



Energy consumption and human development: Evidence from a panel cointegration and error correction model



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ABSTRACT

In this paper we investigate the co-movement and the causality relationship between energy consumption as well as electricity consumption and the HDI (human development index) using as a proxy of human well-being and by including energy prices as an additional variable, in fifteen developing countries for the period 1988 to 2008. Recently developed tests for the panel unit root, heterogeneous panel cointegration, and panel-based error correction models are employed.

The empirical results support the neutrality hypothesis in the short-term, regards total energy or electricity consumption, implying an absence of causality running in either direction. In the short term, energy as well as electricity consumption has a neutral effect on the HDI.

In the long-term the findings provide a clear support of a negative cointegration relationship between energy consumption and the HDI. While a positive cointegration relationship exists between electricity consumption and HDI.

A 1% increase in per capita energy consumption reduces the HDI by 0.8% and, a 1% increase in per capita electricity consumption increases the HDI by 0.22%. Moreover, a 1% increase in energy price reduces the HDI by around 0.11%.

This study thus provides empirical evidence of long-run and causal relationships between energy consumption and the HDI for our sample of countries; supporting the assertion that lack or limited access to modern energy services could hamper economic and human development prospects of countries and underpins all the MDGs (millennium development goals).

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1. Introduction

Energy is essential for any form of economic activity and advances in energy consuming technologies, coupled with increasing energy consumption, have characterised industrialization and economic development processes over the past century [1]. Although developed countries are now beginning to decouple their energy consumption from economic growth (through changes structural-by shifting the production structure away from energy intensive industries to less energy intensive service activities and increases in energy efficiency), there remains a strong direct relationship between energy consumption and economic development in developing countries.

Hence, understanding the linkage between energy consumption and economic growth is extremely important. The relationship

between the energy consumption and economic growth has a very significant implication for policy makers and governments that care about the economic growth in one hand and the environment and scarcity of resources on the other hand. They must understand whether economic growth boosts energy consumption or whether energy consumption causes economic growth because appropriate energy and environmental policy choices depend upon the nature of the causal relationship between energy consumption and economic growth [2,3].

Therefore, the relationship between energy consumption and economic growth has been extensively investigated by many researchers using different data set and econometric methods.

A great number of studies uncover the relationship between energy consumption and economic growth, measured by monetary indicators such as GDP (gross domestic product), GNP (gross national product) or GDP per capita has been conducted for many countries around the world. Long-run cointegration and causality have been found between energy and economic performance, at a country level, by many scholars [4–10].

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While the relationship is clearly real, it is not overwhelmingly compelling, especially if used as a significant indicator of human welfare or quality-of-life [11].

Indeed, if economic growth is an important factor in reducing poverty and generating the resources necessary for human development and environmental protection, it does not alone guarantee human development. It fails to account for important factors of societal well-being that are not directly tied to economic production, such as life expectancy, health and education. Hence, energy policy based on the results of the empirical studies on energy consumption and GDP may fail to promote human and economic development.

Nevertheless, beyond its impact on GDP, energy directly affects some indicators of human well-being. Energy provides services to meet many basic human needs and there is a direct relationship between the absence of adequate energy services and many human well-being indicators such as modern healthcare, education and communication. A lack of access to energy services dramatically affects and undermines health, limits opportunities for education and development, and can reduce population's potential to rise up out of poverty. Increasing energy consumption has long been tied directly to improvement in human welfare. However it is unclear whether increasing energy consumption is a necessary precondition for human development, or vice versa.

Energy impact on human quality-of-life could be more assess by using the Human Development Index as a proxy of Human well-being [11–13].

The UN Human Development Index (HDI) is a composite measure of health, education and income that has become a widely accepted alternative to GDP for assessing countries' progress. It is a standard means of measuring well-being.

The innovative contribution of this paper is to determine the long-run relationship between energy consumption and the HDI, as a measure of human well-being by using the latest dynamic panel unit root, panel cointegration and panel causality.

We focus on the case of 15 developing countries with annual observations over the period of 1988–2008.

The rest of the paper is laid out as follow: the second section reviews the literature on the relationship between energy and growth while the third section describes the methodology and data. The fourth section discusses the empirical results between energy consumption and HDI. Finally, in the section five, we present our conclusions.

2. Literature review

Existing literature on the impact of energy on economic performance at a country level consists of empirical studies of relationship between energy or electricity consumption and GDP or GDP per capita as a proxy of economic growth.

The majority of these empirical studies tests causality between total energy or electricity consumption and GDP in the times-series context while the minority tests causality in the panel context. They are mainly used bivariate models.

Kraft and Kraft [4] did the pioneering research work on the relationship between Energy consumption and economic development, by using a standard version of Granger causality test [15]. They have found unidirectional causality running from gross national product (GNP) to energy consumption for the United States over the period of 1947–1974, suggesting that government could pursue the energy conservation policies. However, by utilizing the technique of Sims [16], Akarca and Long [17] pointed out that the Kraft and Kraft [4] results are spurious by changing the time period by 2 years. Many scholars have joined the debate, but they have never reached a consensus.

Ozturk [18] and Ozturk & Acaravci [19] sum up four possible hypotheses about energy-growth nexus. Firstly, no causality between these variables is referred to as “neutrality hypothesis”. In other words, energy is assumed to be neutral to growth. If this is not a case, conservative or expansive policies on energy consumption could adversely affect economic growth. According to Belloumi [20], the main reason for the neutral impact of energy on economic growth is that the cost of energy is negligible, so it is not likely to have a significant impact on economic growth. The possible impact of energy consumption on growth will also depend on the structure of the economy and the level of economic growth of the country concerned. As the economy grows, its production structure is likely to shift towards service sectors, which are not much dependent on energy [21,22].

Secondly, unidirectional causality from economic growth to energy consumption supports the “conservation hypothesis”. This implies that a country may implement energy conservation policies or environment friendly policies without having any adverse effect on economic growth.

Thirdly, unidirectional causality from energy consumption to economic growth is considered as “energy-led growth hypothesis”. Within this situation, policy makers should pay special attention on restrictions of energy use because this action may, to which extent, impede economic growth. Supporters of this hypothesis believe that energy is a critical input of production and plays as a complement to the basic factors of land, labour and capital. If this is a case, energy is said to be a limiting factor of economic growth ([6] and [23]).

Finally, bi-directional causality between energy consumption and economic growth is known as “feedback hypothesis”. This provides an insight that energy consumption and economic growth are jointly determined and complement each other.

Interest in the causality question has gained new momentum with concerns about *energy costs* and *resource scarcity* in one hand and, climatic change and the need for international policies to reduce greenhouse gas emissions on the other hand. Indeed, the causal link between energy consumption and growth plays a very important role in policies toward reduction of greenhouse gases to control the global warming phenomenon. Because the emission of these gases are related to the amount of energy use, at least in the short and medium-run, existence of a causality running from energy consumption to GDP indicates that emission reduction plan would lead to decrease in GDP [24].

Despite of this extensive investigation, the empirical research on the causal relationship between energy consumption and economic growth has not provided conclusive evidence. Empirical findings on the causal relationship between energy consumption and economic growth are mixed and ambiguous, depending on the functional form adopted, the econometric approach used, the time periods and the sample of countries analysed as seen in Table 1.¹

In summary, these results suggest that the use of different methods, models, time frames and variables could affect the causality results and that causality results are varied across countries and even within each individual/group country.

As mentioned above, the existing literature uses monetary indicators as GDP as a proxy for the economic growth and very little attention has been paid to other measures of development.

If the relationship between energy and growth has been extensively investigated, the literature on energy-human

¹ Beaudreau [25] argues that the energy availability is the cause of economic growth not the energy consumption, per se. He claims that if the energy availability is used instead of energy use the results would be conclusive.

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