Short- and long-run relationships between natural gas consumption and economic growth: Evidence from Pakistan

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ABSTRACT

This paper examines the dynamic relationship between natural gas consumption and economic growth in Pakistan using a multivariate model by including capital and labor as control variables for the period between 1972QI and 2011QIV. The results of the ARDL bound testing indicate the presence of cointegration relationships among the variables. The estimated long-run impact of gas consumption on economic growth is greater than other factor inputs suggesting that energy is a critical driver of production and growth in Pakistan. Furthermore, the results of causality test suggest that natural gas consumption and economic growth are complements. Given that natural gas constitutes to the primary source of energy in Pakistan, the implication of this study is that natural gas conservation policies could harm growth and, therefore, requires the policy makers to improve the energy supply efficiency as well as formulate appropriate policies to attract investment and establish public–private partnership initiatives.

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1. Introduction

Of late, growing interest has emerged on issues pertaining to the use of natural gas and its relationship to economic growth. Due to potential policy implications (Ozturk et al., 2010), the issue of energy consumption and economic growth nexus is being extensively examined by scholars in the field. In any case, if natural gas consumption impacts economic growth directly, then, energy conservation policies could adversely impact economic growth. In order to meet the Kyoto targets and since natural gas records comparatively less CO_2 emissions than other fossil fuels, countries around the world are exploring policy options to encourage the use of natural gas as an alternative fuel (Apergis and Payne, 2010). On average, the percentage of total energy consumption of world natural gas in 1990 and 2007 was around 21% and 23% respectively. In like manner, the total natural gas consumption between 2007 and 2035 is expected to grow at 1.8% on average (EIA, 2010). Thus, investigating both the long and short-run relationships as well as causal links could yield valuable lessons for future policy directions.

Similarly, since natural gas is an important source for electricity generation, a higher demand for electricity translates to an increase in the need for natural gas (EIA, 2010). Projection indicates that electricity generation from natural gas is expected to increase by 2.1% over the

years from 2007 to 2035 (EIA, 2010). Natural gas has become an attractive option since it is more fuel efficient, and provides better operational flexibility and lower emission and capital costs. As such, developing countries that are not likely to attract enough investment (including foreign direct investments) for other fuel mix strategies, especially nuclear energy, resort to the use of natural gas as an alternative.

The growing need for natural gas as well as its implication for economic growth requires one to understand the link between them to better inform the policy makers on the available policy options. This is more acute in case of Pakistan for two main reasons. First, there is a lack of studies examining the long-run relationship as well as the causal link between natural gas consumption and growth to provide sound policy lessons for Pakistan. In the last 20 years, gas consumption has tripled; from 0.6 Btu (quadrillion British thermal units) in 1980 to 1.9 quadrillion Btu in 2001 due to rising demands as a result of consistent rise in per capita income. Second, natural gas had been a dominant fuel in Pakistan accounting for almost 47% of primary energy demand in 2007. Pakistan had development plans for hydropower but was discontinued due to difficulties in acquiring foreign investment (EIA, 2010). Besides that, Pakistan's nuclear power contribution to the total energy production is small; supplying only 2.34% of the country's electricity. Since year 2000, natural gas and petroleum have been considered the main source of energy, recording an average of 50% and 29% respectively, of the total energy consumption in Pakistan (Pakistan Energy Yearbook, 2005). However, the consumption of petroleum based products has since decreased drastically due to a hike in petroleum price. Thus, paving the way for an increase in use of compressed

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gas is revolutionizing the nature of transportation in Pakistan and, consequently resulting in a rise in natural gas consumption in country. Furthermore, the government, on their part, had also made efforts to encourage the local compressed gas (CNG) and liquefied petroleum gas (LPG) for the consumption in transport, agriculture, and power sectors not only due to the high cost of imported oil but also because they are much cheaper and relatively cleaner alternative source of energy for the sectors. Recent records show that transport and the power sectors account for nearly 51% and 40% of the overall gas consumption respectively (Government of Pakistan, 2008–09). In this respect, diversifying fuel mix is the priority not only at the country level but also at the sectoral level especially among power consuming firms. The above description provides a rationale to investigate the impact of natural gas consumption on economic growth and the direction of causal relationship between natural gas consumption and economic growth.

Apparently, existing studies on natural gas consumption and growth are limited (Apergis and Payne, 2010) and consensus on the potential links is still mixed (Lee and Chang, 2005; Sari et al., 2008; Zamani, 2007). Based on the current scenario, Karanfil (2009) correctly stressed on the need for consistent results and recommended the implementation of novel methods using the recent econometric tools that are appropriate to examine the energy-growth nexus. This will enable policy makers to pragmatically draw up realistic future policy directions for their respective countries.

In case of Pakistan, to the best of our knowledge, only four studies (Aqeel and Butt, 2001; Khan and Ahmed, 2009; Siddiqui, 2004; Zahid, 2008) are available and, quite evidently they have all come short of investigating the dynamic relationship between gas consumption and economic growth. On top of that, most of these studies relied on bivariate models to establish the causality between gas consumption and economic growth. As it is, the bivariate model specification issues as well as the use of inappropriate estimation techniques further limit the reliability of these investigations. Lütkepohl, (1982) indicated that the exclusion of other relevant variables contributes to biasness and therefore would yield inconsistent results. On other hand, including the control variables of growth such as capital and labor and, estimating a multivariate model helps provide more reliable evidence on the causal relations between the variables (Loizides and Vamvoukas, 2005). In tandem, most studies use the unit root test such as Augmented Dicky–Fuller (ADF) which is perceived to be less reliable (Shahbaz et al., 2012). For instance, Dejong et al. (1992) and, Harris and Sollis (2003) contended that due to their poor size and power properties, the ADF test is unreliable for small sample data sets. Moreover, ADF test seems to over-reject the null hypotheses when it is true and accepts it when it is false.

We use three traditional and two structural break different unit-root tests. In addition, although it is acknowledged that determing series as $I(0)$ and $I(1)$ is difficult due to power deficiency inherented in classical unit root test, the use of ARDL model will be able to mitigate this problem as the approach does not require pre-testing for unit root. According to Rahbek and Mosconi (1999), although Johansen's approach allows a mixture of $I(0)$ and $I(1)$ variables, the procedure for the cointegration rank can be sensitive to the presence of stationary variables. Jinke et al. (2008) and Wolde-Rufael, (2010) also detailed other limitations of this nature.

The intent of this paper is to overcome the limitations discussed above by offering a more robust specification with the inclusion of control variables using a multivariate framework as well as country specific evidence. The use of recent estimation technique known as Auto Regressive Distributed Lag (ARDL) bound testing as well as vector error correction method, variance decomposition and impulse response function allows us to check the robustness of the results. The ARDL approach is known to offer the following advantages. It yields consistent long-run estimates even when the right hand side variables are endogenous (Inder, 1993). By using appropriate order of the ARDL model, it is possible to simultaneously check for (i) serial correlation in residuals

and (ii) the problem of endogenous regressors (Pesaran and Shin, 1999). The ARDL model is indeed a preferred cointegration technique because of its robustness that lends well for studies using small sample sizes as it allows for the variables to have different optimal lags. The approach is also valid regardless of whether a series is $I(0)$ or $I(1)$. Similarly, the Vector Error Correction Model (VECM) Granger causality also allows the examination of long and short-run causality. In addition, country specific evidence of this study allows us to mitigate the shortcomings of cross-country analysis (see Sari and Soytas, 2009; Chang et al., 2001; Stern, 2000). Chandran et al. (2010) indicate that country specific studies allow one to take into account the institutional, structural and policy reform more specifically as it offers more room to discuss the policy implication for the country under study. This paper fills this gap in energy literature by examining the nature of the direction of causality between natural gas consumption and economic growth in case of Pakistan over a span of period between 1972QI and 2012QIV by including capital and labor.

The rest of the paper is as follows. Section 2 deals with prior literature. Section 3 introduces econometric modeling, estimation techniques as well as data collection. Empirical findings are discussed in Section 4, while Section 5 contains conclusions and policy recommendations.

2. Literature review

The short- and long-run causal relationships between energy consumption and economic growth have been largely investigated in the literature. Both developed and developing countries have been considered using various cointegration and causality approaches. For example, Yu and Choi (1985) for UK, US and Poland, Yang (2000b) and Lee and Chang (2005) for Taiwan, Fatai et al. (2004) for New Zealand and Australia, Ewing et al. (2007), Sari et al. (2008) and Hu and Lin (2008) for US, Reynolds and Kolodziej (2008) for Soviet Union, Zamani (2007) and Amadeh et al. (2009) for Iran, Adeniran (2009) and Clement (2010) for Nigeria, Shahbaz et al. (2013) and Apergis and Payne (2010) for 67 countries. Table 1 summarizes the main findings of empirical studies. A careful inspection of existing works reveals two important issues. First, not only is the evidence mixed and less country specific, but also are the estimation techniques less appropriate in some of the studies that used small sample sizes. For this purpose, Lütkepohl, (1982) suggests that the exclusion of relevant variables makes the results inconsistent and, in most cases no causal relationship can be found between energy-consumption and economic growth. In particular, investigating the link using bivariate models is subjected to omitted variable biasness. Second, the estimation periods are not current, thus leading to a lack of knowledge pertaining to the links between the two variables in the presence of new developments in energy outlooks. Inclusion of these time periods is therefore crucial and imperative for appropriate and relevant policy suggestions to be made. For instance, in view of the global crisis and the recent development in climate change agendas, fuel mix policy has drastically changed. Thus, findings by previous empirical investigations undertaken without considering these events would be less accurate if not invalid.

In the particular case of Pakistan, there are a large number of studies dealing with the energy consumption–economic growth relationship, but only a few studies have investigated the role of natural gas consumption. For example, Hye and Riaz (2008); Masih and Masih (1996) and Saten and Shahbaz (2010) reported bidirectional causality between energy consumption and economic growth in Pakistan, while Khan and Qayyum (2007) and Imran and Siddiqui (2010) found unidirectional causality running from energy consumption to economic growth in SAARC including Pakistan. Similarly, Noor and Siddiqui (2010) concluded that a rise in income per capita Granger caused energy consumption in South Asian countries namely Pakistan, Bangladesh, India, Nepal and Sri Lanka. Therefore, despite its importance to the economic development, the empirical evidence on the causality between natural gas