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Determinants of renewable energy growth: A global sample analysis

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HIGHLIGHTS

- Some public energy policies are shown to impede renewable energy investments; this implies failure in policy design.
- Environmental concern is shown to drive renewables investment but energy security concerns do not seem to influence renewables investment.
- Results suggest that countries are likely to reduce renewables commitments when under pressure to ensure energy supply.
- Results seem to underscore the policy lobbying strength of the traditional energy mix industries.

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ABSTRACT

We investigate factors influencing country-level renewable energy growth by applying FEVD and PCSE estimation methods in a unique sample analysis. With a longer time series (1990–2010) and a broader sample size of countries (including Brazil, Russia, India, China and South Africa) than previous studies, our results reveal new insights. The results suggest that certain government-backed energy policies impede renewable energy investments, thus implying significant failures in policy design. These policies may be failing mainly because of uncertainty and the likelihood of discontinuity. Weak voluntary approaches are introduced in order to satisfy public demand for more sustainable investments and programmes; we find that these may have negative influences on the growth of renewables as well. The insight gained is consistent over the estimation methods employed.

1. Introduction

Renewables deployment has been a component of national planning agenda for many developed countries over the past few decades. Agenda in the 1980s focused largely on the then brewing "energy crises", thus reflecting the volatile nature of oil prices at the time. Renewables therefore emerged as possible alternatives to traditional fuels. Subsequently, in the 1990s, renewable energy sources became linked with sustainable development, forming part of international action aimed at addressing climate change (see Gan et al., 2007). Many countries and international organisations now view renewables as important elements of energy security, dynamic economic development, environmental protection and greenhouse gas (GHG) emissions reduction efforts (Carley, 2009; Gan et al., 2007; Johnstone et al., 2010; Marques and Fuinhas, 2012). Bolstered by this increasing importance, deployment of renewable energy sources has experienced a remarkable global growth profile in recent times. According to the IEA (2010), renewables deployment attained a 165.4% increase in power generation over the decade ending in 2009. However, evenly spread global participation is still limited. Coal still remains the main fuel source of power generation, accounting for 40.9% of total power output globally. The current trend shows a level of deployment asymmetry between developed and developing economies; however, countries from the same economic block and continent also show quite significant differences in deployment levels. Several studies have attributed these variations in renewables deployment to different factors. For example, Marques et al. (2010) identify some political, socioeconomic and country-specific factors as important determinants of renewables deployment. The first category includes policies (political factors), such as quotas, feed-in tariffs or investment in research, development and demonstration (RD&D), among others. The second category includes income and energy consumption, as examples of socioeconomic factors. A third category, which includes renewable energy potential, is identified as consisting of country-specific drivers. The first category, political drivers, is perhaps the most critical; this is mainly because renewables are currently more expensive options than fossil fuels. Of course, this is to be expected, since the environmental

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benefits of renewables and externalities of fossil fuels have not been internalised by firms. This market failure needs to be corrected by governments through policies that can discourage disproportionate dependence on fossil fuels, either by making them more expensive due to emissions or by subsidising clean sources of energy (see also Popp et al., 2011). This will ultimately help renewable energy become cost competitive with traditional energy sources (Carley, 2009). Further, Ibikunle and Okereke (2013) argue that when the cost of employing fossil fuel-based power generators is made prohibitively high enough through the creation of an emissions-constrained environment, renewables will become competitive without the need for any other policy support mechanism.

Most of the available literature discussing policies and other factors affecting renewable energy deployment is qualitative and theoretical (see as examples Bird et al., 2005; Gan et al., 2007; Harmelink et al., 2006; Wang, 2006). Although most of the qualitative and theoretical studies argue in favour of a positive relationship between policy variables and renewables deployment, the scarce body of empirical work available (see as examples Carley, 2009; Johnstone et al., 2010; Marques and Fuinhas, 2012; Marques et al., 2010; Menz and Vachon, 2006) is less clear and conclusive, particularly in terms of the role of policies. Testing the relevance of the different factors and quantifying the relationship between them and renewable energy is critical for policy formulation. In light of several cases of sovereign debt crisis in some developed countries and the struggle for financial independence in many developing countries, this is particularly crucial for governments when valuable (and finite) resources are being exhausted through energy policies. Our study thus, in the first instance, contributes to the limited body of evidence in this area.

Regarding studies directly related to our research questions, Menz and Vachon (2006) were the first to test the effectiveness of policies designed to promote wind power generation in the United States. Using OLS, their study examines 39 states between 1998 and 2003, and considers five different policy instruments, including renewable portfolio standard (RPS), fuel generation disclosure requirement (FGS), mandatory green power option (MGPO), public benefit fund (PBF) and retail choice (RET). Key limitations of this study include the small sample size and the possibility of an omitted variables bias. Carley (2009) controls for these issues, using data covering all 50 states of the United States between 1998 and 2006. Using a Fixed Effects Vector Decomposition (FEVD) model, Marques et al. (2010) conduct an analysis of 24 European countries using panel data covering 1990–2006.

Marques et al. (2010) do not include policy variables and (insufficient) renewable energy potential in their analysis. The omission of policy variables has subsequently been addressed by Marques and Fuinhas (2012) in their investigation of renewable energy adoption as a dynamic process. Using data available from the IEA, nine policy-related variables are formulated: education and outreach, financial, incentives/subsidies, policy processes, public investment, R&D, regulatory instruments, tradable permits and voluntary agreements.

Both Marques et al. (2010) and Marques and Fuinhas (2012) work with several countries, but since they are in a similar political framework and geopolitical structure, their results may still not be applicable to countries from other regions. Only two works have been found to employ a more heterogeneous sample of countries, Johnstone et al. (2010) and Popp et al. (2011); however, their key focuses are not renewable energy deployment or contribution to the energy supply. Johnstone et al. (2010) examine the effect of policies on technological innovation in renewables, using number of patents as a proxy. Their sample is of 25 OECD countries over the 1978–2003 period and in addition to the policy variables they include two further control variables: electricity consumption and price of electricity. Popp et al. (2011) also examine technology, but unlike Johnstone et al. (2010), they test the hypothesis that as technology improves, the cost gap between renewables and traditional fossil fuel-based energy is reduced, thus making the former a more attractive option. Their evidence therefore suggests that countries should adopt more (stringent) policies promoting investment in renewable energy technologies (see Popp et al., 2011).

Our study takes a different approach and improves on the existing literature in several ways. The first improvement comes in terms of the sample of countries ($N=38$) and the period selected. Instead of focusing on the United States, the OECD or the European Union, we include all EU countries with available data, the remaining OECD countries (those outside the EU), and the BRICS (Brazil, Russia, India, China and South Africa), representing the emerging economies component. This is intended to assess the heterogeneity of countries, particularly through the inclusion of the BRICS. Thus, the variation in renewables adoption between developed and developing countries can be examined empirically. Further, our sample period coverage is longer than both Marques et al. (2010) and Marques and Fuinhas (2012); the time series is also more recent. As Marques and Fuinhas (2012) point out, this is significant because certain issues arose after 2006, such as the oil price boom, increasing social and political pressure for the development of cleaner energy, and the financial crisis. Secondly, we introduce more disaggregated and definitive variables. For example, for renewables potential we use scalar values of country-level potential for several renewable energy types, whereas in Marques et al. (2010) – as an example – 'Surface Area' is adopted for the same variable. Thirdly, in our econometric analysis, for robustness, we employ two different procedures considered by existing literature to be most suited to these studies, but which have not been previously conducted and compared within the same study. Thus, in order to test the robustness of our findings, we adopt both FEVD and panel corrected standard errors (PCSE) estimation methods. We also compare these to a further estimation technique. Consistent with previous studies, we report mixed results. The remaining sections of this paper are structured as follows: Section 2 explains the determinants of renewable energy growth included in our study. Section 3 discusses our data and methodology; Section 4 presents and discusses our empirical results, while Section 5 concludes.

2. Determinants of renewable energy growth

Similar to the classification presented by Marques et al. (2010), we present the determinants of renewable energy growth that we use in three categories as political, socioeconomic and country-specific factors.

2.1. Political factors

2.1.1. Public policies

In the 1970s, renewables policy framework was dominated by Research and Development (R&D) programmes, while Obligations and Tradable Certificates became the most employed policy in the 2000s. As important as the type and number of policies implemented by nations, so is the need to evaluate how effective and significant they are in promoting renewables. We present seven policy-type variables, which correspond to year-on-year changes to the accumulated number of policies and measures by year (less the discontinued policies) for the 38 countries. The data employed in our analysis is more disaggregated than previous studies, with the purpose of including as many details and characteristics as practicable within the constraints of our analytical framework. This is in line with Johnstone et al. (2010); thus, we acknowledge