HOW SIGNIFICANT IS THE 'TRUE' ENERGY EFFICIENCY TO MITIGATE CO_2 EMISSIONS? EVIDENCE FROM OECD AND OPEC COUNTRIES

Ibrahim A. Tajudeen, PhD candidate, Resource and Environmental Research Group, University of Manchester, UK
Phone: +447769065096, Email: ibrahim.tajudeen@manchester.ac.uk

Overview

The quest for economic growth is often accompanied by various externalities. A predominant externality is increase in CO_2 emissions. Economic growth is sustained with more energies (largely fossil fuels), consequently leading to higher CO_2 emissions. Between 1971 and 2010, the world experienced about 223.7% increase in economic growth with an average annual growth rate of 3.09%. This is accompanied by 105% increase in energy use with an average annual growth of 1.88%. Consequently, it leads to 119.4% increase in CO_2 emissions with an average annual growth rate of 2.10%[1]. Thus, one of the greatest challenges confronting the world is how to achieve the dual objectives of producing the huge amount of energy required for growth and limiting the level of CO_2 emissions in order to avoid the worst effect of climate change. In what follows, several domestic and international actions were established. A well-known international action is the formation of the United Nations Framework Convention on Climate Change (UNFCCC) and subsequently the Kyoto Protocol, which set legally binding targets for reducing the GHGs was adopted as a supplement. To help achieve these targets, effective policies that help minimize the level of energy use and mitigate CO_2 emissions without necessarily hampering economic growth have to be formulated.

There are two perspectives to mitigate CO_2 emissions – the supply-side and demand-side options. The supply-side solutions entail alternative sources of energy that are more environmental friendly such as renewable energy, nuclear energy and energy mix[2]. These options are not yet widespread for several reasons. For instance, renewable energy is rarely produced or found in large quantities while nuclear energy that could be sizeable has a tendency of radioactive accident and increased production of hazardous nuclear waste that are also dangerous to the environment. The demand-side solutions entail policy options that could help to minimize the level of energy consumption without necessarily hampering economic growth such as promotion of energy efficiency and fuel subsidy reforms. They encourage switch to energy efficient household's appliances, industrial equipment and the discouragement of excessive use or wastage of energy inputs. More importantly, energy efficiency is one of the least expensive and most readily scalable options to support sustainable growth, enhance energy security and reduce further damage to the climate system (United Nations, 2013).

Therefore, energy efficiency improvement is considered a potential way to reduce CO_2 emissions and world governments are encouraged to exploit it as a first choice in their energy policy (e.g. IEA, 2013; IMF, 2013; UNEP, 2008). However, the extent in which energy efficiency can help minimize the level of CO_2 emissions has been underexplored. This kind of information is necessary to guide policy decisions; without it, policy makers may underrate the 'efficacy' of energy efficiency to mitigate CO_2 emissions. Arguably, more evidence and empirical facts addressing this issue can aid in setting priorities for energy efficiency in public decision-making. Following this insight, this study aims to examine and quantify the significance of the energy efficiency as a policy option to mitigate CO_2 emissions. Where applicable, it aims to analyse how energy inefficiency has contributed to increase in CO_2 emissions.

At a macro level, the common measure of energy efficiency is energy intensity that is the ratio of energy use to output. There are however increasing critiques on how best this measure reflects true improvements in energy use. A structural shift in the economy such as changes in manufacturing and other economic activities may reduce the demand for energy as opposed to improvement in use of energy (Metcalf, 2008). To address this problem, studies have applied different decomposition methodologies to the energy intensity index to disentangle the impact of changes in economic activity (economic activity index) from more fundamental improvement in energy use (hereafter referred to as 'true' energy efficiency index). Subsequently, they determined the economic forces that drive changes in the two indices (See for instance Metcalf, 2008; Oseni 2011; Jimenez and Mercado, 2013). While these indices are useful for understanding trends in energy use as well as trends in activity that influences energy use, they provide limited insight into the effects of 'true' energy efficiency or activity index on CO_2 emissions.

In a related strand of literature that links energy use (from economic growth) to CO_2 emissions mainly focus on the traditional '3E', the environment, economy and energy use nexus pioneered by Ang (2009) while ignoring the role of energy efficiency. Therefore, there is limited knowledge on the extent which energy efficiency could help mitigate CO_2 emissions or perhaps how energy inefficiency may have contributed to increase in CO_2 emissions overtime. This is a research void and an important value addition for further study. This study fills the existing gap in the literature

[1] Computed by author based on data sourced from IEA and World Bank database: http://dx.doi.org/10.5257/wb/wdi/2011-04
[2] The combination of different energy sources such renewable energy with less harmful fossil fuel such as natural gas.

by providing improved empirical evidence of the impact of true energy efficiency (or inefficiency where applicable) on CO_2 emissions using the case of OECD and OPEC. In addition, we made attempt to quantify the relative contribution of this salient factor alongside other explanatory variables to changes in CO_2 emissions. This kind of information is necessary to guide policy decisions. It will aid in assessing the compatibility of efficient energy use with the goal of ensuring sustainable economic growth. To the author's knowledge, this is the first study to examine the significant of the 'true' energy efficiency from the decomposition exercise on CO_2 emissions. The remaining part of this abstract is organised as follows: second section presents the methodology. In section three, we present brief empirical results. The final section concludes with some policy implications.

Methodology

We adopt a three steps estimation procedure. First, this study adopts the Fisher ideal index to separate the relative contribution of the fundamental improvements in energy use and structural shifts in the economy to changes in energy intensity. Second, in the context of the 3E the impacts of the 'true' energy efficiency and structural shifts on CO_2 emissions are analysed in a time series and panel model. Lastly, we use the parsimonious model from the second step to quantify the relative contribution of the variables to changes in CO_2 emissions. A structural time series model (STSM) developed by Harvey (1989) is employed for the time series, while the bias-corrected least square dummy variable (LSDVC) by Arellano and Bond (1991) is employed for the panel data. These methods – STSM and LSDVC have several advantages and differ in a number of ways from other techniques. They allow the relationship between the variables to be dynamic and they are relatively simple to comprehend as they use a single equation to estimate short and long run effects. More so, the STSM through the stochastic underlying carbon emissions trends (UCET) help to capture other exogenous non-economic factors such as consumer's taste and preferences, values, lifestyle, increasing awareness and desires to protect the environment, which are not easily measured but could be influencing CO_2 emissions. We could also incorporate time dummies in LSDVC to capture similar effects. These, therefore, inspire our choice for the two estimators in this study.

Results

The first step results reconfirmed the Fisher ideal index as one of the best decomposition techniques as it leaves no residual in our results. Among all the OPEC countries, only Ecuador is found to be energy efficient while the remaining 11 countries are inefficient. Out of the 30 OECD countries studied, only 6 of them are energy inefficient.

In the second step, the STSM indicates that the 'true' energy efficiency as well as structural shift is significant determinants of CO_2 emissions. In addition, the estimated underlying carbon emissions trends (UCET) indicates that consumers in OPEC have either carbon emitting lifestyle or/and insensitive to the environment, while consumers in OECD countries have carbon mitigating lifestyle. More so, the behavioural non-economic factors UCET make a non-trivial contribution to CO_2 emissions. These results are comparable with the results from the LSDVC.

Lastly and perhaps more importantly, average contribution of 'true' energy efficiency to change in CO_2 emissions is found to be relatively high. E.g., we found CO_2 emissions to be falling at an average of 0.50% per annum for Austria and energy efficiency contributes share of 1.18%. In contrast, income and structural shift have negative shares of 0.43% and 0.19% respectively. In other words, improving energy efficiency has the biggest contribution in driving down CO_2 emissions, so that despite the relatively strong positive contribution from income, the actual growth in CO_2 emissions slowdown considerably.

Conclusions

The 'true' energy efficiency has huge impact in mitigating CO_2 emissions. Similarly, the behavioural non-economic factors have a non-trivial impact on CO_2 emissions. Therefore, investing more on energy efficiency and sensitizing people about the need to protect the environment could help restrain CO_2 emissions to desirable targets and conserve available fuels for future use. More so, subsidy reforms (especially in OPEC countries) could help influence consumer's energy using lifestyle and behaviour, hence to mitigate CO_2 emissions.

References

Arellano, M. and Bond, S. (1991) "Some tests of specification for panel data: Monte Carlo evidence and application to employment equations." *Review of Economic Studies*, 58(2), 277-297.

Harvey, A. C. (1989) *Forecasting Structural Time Series Models and Kalman Filter*. Cambridge University Press, Cambridge UK.

Jimenez, R. and Mercado, J. (2013) "A decomposition and counterfactual exercise for Latin American countries." *Inter-American Development Bank (IDB) Woking paper series*, No. IDB-WP-441.

Metcalf, G. E (2008) ''An empirical analysis of energy intensity and its determinants at the state level'', *The Energy Journal*, 29 (3), 1-26.

Oseni, M. O (2011) ''Analysis of energy intensity and its determinants in 16 OECD Countries'', *Journal of Energy and Development*, 35 (1), 101-140. **[*Note: This is just selected references from this study*]**