PHASE-IN OF ENGINE BIOFUELS AND URANIUM UNDER RAPID GROWTH OF CARBON EMISSIONS IN TURKEY

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1. Overview

Turkey's CO_2 emissions increased by 131% between 1990 and 2010, which is by far the highest growth rate in the group of Annex I countries. Therefore, the target of Turkey is to reduce the quick growth of emissions without sacrificing economic growth. In this respect, a rapid diffusion of renewable energy sources and nuclear power is envisaged. Turkey's energy strategy highlights the use of domestic resources and renewable energy resources, and increasing share of renewable energy resources, domestic coal and nuclear power continues closely. In contrast to Germany, there is a phase-in of nuclear power in Turkey with the country's first reactor expected to supply electricity in 2019. On the other hand, the legislations for engine biofuels (biodiesel, bioethanol) are prepared towards the EU. Engine biofuels, which are produced from biological resources, are assumed to be potentially carbon neutral, because the amount of CO_2 released when a biofuel is burned is generally equivalent to the amount captured during the growth of the crop that produced it. Hence, using engine biofuels could be decelerating the effects of climate change. In addition to the environmental benefit engine biofuels have importance for contibuting to replace the imported oil. In this study, the roles of two emerging energy sources, engine biofuels and nuclear power, are explored from an energy economics and carbon emissions viewpoint and various important results on the underlying effects of emission growth are determined. The results shed light on alternative policy options to reduce CO_2 emissions.

2. Methods

In the literature two well-known decomposition techniques, namely the structural decomposition analysis (SDA) and the index decomposition analysis (IDA), have been widely applied to analyze the driving forces [1]. Both SDA and IDA methodologies are employed in energy and CO_2 decomposition studies. However, the number of IDA studies on CO_2 emission decomposition is much larger. An advantage of IDA is that it can readily be applied to any available data at any level of aggregation [2]. Different methods have been developed due to the IDA methodology [3]. One of them, the refined Laspeyres index method, has been widely adopted due to ease of both calculation and understanding.

In this study, a Kaya Identity is defined to express carbon emissions as a product of four factors: population, carbon intensity of energy use, energy intensity of production and per capita GDP. To study the implied effects, a decomposition analysis is carried out over the period 1990-2010 employing the refined Laspeyres index method.

3. Results

Given the data availability, changes in CO_2 emissions (per capita) over time are decomposed into a number of factors. It is found that the scale effect is a major reason for the rapid growth of CO_2 emissions in Turkey. Moreover, it is observed that the composition and carbon intensity effects interact with each other. The same variations in the carbon intensity are more influential than the composition effect, showing that CO_2 emissions mainly originate from the carbon intensity effect over time. However, according to the energy intensity effect, emission values decrease for a while, nearly 6 years.

Nuclear power, perceived with the connotations of ''modernization''and ''technological advancement'' is seen as a reliable, low-carbon and efficient energy source [4]. The Akkuyu project, if materialized, willbe the first nuclear power plant on a state's sovereign land owned and operated by another state [5]. The government's projections show that nuclear energy will meet 5% of the domestic electricity supply of Turkey by 2023 [6]. The current government's focus on this source can be explained by concerns on energy security and rapidly increasing greenhouse gas emissions, especially CO_2. The analysis of CO_2 emissions from power generation and transportion reveals the scale effect as a major determinant of CO_2 emissions. In the transport sector, however, energy intensity effect is identified to have a more dominant impact on CO_2 emissions. Results indicate a considerable decrease of CO_2 emissions due to energy intensity, implying improvements in the fuel efficiency of vehicles. However; the relatively high fuel consumption of LPG cars, an increase in CO_2 emissions due to this energy intensity for the last years. As an alternative to this; the use of engine biofuels will reduce release of CO_2 emissions because

of decreasing energy intensity. Figure 1 below provides a summary of the components of changes in CO_2 emissions of electricity generation and transportation.

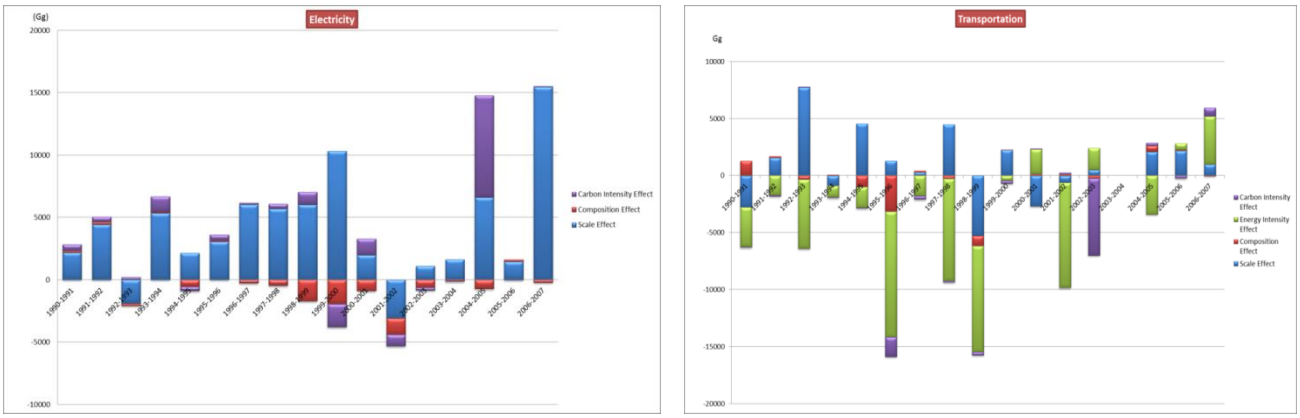

Figure 1. Decomposition results: components of changes in CO_2 emissions from electricity generation and transportation

4. Conclusions

A decomposition analysis of CO_2 emissions from the Turkish electricity production and transportation sectors is performed in this study. As a main result, it is determined that the scale effect was a major dominant source of rapid emission growth in the production of electricity and transport sectors. It could be forecasted that emissions will continue to grow with a continuation of the scale effect due to economic development. An effective emission reduction policy that is economically sustainable could be achieved by developing renewable energy technologies and nuclear power technology in Turkey. A renewable energy source, engine biofuel would be an alternative to CO_2 emissions based on fossil-fired transport. Therefore, this energy source seems to have a favorable green image so far in Turkey and is considered to have significant diffusion potential with targeted policy implementation. Similarly; in electricity production sector, nuclear power generation technology appears to be more attractive than thermal or renewable power generation for an economically sustainable reduction of carbon emissions.

The relationship between knowledge of climate change and nuclear support, in many instances, leads experts and policy-makers to jump to the conclusion that all people who are more aware of the climate change problem will readily support nuclear energy. Empirical evidence indicates that environmental knowledge may also trigger endorsement of renewable energy sources. The relative cost of different technologies, however, is mostly the triggering factor for incentives and subsidies. For renewable energy sources, specifically the production and utilization of engine biofuels appears to have a bright future in Turkey as supported by governmental policies and regulations.

REFERENCES

[1] Zhang, M. , Mu, H., Ning, Y., Song, Y. Decomposition of energy-related CO_2 emission over 1991-2006, *Ecological Economics*, 2009, 68 (2122-2128).

[2] Kumbaroğlu, G., A sectoral decomposition analysis of Turkish CO_2 emissions over 1990-2007, *Energy*, 2011, 36, (2419-2433).

[3] Ang BW, Huang HC, Mu AR. Properties and linkages of some index decomposition analysis methods, Energy Policy 2009:37:4624-32.

[4] Ertör-Akyazı, P., Adaman, F., Özkaynak, B., Zenginobuz, Ü., Citizens' preferences on nuclear and renewable energy sources: Evidence from Turkey, *Energy Policy*, 2012, 47 (309-320).

[5] Şahin, U., Country Perspective: Turkey. In: Netzer and Steinhilber (Eds.) The End of Nuclear Energy? International Perspectives After Fukushima. *Friedrich Ebert Stiftung*, 2011, 71–74.

[6] MENR (Ministry of Energy and Natural Resources), 2010a. MENR Strategic Plan: 2010–2014.

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