Energy Policy 39 (2011) 2265–2272

Contents lists available at ScienceDirect

Energy Policy

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

Interpreting the dynamic nexus between energy consumption and economic growth: Empirical evidence from Russia

Yue-Jun Zhang [a,b,*]

[a] School of Management and Economics, Beijing Institute of Technology (BIT), 5 South Zhongguancun Street, Haidian District, Beijing 100081, PR China
[b] Center for Energy and Environmental Policy Research, Beijing Institute of Technology, Beijing 100081, PR China

ARTICLE INFO

Article history:
Received 30 June 2010
Accepted 11 January 2011
Available online 3 March 2011

Keywords:
Russia
Energy consumption
Economic growth

ABSTRACT

Research on the nexus between energy consumption and economic growth is a fundamental topic for energy policy making and low-carbon economic development. Russia proves the third largest energy consumption country in the world in recent years, while little research has shed light upon its energy consumption issue till now, especially its energy–growth nexus. Therefore, this paper empirically investigates the dynamic nexus of the two variables in Russia based on the state space model. The results indicate that, first of all, Russia's energy consumption is cointegrated with its economic growth in a time-varying way though they do not have static or average cointegration relationship. Hence it is unsuitable to merely portrait the nexus in an average manner. Second, ever since the year of 2000, Russia's energy efficiency has achieved much more promotion compared with that in previous decades, mainly due to the industrial structure adjustment and technology progress. Third, among BRIC countries, the consistency of Russia's energy consumption and economic growth appears the worst, which suggests the complexity of energy–growth nexus in Russia. Finally, there exists bi-directional causality between Russia's energy consumption and economic growth, though their quantitative proportional relation does not have solid foundation according to the cointegration theory.

1. Introduction

It has been universally acknowledged that Russian Federation proves a key energy producing country, especially with abundant oil and natural gas resources. In 2009, the Russian primary energy production ranks the third in the world. Specifically, the proved reserves of oil and natural gas accounts for 5.6% and 23.7% of the total, respectively, and the production of oil and natural gas accounts for 12.9% and 17.6% of the total, respectively (BP, 2010).

However, besides the role of a key energy producing country, Russia actually is also a giant energy consuming country. In 2009, its primary energy consumption also ranks the third of the world with the share of 5.7%, larger than that of the Southern and Central American region (5.0%) and the African continent (3.2%) and only less than that of the US and China (BP, 2010).

Additionally, it is well-known that energy acts as the very basis for economic growth, and economic growth cannot sustain without sufficient energy consumption; hence, intuitively, energy consumption should maintain a long-term equilibrium with economic growth. Does this logic hold in Russia? Does the effort for energy saving in Russia affect its economic growth? Does the nexus of energy consumption and economic growth in Russia differ from that in other BRIC countries?[1] Little attention has been paid to these questions up to now, which are not in accord with the key position of Russia in the whole world.

Under this circumstance, this paper aims to study the relationship between energy consumption and economic growth in Russia, not only their quantitative proportional relation but also their interactive directions, i.e., causality, and compare the relationship with that in other BRIC countries, so as to provide some insights for the energy-saving policy making in Russia.

The rest of the paper is organized as follows. Section 2 presents an overview of the existing literature regarding the relationship between energy consumption and economic growth. Section 3 explains the empirical approach and data definition. Section 4 gives the empirical analysis results and Section 5 concludes the research.

* Correspondence address: School of Management and Economics, Beijing Institute of Technology (BIT), 5 South Zhongguancun Street, Haidian District, Beijing 100081, PR China. Tel.: +86 10 68918843; fax: +86 10 68918651.
E-mail address: zyjmis@126.com

[1] Ever since the beginning of the 21st century, four giant developing countries, Brazil, Russia, India and China, have witnessed continuous economic growth and become the powerful engines for the global economic growth; hence, are often called the BRIC countries.

0301-4215/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2011.01.024

2. Literature review

Research on the nexus between energy consumption and economic growth has attracted vast attention up to now, and much of them appears focused on the causal relationship between the two variables. To sum up, four results or *hypotheses* currently exist in terms of the causality of energy consumption and economic growth, and a detailed overview of empirical literature on this causality can be seen from Odhiambo (2010), Ozturk (2010) and Chandran et al. (2010).

The first result refers to a unidirectional causality running from economic growth to energy consumption (Wolde-Rufael, 2006; Yoo, 2006; Mozumder and Marathe, 2007), which holds that economic growth causes energy consumption and as the economy grows, energy demand from different sections of the economy increases. It is also called the "*conservation hypothesis*". Under this circumstance, a country is not entirely dependent on energy for its economic growth and energy conservation policies can be implemented with little or no adverse effect on economic growth.

The second result, however, argues that it is the energy consumption that causes economic growth, which econometrically means a unidirectional causality exists running from energy consumption to economic growth (Narayan and Singh, 2007; Odhiambo, 2009). This argument implies that economic growth is dependent on energy consumption hence is called the "*growth hypothesis*".

The third result considers that both energy consumption and economic growth cause each other, which means there is a bi-directional causality between energy consumption and economic growth (Glasure and Lee, 1997; Soytas and Sari, 2003; Paul and Bhattacharya, 2004). Consequently, it is also called the "*feedback hypothesis*".

The last result contends that there is no causal relationship between energy consumption and economic growth in either direction, which is referred to as the "*neutrality hypothesis*". In other words, energy conservation policies have little or no effect on economic growth (Cheng, 1997; Asafu-Adjaye, 2000; Paul and Bhattacharya, 2004; Wolde-Rufael, 2006; Odhiambo, 2009), and the change of economy may not affect the consumption of energy sources.

Besides, although a number of studies have been conducted regarding the causality between energy consumption and economic growth in American countries (such as USA, Mexico, and Brazil), African countries (such as South Africa, Algeria, Congo, Kenya, and Sudan), Asian countries (such as India, Singapore, South Korea, Malaysia, and Philippine), European countries (such as the UK, Italy, and Portugal), etc., little research has been done about the causal relationship between the two variables in Russia.

It should be noted that, compared with Russia's energy production, little attention indeed has been paid to the features of Russia's energy consumption, especially its link to the economic growth. Opitz et al. (1997) discusses the energy consumption of buildings in Moscow and argues that the relatively high space-heating energy use in the building mainly results from the poor control of heat delivery from the district heating system of Moscow. Fromme (1996) analyzes the potentials and obstacles of energy conservation in the Russian manufacturing industry, and argues that in the early 1990s, considerable energy conservation can be achieved, and a general lack of awareness stemming from traditional thinking and structures, compounded by a lack of financing possibilities, constitutes some of the most important obstacles for energy conservation in Russia. Korppoo (2005) points out that the current level of energy efficiency has potential to retard the economic recovery of the country and cause problems on the energy sector; hence, Russia needs to improve energy efficiency. Apergis and Payne (2010) empirically discusses the nexus among carbon emissions, energy consumption and economic growth with a panel vector error correction model for eleven countries of the Commonwealth of Independent States[2] over the period of 1992–2004, and finds that the impact of energy consumption on economic growth appears sensitive to the inclusion of Russia in the panel data set. Specifically, the inclusion of Russia reveals that energy consumption has a negative impact on economic growth in the short-run. In this case, energy conservation policies that reduce carbon emissions may not adversely impact economic growth in the short-run. Overall, scarce literature concerned with energy consumption of Russia can be found up to now.

Additionally, existing literature focused on the relationship between energy consumption and economic growth mainly analyzes their static relationship by constant parameter models. In fact, this is not completely consistent with the reality and proves hard to describe their dynamic interaction. Therefore, this paper is aimed to overcome these drawbacks and investigate the dynamic nexus between the two variables in Russia with the time-varying parameter cointegration model.

In brief, the contribution of this paper is two-fold. For one thing, this paper attempts to explore the energy consumption issue of Russia. For another, the dynamic nexus between energy consumption and economic growth is examined by the state space model, which may provide some insights for the energy-saving policy making in Russia.

3. Empirical methodologies and data definitions

3.1. Empirical methodologies

This paper first investigates the dynamic nexus between Russia's energy consumption and economic growth according to the state space model and time-varying cointegration approach, and then compares the energy–growth nexus in Russia with that in other BRIC countries from cointegration and causality perspectives, so as to present a relatively profound understanding of the energy–growth nexus in Russia. Therefore, here we briefly introduce the time-varying cointegration and causality test approaches as follows.

3.1.1. The time-varying cointegration based on the state space model

When it comes to the quantitative relationship of energy consumption and economic growth, most studies tend to develop a regression model as follows.

$$Ln\_E\_Russia_t = \lambda + \omega Ln\_Y\_Russia_t + u_t, \quad (1)$$

where $Ln\_E\_Russia_t$ and $Ln\_Y\_Russia_t$ are the log values of energy consumption and real GDP in Russia in year t, respectively; while λ and ω are the coefficients to be estimated and u is the residual term.

The parameters estimated from the Eq. (1), however, are constant and static with average statistical and economic implications. Hence, it is hard for them to reflect the dynamic relationship over the time between energy consumption and economic growth in Russia. Against this shortcoming, in order to explore the possible time-varying relationship between the two variables of Russia, a state space model based on Eq. (1) is developed as

[2] The Commonwealth of Independent States (CIS) includes Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russian Federation, Tajikistan, Ukraine, and Uzbekistan.