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Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis

Mohammad Jahangir Alam^{a,b,*}, Ismat Ara Begum^c, Jeroen Buysse^a, Guido Van Huylbroeck^a

^a Department of Agricultural Economics, Ghent University, 653 Coupure Links, 9000 Ghent, Belgium

^b Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

^c Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

ARTICLE INFO

Article history:

Received 7 September 2010

Accepted 9 February 2012

Available online 3 March 2012

Keywords:

Energy consumption

Economic growth

Bangladesh

ABSTRACT

The paper investigates the possible existence of dynamic causality between energy consumption, electricity consumption, carbon emissions and economic growth in Bangladesh. First, we have tested cointegration relationships using the Johansen bi-variate cointegration model. This is complemented with an analysis of an auto-regressive distributed lag model to examine the results' robustness. Then, the Granger short-run, the long-run and strong causality are tested with a vector error correction modelling framework. The results indicate that uni-directional causality exists from energy consumption to economic growth both in the short and the long-run while a bi-directional long-run causality exists between electricity consumption and economic growth but no causal relationship exists in short-run. The strong causality results indicate bi-directional causality for both the cases. A uni-directional causality runs from energy consumption to CO₂ emission for the short-run but feedback causality exists in the long-run. CO₂ Granger causes economic growth both in the short and in the long-run. An important policy implication is that energy (electricity as well) can be considered as an important factor for the economic growth in Bangladesh. Moreover, as higher energy consumption also means higher pollution in the long-run, policy makers should stimulate alternative energy sources for meeting up the increasing energy demand.

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1. Introduction

The causality relationship between energy consumption and income is widely discussed and debated since the seminal work of Kraft and Kraft (1978). There exists plenty of literature on the casual relationship between electricity consumption and economic growth in the case of developing economies across the world. However, this empirical evidence is mixed and goes from unidirectional or bi-directional causality to no causality. Results vary across different countries because probably it depends on the country's development path, development stage, the sources of energy used, energy policies applied, energy consumption level, institutional arrangements and so on. Further most studies take electricity consumption as a proxy to total energy consumption, a choice that is may be not justified in all cases depending on energy sources in a country. This illustrates that the relationship between energy consumption and economic growth remains an issue of debate and of high importance for policy makers

irrespective whether they come from developing or developed countries in the world.

There exist two theoretical points of view in literature: first, a neo-classical view stating that economic growth of a country can be 'neutral' to energy consumption which thus postulates that a country may pursue an energy conservation policy for reducing CO₂ emissions without undermining the pace of economic growth. This is defined as the 'neutrality hypothesis'. Altinay and Karagol (2004); Jobert and Karanfil (2007); Halicioglu (2009) for instance did find evidence for this theory of no causal relationship between energy consumption and economic growth for Turkey. Similar results are found by Soytaş and Sari (2003) for Canada, Chiou-Wei et al. (2008) for Korea, Malaysia and Thailand. The second theory postulates that a country's economic growth is highly associated with energy consumption because energy as any other production factor may be the limiting factor to economic growth. Stern (1993, 2000) found evidence for the theory that energy is a driving factor to the economic growth for the US. Similar results were found by Masih and Masih (1996) for India, Wolde-Rufael (2005) for Algeria, Cameroon, Congo DR, Egypt, Nigeria; Wolde-Rufael (2004) for Shanghai; Soytaş and Sari (2003) for France, Germany and Japan; Chontanawat et al. (2006, 2008) for Kenya, Nepal and the Philippines. In this theory,

* Corresponding author at: Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Tel.: +88 01760648754; fax: +88/091 61510.

E-mail address: alambau2003@yahoo.com (M. Jahangir Alam).

reduction in energy tends to reduce output growth and thus energy conservation policies may hamper the growth of an economy. This view rejects thus the 'neo-classical' hypothesis that energy is neutral to economic growth.

Mozumder and Marathe (2007) in their review of literature on the energy consumption and economic growth nexus conclude that the findings not only vary across countries but also across econometric methodologies. Payne (2010a) and Payne (2010b) also provide comprehensive surveys on the literature of causal relationship between energy consumption, electricity consumption and economic growth. Payne (2010a) concludes that there is no clear consensus whether particular countries or group of countries are energy dependent or energy neutral. He also emphasizes the need of using alternative econometric approaches. Payne (2010b) finds varied evidences supporting as well the neutrality hypothesis, the growth hypothesis and the feedback hypothesis.

Another aspect is that because of the global warming problem and a growing concern about scarce energy sources on one hand and a new paradigm on a green economy on the other, the causality relationship between economic growth and environmental pollution because of CO₂ emission became high on the research and policy agenda. The emission of CO₂ is a core cause of global warming. Therefore, it is also important and necessary to investigate whether economic growth and energy consumption lead to higher environmental pollution. The well known environmental Kuznets Curve (EKC) (Kuznets, 1955) postulates that there is an inverse U-shaped relationship between economic activity and environmental pollution. It explains that environmental degradation initially increases with the increase of income, reaches a threshold point and then it declines with increased income (Grossman and Krueger, 1991; Selden and Song, 1994; Stern et al., 1996). Using the Toda and Yamamoto (1995) approach, Soytaş and Sari (2007) found that CO₂ emission Granger cause energy consumption in Turkey but not vice-versa. The causality relationship between energy consumption and CO₂ emissions is investigated by Ang, 2008; Apergis and Payne, 2009; Menyah and Wolde-Rufael, 2010. However, the knowledge whether continued increase in national income brings more degradation to the environmental quality is critical for the design of development strategies (Ang, 2007). The author found that CO₂ emission Granger causes economic growth. Elif et al. (2009) found a monotonically increasing relationship between CO₂ and income in Turkey. However, the empirical evidence remains controversial and ambiguous until now, and there is no consensus in the literature on the economic level at which environmental degradation starts declining (Dinda, 2004). This is particularly important for developing countries where economic growth is still essential to escape from the poverty trap.

Our study takes Bangladesh as a case study. This is motivated by following reasons: First, it is a country where the energy sector is poorly managed (Mozumder and Marathe, 2007). This is witnessed by the limited coverage of supply, poor quality services, energy stealing, utilities going bankrupt and huge government subsidies (Temple, 2002). Further, it is an energy deficit country which means that availability of energy (including electricity generation) from domestic supply is not sufficient to meet up the growing demand which can be illustrated by the regular electricity power cuts (called as load-shedding) caused by the lack of supply. The per capita energy consumption is 227 kg oil equivalent only which is much below the world average of 1680 kg oil equivalent (Islam et al. 2008). The major commercial energy sources consist of natural gas (from which almost half is used for electricity generation), petroleum, coal and hydro-power (BBS, 2005). The shares of natural gas, petroleum, coal and hydropower to total commercial energy consumption is

70.8%, 25%, 2.4% and 1.8%, respectively, (BP, 2011). The petroleum and coal are mostly used for transportation and industrial purposes. However, since independence in 1971, the economy is growing moderately, with an average economic growth ranging between 4 and 6% per annum (BBS, 2005). The government strategic policies are to increase the growth at least with an extra 2% by 2015 (Sixth-Five Year Plan, Government of the People's Republic of Bangladesh, 2011). So, it indicates that if the economic growth is associated with energy or electricity consumption and if causality runs from energy consumption (or electricity consumption) to economic growth, the lack of a smooth energy supply could be a serious constraint for the planned growth path.

Second, in the Sixth-Five Year Plan (2011), the country plans an ambitious poverty reduction target by 2015 which can only be achieved if the above planned economic growth can be realized while keeping all other constraints constant, and assuming economic growth is pro-poor. Therefore, policy makers and development practitioners are very much concerned and interested in knowing whether the economic growth performance can be maintained according to the planned path and whether it will be possible to reach the poverty reduction target if this is associated with higher energy consumption given the poor state of the energy sector. If economic growth is not related to energy consumption or electricity consumption and is even not associated with CO₂ emissions, then an energy conservation policy could be a feasible policy option as it would not affect the economic growth and poverty reduction target. In the opposite case, it may be a huge problem.

Third, Bangladesh is one of the countries in the world that is likely to suffer extremely from the adverse effects from climate change because of global warming problem caused by environmental pollution. The Intergovernmental Panel on Climate Change (IPCC, 2001) predicts a high frequency of extreme climate events, like sea level rise, drought, flood and cyclones for Bangladesh. Although the country's contribution to global climate change via emissions of CO₂ from energy uses is presently rather insignificant and this may change if the country's economic growth is associated to increased emission. But even if the contribution of the country to emissions and thus also potential emissions reduction is insignificant at the global scale, it may be of symbolic and political value for Bangladesh to show that it contributes to the problem and to convince other countries to reduce CO₂ emission.

All this makes Bangladesh an interesting case also because this is the first study to analyze the real income, energy consumption, electricity consumption and CO₂ emission nexus in Bangladesh in a single study. So far, there exists only the study of Mozumder and Marathe (2007) who has analyzed the causal relationship between electricity consumption and economic growth in Bangladesh using a Johansen vector error correction model. The authors found a uni-directional causality that runs from economic growth to electricity consumption in the long-run. On this basis they concluded that an electricity saving policy must not be harmful to economic growth. However, we think that this provides only on a partial result as only about 50% of the country natural gas is used for electricity generation (BBS, 2005). Hydro-power (3.28% of total electricity generation) is another main source of electricity generation. The country's overall power generation capacity has been unable to meet the demand over the past decades (EIA, 2005). Currently, per capita electricity generation in Bangladesh is the lowest in the world with only about 154 kWh/per year and 30% of the population has access to electricity (Bhattacharyya, 2007). The demand of electricity is growing at a rate of 10% per year which is assumed to be further increasing over the years. However, energy dependency does not

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