HOW SIGNIFICANT IS THE TRUE ENERGY EFFICIENCY TO MITAGATE CO_2 EMISSIONS? EVIDENCE FROM 30 OECD COUNTRIES

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Overview

The quests for economic growth often move in tandem with various consequences posing a threat to human health and the environment. A predominant externality is CO_2 emissions[1]. Economic growth is sustained with more energies (largely fossil fuels) leading to higher CO_2 emissions. Between 1971 and 2011, the world attained about 232.7% increase in economic output with an average annual growth rate of 3.09%. An increase in energy use of 109% with an average annual growth of 1.87% accompanied the growth in economic output. By 2011, CO_2 emissions were also 122.6% above the 1971 level and were found to be rising at an average of 2.04% per annum[2]. 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. To help achieve address task, effective policies that help minimize the level of energy use and mitigate CO_2 emissions without necessarily hampering economic growth have to be formulated.

In what follows, this study analyses the impact of demand side strategies in influencing the quantities of energy use. The demand-side strategies often referred to as demand side management (DSM) entail policy options that help to minimize the level of energy consumption without necessarily hampering economic growth such as improvement of energy efficiency and energy 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 (EGEE, 2007). 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 strategy (e.g. Ang, 2006 and IEA, 2013). Nevertheless, the extent in which energy efficiency can help minimize the level of CO_2 emissions has been underexplored in the extant literature. 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 decisions making. Following this insight, this study aims to examine and quantify the significance of energy efficiency as a policy option to mitigate 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 quantity of energy use (Metcalf, 2008). To address this problem, extant studies have applied different decomposition methodologies to energy intensity index to disentangle the impact of changes in economic activity (economic activity index) from a more fundamental improvement in energy use (hereafter referred to as 'true' energy efficiency index). Subsequently, they determined the economic forces that drive changes in these 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 structural shifts on CO_2 emissions.

Similarly, a related strand of literature that links energy use (due to economic growth) to CO_2 emissions focus mainly on testing the environment, economy and energy use nexus (commonly referred as the traditional '3E'). In addition to the fact that the results from these studies are mixed and inconsistence, as far as is known, none of them include energy efficiency in the CO_2 emission model. Although most of these studies interpret their results within the context of income, efficiency and composition effects, they rarely provide separate estimates for the magnitudes of these effects. In other words, there is limited knowledge on the extent which energy efficiency can 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 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. In addition, the study attempts to quantify the relative contribution of this salient factor in light of other economic and non-economic factors to changes in CO_2 emissions.

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[1] CO_2 emission has the largest single share in GHGs emissions. Among other environmental pollutants causing climate change, CO_2 emissions account for about 60% of GHGs emissions (Ozturk and Acaravci, 2010 and Pao and Tsai, 2011). Although, Ozone has a higher global warming potential relative to CO_2 emissions the latter has a longer atmospheric life span than ozone. Consequently, attentions of many environmental studies including policy debates are more on CO_2 emissions vis-à-vis other forms of environmental emissions.

[2] Computed by author based on data sourced from IEA and World Bank database: http://dx.doi.org/10.5257/wb/wdi/2011-04

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 a dynamic time series and panel model of the traditional 3E, the impacts of the ‘true’ energy efficiency, structural shifts and non-economic factors (such as consumer behaviour, lifestyle and attitudes towards the environment) on CO_2 emissions are analysed. Lastly, we use the parsimonious models 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 dynamic time series, while the bias-corrected least square dummy variable (LSDVC) by Arellano and Bond (1991) is employed for the dynamic 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. Time dummies in LSDVC can be used to capture similar effects (e.g., Griffin and Schulman, 2005 and Adeyemi et al. 2010).

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 30 OECD countries studied, only six of them – Greece, Israel, New Zealand, Portugal, Spain and Turkey 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 overall consumers in OECD countries have either carbon mitigating lifestyles or/and increasing awareness of the need to protect the environment. More so, these 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 a 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 to improve energy efficiency and sensitizing people about the need to protect the environment will help restrain CO_2 emissions to desirable targets and conserve available fuels for future use. More so, energy price reforms (especially in countries with deteriorating energy efficiency) could help influence consumer’s energy using lifestyle and behaviour, hence mitigate CO_2 emissions.

References

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