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EXTENDED ABSTRACT

Title:

Regional convergence of GHGs in Spain. Empirical evidence from emissions sectors

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Abstract:

In the last three decades, Spain has undergone a cycle of strong economic expansion, establishing itself as a leader country with regard to its European neighbours. Economic prosperity has been displaced to the Spanish regions, thanks to the transfer system and the autonomy of the political decision-making. To fulfill the international greenhouse gas (GHG) Paris Agreement targets, Spain could have provided a robust response, but has not done so. Despite the implementation of new ecological measures and the development of sustainable activities, such as world

leadership in the renewable energy sector, the country has not sufficiently improved the environmental efficiency of its economic structure. So that Spain today is not on track to meet its current reduction commitments. For this reason, understanding the dynamics of the environmental performance of the Spanish regions is thus essential for policymakers to achieve the international emission targets.

One of the best proxies for efficiency of productive activity from an environmental point of view, as the literature recognizes, is emission intensity, measured as the ratio between GHG emissions and GDP. A decreasing intensity reflects an efficiency gain based on a solid environmental performance. Emission intensity has been increasing in recent decades, and economic growth only seems to be possible as a result of greater boost in GHGs with little or no environmental efficiency. Nevertheless, it is clear, the pattern among countries has not been uniform. The observed differences, as well as an international context more prolific of agreements to cut emissions, have encouraged a number of researchers to analyse the following two aspects. First, whether economic growth at any stage inevitably implies an increase in country's GHG emissions. At this point, the focus of the literature has been the analysis of the relationship between economic development and environmental loss, based mainly on compliance - or not - with the Environmental Kuznets Curve (EKC). This approach postulates increasing emissions intensity, up to a certain level of development from which intensity is continuously going to be reduced (an inverted U-shaped relationship between emissions and income). Nevertheless, the evidence of favour of the EKC concept from original papers to the present, getting mixed results (Kaika and Zervas, 2013). Second, whether emissions converge - or not - among countries. Recent studies indicate that environmental convergence is partially supported by ambiguous results (Pettersson et al., 2014). In this regard, the development of modern techniques by (Phillips and Sul, 2009, 2007) has made it possible to revisit the analysis of convergence. This new econometric approach is a nonlinear factor model with a growth component and a time-variant idiosyncratic component that enables us to identify the relative transitions of heterogeneity that occur, and to measure these transitions against the correlative of a common growth trend. Likewise, this new approach also gives rise to a simple and convenient time series regression test for convergence. The log t convergence test further provides the basis for a stepwise clustering algorithm that is

proposed for finding convergence clusters in panel data and analyzing transition-differential behaviour among all clusters. In other words, we can identify groups of economies that converge to different equilibria and others that diverge from the rest without finding any stationary equilibrium. These features have allowed recent research to delve into the formation of clubs of different nations that share the same emissions intensity pattern, and others whose behaviour is unique and different (Panopoulou and Pantelidis, 2009); (Herrerias, 2013); (Haider and Akram, 2019). Empirical results have shown the existence of socioeconomic factors underlying the heterogeneity of GHG emissions convergence clubs, such as, development factors, energy factors, technology research and development (R&D) factors, globalization factors, demographic factors, and climate factors, among others.

At a glance, the analysis undertaken on a global scale reveals limitations due to the large heterogeneity of countries, and it is clear that many prior studies make a set of assumptions that may distort the final evidence (Payne, 2020). The fundamental critiques are the non-detection of intra-country properties inherent to their social and economic structure, and the lack of availability and quality of cross-country aggregate data. Some few studies, explore the EKC and environmental convergence by examining the determinants of GHG emissions using within-country panel data, getting sub-national evidence for regions within countries. In recent years, some analyses for individual countries have been undertaken in, among others, United States (Burnett, 2016); (Apergis and Payne, 2017), Australia (Ivanovski and Awaworyi Churchill, 2020), Canada (Hamit-Haggar, 2019), and China (Wang et al., 2014); (Hao et al., 2015); (Zhao et al., 2015), using different methodologies and definitions of EKC and convergence.

We contribute to the previous literature by providing evidence across the Spanish regions. Our major key is the distinction of the total GHGs between direct and diffuse sectors. Emissions in both sectors come from economic activities vastly different in terms of energy-intensity use that trigger a larger- or smaller- scale ecological impact. In reaction to this distinction, policymakers have elaborated new and appropriate environmental legislation to reduce emissions of specific activities. The direct sector represents the most polluting activities whose regulation by governments has traditionally been stricter. In contrast, the diffuse sector is a pool of less harmful

activities and, therefore, whose regulation has been looser and more flexible. In this context, analysis is conducted via three different measures of emission intensity, to evaluate the environmental efficiency of economic activities based on emission reduction regulations. The policymakers could have contributed to intensify or mitigate the effects of climate change. Another important issue is the country itself, Spain is interesting because the regions have a high degree of disaggregation of political decision-making, even though the national government has introduced homogeneous policies, all regions have essential differences. In the past three decades, the Spanish economy has had strong economic growth, which has allowed it to become a world leader in renewable energy, thanks to a rich natural resource endowment, especially, wind and solar.

Data on emissions are obtained from the Informative Inventory Report provide by the Spanish National Inventory System within the Ministry of Ecological and the Demographic Challenge. The dataset is measured in tonnes of carbon dioxide equivalents (tCO2 eq) for each economic activity. The period spans from 1990 to 2018 on an annual frequency basis, and covers the 17 Spanish regions: Andalucía, Aragón, Asturias, Islas Baleares, Islas Canarias, Cantabria, Castilla y León, Castilla – La Mancha, Cataluña, Comunidad Valenciana, Extremadura, Galicia, La Rioja, Madrid, Murcia, Navarra, and País Vasco. The data for the autonomous cities of Ceuta and Melilla, both small cities located in North Africa belonging to the territorial organization of Spain, are not shown individually because of their low degree of representation. In this manner, our analysis always has 18 regions, the last one being the combination of these two. Additionally, GDP data by region are expressed in 2016 constant prices, obtained of the last update database RegData and RegData Dem version 6.0 – 2019 from the Applied Economics Studies Foundation (FEDEA) with long series of regional economic and demographic aggregates. To measure environmental efficiency, we employ three approaches to emissions intensity. First, we define Direct Emissions Intensity as the ratio between economic activities of the direct emissions sector (energy production and distribution; and energy use in industry) and GDP. We also define Diffuse Emissions Intensity as the ratio between economic activities of the diffuse emissions sector (transport; commercial, institutional and households; industrial processes and product use; agriculture; and waste). Thus, the main difference between

both measures is the degree of energy consumption: the first represents activities with a high degree of dependence on energy, therefore more traditionally polluting than the latter activities. Finally, Total Emissions Intensity is the ratio between all economic activities and GDP. In all cases, the lower the ratio, the less emissions are generated to produce one unit of output, so efficiency is higher.

We link our emissions intensity ratios to the study of the so-called EKC hypothesis in Spain, to investigate whether economic growth is condemned to inevitably increase GHGs. The analysis determines that the results for all regions are lower at the end of the period, indicating a decoupling between the economy and pollution. The Great Recession has not done more to accelerate this trend, whereby each additional unit of gross economic value leads to a marginal increase of total pollution of less than one. Another consequence of this economic shock has been the change in the emissions pattern, where the diffuse emissions sector is the engine of total emissions increase. At the regional scale, there is a substantial heterogeneity of performance, because the efficiency gains attained are different in each. Regions where the direct emissions sector is predominant have been more successful when it comes to improving environmental efficiency. Conversely, those regions with a greater share of diffuse emissions have improved more slowly and tentatively. Thus far, environmental policy guidelines have not been conductive to sharing efforts to reduce GHG emissions more fairly among all regions. This regulation does not appear to be a way forward in the immediate future. While the diffuse emissions sector is becoming more important, a commitment to increase efforts to cut emissions is necessary in the most polluting regions, and a mechanism is needed that encourages the search for efficiency in transport, commercial, household, industrial processes, agriculture, and waste management.

From the analysis of convergence, the empirical evidence shows the rejection of the null hypothesis for all intensity measures. The evidence in favour of no convergence is stronger in the cases of diffuse emissions sector and total emissions. In a second step, we develop a clustering study, with different results depending on the ratio of emissions intensity chosen. When the diffuse emissions intensity is examined, we collect the largest number of clubs, a total of four. On the other hand, the number of clubs is two - and just one - when total and direct emissions intensities are studied.

We extend our analysis to determine the drivers behind the formation of the clubs. To model this process, we have only taken into account the estimated clubs for the total and diffuse emissions sectors, with special attention to the latter. The results of this analysis suggest that income level and added value breakdown, just as energy mix of renewables power are the main determinants of GHG emissions in the Spanish regions. In the specific case of the diffuse emissions sector, the results also point to the importance of temperature of the climate, in addition to the above factors. With these findings, we confirm our support for the EKC hypothesis, with the following cautions. First, these results should be taken with some caveats given that the relationship between income and emissions depends on multiple factors. And second, we recognise that a major drawback of our analysis is that we cannot determine the tipping point in income level.

Certain policy recommendations arise. In light of our results, an agreement at the national scale among all Spanish regions, to fairly share efforts to reduce emissions, particularly in the diffuse emissions sector. Second, this agreement should be aware of the range of behaviours across the regions, and the regional governments should develop strategies to combat climate change, taking actions in territorial development, transport, education, and households, among others. And third, the regions must improve their long-term environmental efficiency, focused on the following elements: (1) sponsor zero-emissions solutions in all economic activities; (2) promote the renewable energy field as an alternative source to fossil fuels in all regions, not only where better endowed with resources; and (3) make the most of the relentless growth of consumption to design sustainable standards of energy saving for citizens.

In the end, for future research, it would be worthwhile to investigate the emissions performance on a more local level, to determine whether large metropolitan areas converge to the same club, or become divergent. It would also be interesting to do a similar regional analysis with countries of homogeneous socio-economic structures. For this forthcoming study, we can think of no better candidates than other European countries. Finally, we might be able to respond to this call by providing analysis of the direct and diffuse emissions sectors for countries with dissimilar environmental regulations.

Keywords:

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