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Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member

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ABSTRACT

This paper investigates the long run Granger causality relationship between economic growth, carbon dioxide emissions and energy consumption in Turkey, controlling for gross fixed capital formation and labor. The most interesting result is that carbon emissions seem to Granger cause energy consumption, but the reverse is not true. The lack of a long run causal link between income and emissions may be implying that to reduce carbon emissions, Turkey does not have to forgo economic growth.

1. Introduction

The Intergovernmental Panel on Climate Change IPCC (2007) report puts forward the fact that the most important environmental problem of our ages is global warming. The ever increasing amount of world wide carbon dioxide (CO_2) emissions seems to be intensifying this problem. Since the emissions mainly result from consumption of fossil fuels, reducing energy consumption seems to be the direct way of handling the emissions problem. However, due to the possible negative impacts on economic growth, cutting back from energy use is likely to be the "less traveled road". Furthermore, if the Environmental Kuznets Curve (EKC) hypothesis applies to the emissions and income link, economic growth by itself may become a solution to the environmental degradation problem (Rothman and de Bruyn, 1998). Indeed, according to Coondoo and Dinda (2002) both developing and developed economies must sacrifice economic growth. However, depending on the nature of the long run relationship between CO_2 emissions, income, and energy consumption in their economies, countries may resort to different policy options in contributing to the fight against global warming (Soytas and Sari, 2006a,b). Hence, the emissions–energy–income nexus needs to be studied carefully and in detail for all economies.

In this paper, we investigate the relationship between energy consumption, economic growth, and CO_2 emissions in Turkey from a long run Granger causality perspective, in a multivariate framework controlling for gross fixed capital investment and labor by employing The Toda and Yamamoto (TY hereafter) (1995) procedure. We have chosen Turkey as a

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case study first because it is an emerging economy and a candidate country for full membership in the European Union (EU). Turkey needs to adjust her infrastructure, economy, and government policies (including environmental, energy, and growth policies) to make them inline with EU requirements. Secondly, with a 72.6% rise in GHG emissions in 2000–2004, Turkey has the fastest growing emissions in the world (UNFCCC, 2006), although her per capita emissions and per capita GDP are among the lowest ones of the countries in Annex 1 of the Kyoto Protocol. Thirdly, we want to examine whether Turkish concerns regarding negative effects of emission constraints on the economy may be justified, since this is the main reason why the country has not ratified the protocol. As the Turkish economy grows the pressure on energy security is also building up. Therefore, the country is in need of a sound long term plan that integrates energy, environment, and growth concerns.

The analysis relies on recent time series techniques that offer potential solutions to the methodological problems listed in Stern (2004). The Toda and Yamamoto (1995) approach eliminates the need for pre-testing for cointegration and therefore avoids pre-test bias and is applicable for any arbitrary level of integration for the series used. The most striking result may be that the long run Granger causality is running from CO_2 emissions to energy consumption in Turkey. That is, emissions improve the forecasts of energy consumption in Turkey, but not vice versa. This may have important policy implications for Turkey.

The organization of the paper is as follows. In the next section we briefly review the literature. Then, we introduce the data definitions and discuss the time series properties of the variables in Section 3. In Section 4 we provide the empirical results and their discussions. Section 5 provides policy implications and concludes.

2. Income–emissions–energy consumption nexus

There are quite a few theoretical studies that formally model a direct link between the environment and growth, energy and growth, and energy and environment. The empirical literature seems to be more abundant. First, we briefly discuss the theoretical considerations. Then, empirical investigations that relate to the transmission mechanisms within the energy–environment–growth nexus are introduced.

3. Theoretical background

There has been a vast amount of theoretical work on economic growth, most of which relying on the Solow growth model. More recently growth models rely increasingly on the endogenous growth theory (see for a review Jones and Manuelli, 2005).[1] There are also a considerable number of studies that model the relationship between the environment and economic growth, and natural resource management and environment (see for reviews Xepapadeas, 2005, and Kolstad and Krautkraemer, 1993 respectively). Jorgenson and Wilcoxen (1993) on the other hand seem to selectively cover theoretical work that focuses on modeling interrelationships between energy, the environment, and economic growth in an intertemporal general equilibrium framework and also discuss aggregate growth models.

According to Xepapadeas (2005) early works on economic growth failed to take environmental aspects of growth into account. Reviewing more recent studies he further argues that there is a "…necessity for growth theory to delve deeply into the analysis of the interrelationships between environmental pollution, capital accumulations and the growth of variables which are of central importance in growth theory." (Xepapadeas, 2005, p. 1221). Kolstad and Krautkraemer (1993) point out the fact that there is a dynamic link between the environment, resource use and economic activity. They argue that while resource use (especially energy sources) yield immediate economic benefits, its negative impact on the environment may be observed in the long run. They argue that most theoretical work is dynamic, whereas empirical studies are largely static in nature, implying the need for dynamic empirical analysis. Jorgenson and Wilcoxen (1993) point out the common feature of Nordhaus's (1992) and Manne and Richels's (1992) models as relying on the impact of policies on capital accumulation in modeling the interrelationships between energy, environment, and growth. Furthermore, they argue that intertemporal general equilibrium modeling is critical in accounting for the effects of oil price shocks on growth.

Ricci (2007) in his survey of theoretical work points out several transmission mechanisms through which environmental policy and economic growth may interact. This may be partly due to some models treating pollution as an input to production, and others as a negative by-product. Regarding the policy effects, he mentions that generally environmental policies are deemed to have negative effects on growth, because they are taken as additional constraints. However, if environmental improvement results in increased factor productivity and stimulate innovation, the growth prospects will be enhanced. Indeed, Dudek et al. (2003) show that the ancillary benefits from reduction of emissions will exceed the average cost of carbon reduction. Ricci (2007) also discusses how benefits may be achieved via reaching increasing returns to scale in abatement activity, and providing an urge to save more if environmental improvement is expected. Hence, empirical methodology employed should allow dynamic effects in the energy–environment–growth nexus. Furthermore, Ricci (2007) admits that how the transmission mechanisms work may differ across countries at different stages of development.

Theoretical studies mainly consider policy tools that focus on pollution taxes, emissions trading, and conservation. They mention that any effective policy should take the dynamic nature of the relationships between energy, environment, and growth into account and should have a long term vision. Hence, understanding the intertemporal relationship between emissions, energy use, and economic growth in individual countries is essential in generating effective policies.

[1] Here we refrain from a detailed review of the vast theoretical literature; instead we briefly discuss points shown by surveys of the related literature.