[ENERGY MIX, POWERGENERATION EFFECTS ON CARBON DIOXIDE (CO2) EMMISSIONS]

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Overview

Most scientists consider the increase of carbon dioxide (CO2) emissions as a major factor contributing to the deterioration of global climate more commonly described as global warming. The faster the pace of climate changing the more interested countries and institutions are to increase their knowledge on how it can be dealt with most efficiently. Global warming and its' environmental consequences, may change the life in many parts of the earth, and it may also influence global economic growth. Renewable and nuclear energy sources have been proposed as a viable solution to reduce the carbon dioxide emissions and hence reduce the pace at which climate changing is occurring. Since nuclear and renewable (hydro, wind, solar, biomass and geothermal) power generation are being seen as alternative ways of reducing the carbon dioxide emissions, many efforts have been towards investigating the potential replacement of fossil fuels and the cost of it. Many studies investigate the interrelationships and causality patterns between carbon emissions, energy mix, and growth (Apergis et al., 2010; Menyah and Wolde-Rufael, 2010). While there have been many studies investigating causal relationships between energy consumption and economic growth (Stern 1993; Asafu-Adjaye 2000; Lee & Chang 2008), between energy consumption and carbon emissions (Zhang & Cheng 2009; Soytas et al. 2007; Acaravci & Ozturk 2010), long run relationships between growth, energy consumption and carbon emissions (Soytas & Sari 2009; Ghosh 2010; Zhang & Cheng 2009), in this paper we take another perspective. We consider that the relationship between carbon emissions, power consumption, nuclear power consumption and renewables power consumption does exist and in fact carbon emissions depend on the energy mix which is well documented. We find interesting to investigate the dynamic relationships and direct and indirect effects of the energy mix (nuclear, renewable power) and growth to CO2 emissions over a panel of countries throughout the last two decades. We use percentages in the analysis of carbon emissions, which is less common. However, we are in line with studies such as Schmalensee et al. (1998) who used per capita variables to forecast carbon emissions, and Tamazian & Rao (2010) to find out the changes in CO2 caused by economic, financial, and institutional developments.

Methods

We investigate 57 countries from which roughly half (28) make use of nuclear energy. We are interested in direct and indirect effects of nuclear and renewable energy consumption. The variables of interest are scaled by energy output, which provides us a dependent variable, CO2 emissions per energy unit, and main explanatory variables, nuclear or renewable energy use as a percentage to the total energy. We also use control variables and interactions of the direct effects so as to have more information on how carbon emissions are affected by them. We have three main direct effects. These are the nuclear and renewable energy consumptions, and the GDP per capita of each country. Nuclear and renewable energy consumption has a direct mitigation effect on reducing carbon emissions since they are replacing polluting technology. GDP per capita is an index of prosperity of a country and of its ability to spend resources for environmental causes. Hence we expect that more rich countries would have more incentive in concentrating their efforts in reducing emissions. The second part of our analysis involves the three direct effects but after controlling for variables that may affect CO2 emissions and mistakenly being partly captured by the previous part. These controls variables namely are: two rank variables for GDP and energy, a time adjusted dummy for a distinct nuclear effect, and a time trend. The purpose for the two rank variables is to capture differences for different levels of GDP and energy. While changes of energy consumption or growth may induce changes in emissions, it may be that these changes differ between poor and rich countries and between high and low energy consuming countries. As explained earlier more wealthy countries may be better able to finance reduction on carbon emissions beyond the direct effects of nuclear and renewable energy use. Similarly we add a control for changes in the levels of energy use. In addition we use a time indicating variable. This may capture the gradual development of technology and constant decrease of emissions that could mistakenly be attributed directly to renewable or nuclear energy consumption. In order to be able to investigate a further debate on whether nuclear energy consumption is positively affecting future

decrease of carbon emissions we use a time adjusted dummy for nuclear use. This takes the value of 1 for countries that use nuclear power at a given year (zero otherwise) and is multiplied by the aforementioned time trend. This is extending the time trend by transforming it in a benchmark for the non-nuclear countries, adding the effect (through the nuclear dummy) nuclear consumption has throughout time. Finally, the third part of our analysis takes into account potential indirect effects of the three main variables of interest.

Results

We find that changes in nuclear energy consumption do not directly affect carbon emissions. However it seems there may be a long term effect where countries that make use nuclear energy are able to reduce their carbon emissions over time more than other countries. On average all countries reduce their carbon emissions over these 19 years. Countries with higher GDP level are reducing carbon emissions more efficiently. In contrast, countries with positive change in GDP per capita (growth), increase their carbon emissions. Growth may able to help mitigating the carbon emission problem only when this is occurring together with increase in renewable energy consumption. Changes in renewable energy consumption also directly negatively affect carbon dioxide emissions.

Conclusions

In this paper we investigated a model describing relationships between carbon dioxide emissions, nuclear energy consumption, renewable energy consumption, and GDP growth. We controlled for a set of relevant variables and used a three way interaction for the main three explanatory variables. We used a panel of 57 countries during a 19 years period (1990 – 2008). The main finding is that countries making use of nuclear energy reduce carbon emissions in the long run betten than the non-nuclear countries. However there are no direct effects from use of nuclear power to carbon emissions. More rich countries reduce their carbon emmissions faster. Growth is a signal for increase of carbon emissions, while use of renewable energy mitigates that.

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