee sustainable economic development and secure energy supply (The Council of the European Union, 2007). The EU energy strategy has been projected and implemented in recent times through different European regulations which are globally known as the 2020 Climate and Energy Package. The EU energy action plan indicates three main targets to achieve by 2020: a 20% cut in greenhouse gas emissions from 1990 levels, a 20% share of renewable energy in energy consumption, a 20% improvement in energy efficiency. The so-called “20-20-20” goals have been updated recently through the 2030 Energy Strategy that contains new and more ambitious targets to achieve within 2030: the reduction of greenhouse gas emissions from 1990 levels has been increased to 40%, while the shares of renewables and the energy efficiency improvement have been raised to 27%. These objectives are particularly important for Italy which heavily depends on energy imports (Vaona, 2013).[1] As summarized in the very recent draft of the 2017 National Energy Strategy (Italian Ministry of Economic Development and Ministry of Environment, 2017) Italy has reached a very high penetration (17%) of renewables by 2015, so that the target of 27% required by the EU 2030 Energy Strategy does not seem impossible to address. However, the 27% target will be pursued differently in the electricity industry (48–50%, compared to the 2015 level of 33.5%), in the heating sector (28–30%, compared to the 2015 level of 19.2%) and in the transport sector (17–19%, compared to the 2015 level of 6.4%). Since Italy is a net importer of electricity and imported fossil fuels are partially used for electricity production,[2] meeting the electricity demand is rather costly. In particular the cost of importing electricity from neighbouring countries has been affected by the recent energy policies implemented by France through the reduction of the nuclear generation and by Germany as a consequence of the reduction of coal generation (Italian Ministry of Economic Development and Ministry of Environment, 2017). Moreover, medium and long-term forecasts for electricity demand in Italy show a growing trend, partly driven by the gradual electrification of demand, i.e. increased electricity applications in industry, for heating and for transport (Terna, 2014). These issues have led Italian energy policy-makers to analyse changes in electricity consumption, given the increasing share of electricity consumption in final energy consumption and the need to reach EU energy saving targets. Within this framework, separating the different components of electricity consumption changes is crucial for an

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[1] Imported fossil fuels (solid fuels, natural gas and oil) covered 84.6% of primary energy consumption in Italy in 2015, the most recent year for which data are available (Italian Ministry of Economic Development, 2017a).

[2] In 2015, 33.7% of imported natural gas and 81.1% of imported solid fuels were used for electricity production (Italian Ministry of Economic Development, 2017a).

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explanation of the roles of output changes, structural changes in the economy and energy efficiency improvements. This analysis can be carried out by applying one of the decomposition techniques that split energy consumption change in a country into its components, the most popular of which is the index decomposition analysis (Ang, 2004; Mulder and de Groot, 2013). However, an analysis at the national level does not show regional disparities in electricity consumption changes due to imbalances in economic activity and energy efficiency between regions. The focus of the paper on regional electricity consumption changes could shed light on previously unexplored aspects of energy consumption in Italy that are of interest to policy-makers for two main reasons. First, the Energy Union strategy (The European Commission, 2015) indicates the need for regional and local levels to be more extensively involved in achieving the EU energy targets for curbing energy consumption. Both the Cohesion Fund and the European Regional Development Fund allocate resources for investments in energy efficiency, smart energy distribution and innovative low-carbon technologies.[3] Therefore, examining energy consumption at the sub-national level has become a crucial task to implement optimum energy policies for EU member states. Second, the analysis of electricity consumption changes at the regional level in Italy is carried out by considering that the spatial interaction between regions can have an impact on energy efficiency change at the regional level, as the spread of energy efficiency technologies and the implementation of best practices for energy conservation can be facilitated between neighbouring regions.

In the 1997–2010 period, Italian NUTS 2 regions have enacted a Regional Plan for Energy and Environment (Piano Energetico-Ambientale Regionale, PEAR). The main goal of PEAR is to plan and coordinate the local energy supply and consumption according to the international agreements made by Italy to reduce greenhouse gas emissions and to ensure a sustainable development. As the PEARs are realized by means of local regulations and laws which are binding at local level, two effects should be expected: a spatial correlation in energy consumptions within a region (in particular between NUTS 3 regions belonging to the same NUTS 2 region) and differences in energy consumption across regions. For these reasons the analysis of energy consumption is more informative if conducted at the sub-national level. A decomposition technique able to reveal the neighbourhood effects on regional electricity consumption changes would be useful to understand the dynamics of regional electricity consumption taking spatial correlation effects into account. The spatial decomposition is obtained by developing the shift-share formula for the analysis of energy consumption suggested by Polenske and Lin (1993). The basic idea of shift-share analysis is to achieve an accounting identity in which the change over time of a variable is broken down into its components, as in the case of index decomposition analysis. An appealing feature of shift-share analysis is that its formulation can be extended to detect the spatial structure of the change in energy consumption. The contribution of this paper is therefore two-fold: (i) it introduces a shift-share decomposition of regional energy consumption changes which takes neighbourhood effects into account; (ii) this decomposition technique is used to explore the differences in regional electricity consumption changes in Italy, separating the components of electricity consumption changes and providing new insights for regional energy planning.

The traditional form of shift-share analysis was introduced by Dunn (1960) and then developed in alternative versions (Esteban, 2000; Nazara and Hewings, 2004). It is a popular tool for analysing regional dynamics in employment and labour productivity (Ezcurra et al., 2007); however, its use in energy field has been less common. Polenske and Lin (1993) re-formulated shift-share decomposition to break down the energy consumption of a region into the contributions of three components: one due to regional output, a second component attributable to the industry composition of the regional economy and a third component related to energy efficiency in the region. We extend the Polenske and Lin decomposition to explain the link between the change in the energy consumption of a region and the spatial structure underlying the change in energy efficiency. To develop this spatial shift-share decomposition of regional energy consumption change, we adopt the spatial shift-share approach recently suggested by Espa et al. (2014). Espa et al. (2014) broke down the regional business change at the plant level in Italy by introducing a shift-share analysis explaining the spatial structure of regional business change. More specifically, their spatial shift-share analysis explains whether the competitive effect of a given region is mainly due to the performance of the region or to those of neighbouring regions. Following the approach outlined by Espa et al. (2014), our shift-share decomposition of regional energy consumption change reveals the regional advantage (or disadvantage) in energy efficiency excluding the influence of neighbourhood performance in terms of energy efficiency. We obtain a five-term decomposition of the change in regional energy consumption, where the first and second components explain the energy consumption changes due to output change and industry-mix change, respectively. The other three components separate the effect of the change in regional energy efficiency into the national energy efficiency effect, the neighbourhood energy efficiency effect and the regional energy efficiency effect.

The spatial shift-share decomposition is applied to examine changes in regional electricity consumption at the NUTS 3 level in Italy from 2000 to 2013. Based on that analysis, the regional advantage (or disadvantage) in energy efficiency and the impact of energy efficiency performances in neighbouring regions on regional electricity consumption are detected, so that policy-makers can have useful information to draw region-specific energy action plans. The results of the decomposition show that the industry-mix component tends to reduce electricity consumption in almost all regions, due to a shift of the regional economies toward less electricity-intensive activity sectors. A decrease in economic activity contributes to reducing electricity consumption in many regions, especially in Southern Italy. The national efficiency change component indicates a decrease in efficient electricity consumption at the national level. A neighbourhood disadvantage in energy efficiency reinforces the increase in electricity intensity in Southern and North-Eastern regions. Few regions have a regional advantage in energy efficiency.

The article is organized as follows. Section 2 briefly reviews the Polenske and Lin shift-share decomposition of energy consumption. Section 3 introduces the spatial shift-share decomposition of energy consumption change. Section 4 presents the data and discusses the results. Conclusions and policy implications are presented in Section 5.

2. Some background notes

Polenske and Lin (1993) introduced a shift-share decomposition to break down the energy consumption of a country (or region) into three components: one measuring economic activity, and two other components due to changes in industry-mix and energy efficiency respectively. Since our analysis is conducted at the regional level, the Polenske and Lin decomposition is applied to regional energy consumption. Let us consider k regions, m sectors of economic activity, and two points in time t and $t+1$. Let $E_{r,t+1}$ and $O_{r,t+1}$ be the energy consumption and the output, respectively, in region r in $t+1$. Let $O_{i,r,t+1}$ stand for the output of sector in region r in $t+1$. Let $e_{r,t}$ be the energy intensity in region r in t.[4] Let $e_{i,r,t}$ and $e_{i,r,t+1}$ be the energy intensities of sector in region r in t and $t+1$, respectively. Following the procedure suggested by Polenske

[3] The Cohesion Fund and the European Regional Development Fund are going to invest 38 billion euros to fund the shift toward a low-carbon economy over the 2014–2020 period. In addition, the European Smart Specialization platform on energy was established in 2015 to support regions to facilitate access to EU funding for energy efficiency projects (The European Parliamentary Research Service, 2015).

[4] Energy intensity is the ratio of energy consumption to output, and indicates the amount of energy required to produce a unit of output.