Energy Policy 63 (2013) 514–520

Contents lists available at ScienceDirect

Energy Policy

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

Interactions between energy and imports in Singapore: Empirical evidence from conditional error correction models

Salih Turan Katircioglu *

Department of Banking and Finance, Eastern Mediterranean University, PO Box 95, Famagusta, North Cyprus 95, Via Mersin 10, Turkey

HIGHLIGHTS

- Singapore is energy dependent country.
- More than 96 percent of energy is imported.
- Present study investigates interactions between imports and energy in Singapore.
- Results reveal that energy consumption is catalyst in both long and short terms of the Singapore economy.

ARTICLE INFO

Article history:
Received 17 October 2012
Accepted 9 August 2013
Available online 30 August 2013

Keywords:
Energy consumption
Imports
Singapore

ABSTRACT

This study empirically tests for long-run equilibrium relationship and the direction of causality between imports and energy consumption in Singapore. The results of the present study reveal that a long-run equilibrium relationship exists between import growth and energy consumption growth in Singapore by using bivariate systems. Imports of Singapore converge to long-term equilibrium levels by 79.9 percent speed of adjustment through the channel of energy growth. Furthermore, the major finding of this study is that there are long- and short-term undirectional causalities that run from energy growth to import growth in Singapore, which denote that energy consumption in Singapore is a catalyst for importing.

1. Introduction

In the energy economics literature, many studies have analyzed the empirical relationship between energy consumption and output; however, the results remain unclear. Among the latest studies are those of Bélaïd and Abderrahmani (2013), Dagher and Yacoubian (2012), and Wesseh and Zoumara (2012). Many studies in the energy economics literature have proven that energy consumption is in long-term interaction with economic growth. On the other hand, the trade-led growth hypothesis (including export-led and import-led growth hypotheses) has also been tested extensively in the relevant literature. Although many studies have focused on the relationship between energy and economic growth, the interaction between energy and particular components of the economy has not yet received sufficient attention. Some exceptions are the studies of Sadorsky (2012,2011), Lean and Smyth (2010a,2010b), and Narayan and Smyth (2009), which have focused on the links between energy consumption, international trade, and income in the selected countries.

Sadorsky (2012) examines the interaction between energy, income, and international trade in South American countries and finds that a long-run relationship exists between energy consumption, real income, and international trade (either exports or imports). Lean and Smyth (2010a) find that the unidirectional causality that runs from electricity generation to exports exists in the case of Malaysia, while Lean and Symth (2010b) do not find any causality between exports and electricity consumption, again in Malaysia. The results of Narayan and Smyth (2009) suggest long-run causalities that run from exports and electricity consumption to real income and from exports and real income to electricity consumption, and short-term causalities that run from electricity consumption to real income and from real income to exports in the selected Middle Eastern countries.

Many countries import energy, and it is expected that imports drive energy consumption. Therefore, the first research question for the present study can be described as follows: Do imports significantly drive energy consumption? In return, demand for energy also drives imports. Countries like Turkey, which have high foreign energy dependency, experience persistent trade deficits over the years due to high import levels. Therefore, the second research question can be described as follows: Does demand for energy drive overall imports? As the relationship between energy consumption and international trade – in particular, imports – deserves further attention from researchers, the aim of the present study is to investigate the empirical relationship between importing

* Corresponding author. Tel.: +90 630 392 6302008; fax: +90 392 630 2032.
E-mail address: salihk@emu.edu.tr

0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.08.037

activity and energy consumption in the case of Singapore, which ranks ninth in oil imports. For Singapore, 99.36 percent of total energy consumption is imported from abroad as of 2011 (World Bank, 2012).

Singapore is one of the Asian countries most affected by world oil price movements due to its dependency on oil imports (Chang and Wong, 2003). Singapore's strategic location, between the Indian and Pacific Oceans, has allowed it to become a major Asian petrochemical and refining hub (EIA, 2013). According to the EIA (2013), the Port of Singapore is one of the busiest in the world, and handles around 130,000 vessels a year at its various terminals. Furthermore, many global energy companies have regional headquarters in Singapore. China and Vietnam are major competitors of Singapore in the petroleum products market. According to an EIA (2013), the Government of Singapore has announced its mission to improve its market share in refining and to be an oil trading leader. Furthermore, Malaysia and Indonesia supply Singapore with natural gas; the Singaporean government promotes the use of natural gas in the country, and terminals for importing liquefied natural gas and diversifying its supply are being built as of 2013. In addition to these, the Singaporean government has other plans and projections that surely affect importing activity in Singapore (see EIA, 2013 for further details). It would be interesting to investigate the empirical association between energy consumption and importing activity in Singapore. Since Singapore is one of the top energy importing countries, it is important to investigate how the demand for energy contributes to increases in overall importing.

There are other, general reasons for studying the interactions between energy and imports. As mentioned by Sadorsky (2011), if energy consumption is found to be a catalyst for exports or imports, then any reductions in energy consumption due to energy conservation polices will reduce exports or imports and therefore reduce the benefits of trade. This will result in a lower economic growth rate. However, in cases where exports and imports are catalysts for energy, energy conservation policies will not negatively affect the benefits of trade, resulting in higher economic growth. All of these justifications indicate that studying the interactions between energy and imports would contribute to the existing energy economics literature.

The present study does also make any methodological contributions to the literature. Bounds testing plus conditional error correction methodology under the autoregressive distributed lag (ARDL) system and the Johansen methodology are adapted to the present study in order to investigate the empirical association between imports and energy consumption in Singapore. Different scenario options, as proposed by Pesaran et al. (2001) and coded in programming language for EVIEWS software, have been employed, which will enable us to check whether results are robust with the Johansen approach. The comparison through adaptation of difference scenarios – of the ARDL and Johansen methodology – is another contribution of the present article.

The results of this study suggest that the first research question described above cannot be validated for Singapore, while the second research question about whether demand for energy drives imports is validated and confirmed in the case of the Singaporean economy. The rest of this study is organized as follows: Section 2.1 describes theoretical setting of the study; Section 2 presents data and methodology, Section 3 provides the results of the empirical analysis, and Section 4 concludes the study.

2. Data and methodology

2.1. Theoretical model

The present study proposes that imports and energy consumption might reinforce each other. Therefore, empirical analysis in a bivariate setting will be carried out in this respect. The following functional relationships are proposed in this study:

$$M_t = f(E_t) \tag{1}$$

$$E_t = f(M_t) \tag{2}$$

where M is imports and E is energy consumption. The functional relationships in Eqs. (1) and (2) can be expressed in logarithmic form to capture the growth impacts in the economic long-term period:

$$\ln M_t = \beta_0 + \beta_1 \ln E_t + \varepsilon_t \tag{3}$$

$$\ln E_t = \beta_0 + \beta_1 \ln M_t + \varepsilon_t \tag{4}$$

where at period t, $\ln M$ is the natural log of imports, $\ln E$ is the natural log of energy consumption, and ε is the error disturbance.

The dependent variables in Eqs. (3) and (4) may not immediately adjust to long-term equilibrium levels following a change in their determinants (Katircioglu, 2010). Therefore, the speed of adjustment between the short-run and long-term levels of the dependent variable as well as the short-term coefficients can be captured by estimating the following error correction models:

$$\Delta \ln M_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta \ln M_{t-j} + \sum_{i=0}^{n} \beta_2 \Delta \ln E_{t-j} + \beta_3 \varepsilon_{t-1} + u_t \tag{5}$$

$$\Delta \ln E_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta \ln E_{t-j} + \sum_{i=0}^{n} \beta_2 \Delta \ln M_{t-j} + \beta_3 \varepsilon_{t-1} + u_t \tag{6}$$

where Δ represents a change in M and E, and ε_{t-1} is the one period lagged error correction term (ECT), which is estimated from Eqs. (3) and (4). ECT in Eqs. (5) and (6) shows how quickly the disequilibrium between the short-run and long-run values of the dependent variables is eliminated each period. The expected sign of ECT is negative (Gujarati, 2003). The next section will describe bounds tests, conditional error correction models, and conditional Granger causality tests under the ARDL approach in order to investigate a bivariate relationship between imports and energy consumption in Singapore.

2.2. Data

The data used in this study are annual figures covering the period 1960–2011, and the variables of the study are energy use (E) (kt of oil equivalent) and imports of goods and services (M). Imports are at constant 2000 prices in USD. The data were taken from World Bank (2012).

2.3. Unit root tests

Kwiatkowski Phillips, Schmidt, and Shin (KPSS) (Kwiatkowski et al., 1992) unit root tests were initially employed in the present study in order to eliminate a possible low power against stationary near unit root processes, which occurs in the Augmented Dickey–Fuller (ADF) (Dickey and Fuller, 1981) and Phillips and Perron (PP) (Phillips and Perron, 1988) tests (Katircioglu and Naraliyeva, 2006). The KPSS test complements the ADF and PP tests and the null hypothesis of the KPSS test is that a series is stationary.

The post-1990 periods focus more on trade openness than do the previous periods in Singapore. Therefore, tests for a structural break in the data series are needed. Alternatively, in addition to Kwiatkowski et al. (1992) unit root tests, Zivot and Andrews (1992) test for unit root has also been employed in the present study in order to investigate the order of integration of the variables due to the reason mentioned above. Zivot and Andrews (ZA) (Zivot and Andrews, 1992) unit root tests allow a single break in the series, and tests are carried out for the null hypothesis of a unit root.