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Do population age groups matter in the energy use of the oil-exporting countries?

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ABSTRACT

This study examines the impacts of the population age groups of 20–34, 35–49, 50–64 and 65–79 on the per capita energy use of the oil-exporting countries of Commonwealth Independent States: Azerbaijan, Kazakhstan and Russia employing the modified-STIRPAT framework. Considering that estimations using non-stationary data may yield spurious results, unlike many prior STIRPAT studies, we explore integration and cointegration properties of the data and then estimate long- and short-run elasticities as well as speed of adjustment coefficients. Since our time series analysis covers only 23 observations (1990-2012), as a robustness check, we also conduct panel data analysis by pooling the mentioned countries data with that for members of Organization of Petroleum Exporting Countries. We apply the Autoregressive Distributed Lags Bounds Testing approach in the time series analysis and Pooled Mean Group estimator in the panel analysis, both are superior in small samples. The findings from the time series analysis are supported by those from the panel data analysis. According to the results, there is cointegrated relationship among the variables. The age groups together with affluence and oil prices have statistically significant impacts on the per capita energy use in the selected countries. Moreover, we find the speed of adjustments exhibiting different magnitudes for different countries depending on which population age group is considered. The findings suggest that policymakers should pay special attention to the population age groups of 35–49 and 50–64, as they have a large effect on per capita energy use. Since these groups are the main part of the working age population, increase in their energy consumption is likely to lead to economic growth. Furthermore, the policymakers should take into consideration the finding that speed of adjustments towards an equilibrium path is quite high. It implies that any policy related shocks to the per capita energy use relationship could disappear within a year or even sooner.

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1. Introduction

Energy is vital for society, and therefore has rightly attracted a huge number of studies devoted to investigating different aspects how its use affects social wellbeing. Since the seminal study by Kraft and Kraft (1978), a number of studies have investigated the nexus between energy use and economic growth at national and cross-national levels (Bozoklu and Yilanci, 2013; Damette and Seghir, 2013; Ozturk, 2010; Narayan and Smyth, 2009 among others). As Liddle (2013) emphasizes, these studies basically analyze energy use as a function of affluence and price (see e.g. Holtedahl and Joutz, 2004; Halicioglu, 2007; Dergiades and Tsoulfidis, 2008; Narayan et al., 2007) and one significant shortfall of this line of literature is that it does not take into account of the impact of demographic changes.

In 1990s and early 2000s, the co-called STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) framework has been developed based on IPAT framework (Impacts by Population, Affluence, and Technology. See Ehrlich and Holdren, 1971; Dietz and Rosa, 1994, 1997). One of the advantages of the STIRPAT modeling approach, among others, is that it brings together population and economic effects of energy consumption and environmental changes and thereby, addresses the above-mentioned shortfall. As suggested by Liddle (2014), the STIRPAT framework has become the main workhorse in investigation of population and affluence impacts on environment and energy consumption.

Despite the growing number of research examining energy use effects of population and economic growth utilizing the STIRPAT framework, a number of issues remain to be addressed in the existing literature. For example, most of the STIRPAT based studies were devoted to developed and developing countries using cross-national or panel data (York et al., 2003b; Poumanyvong et al., 2012; York, 2007; Liddle and Lung, 2010; Salim and Shafiei, 2014). As Brizga et al. (2013) states, few studies have investigated the environmental and especially energy

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use effects of affluence and population in the oil-exporting countries of the Commonwealth Independent States (CIS): Azerbaijan, Kazakhstan and Russia. Among the few studies that have examined this region, either cross-sectional or panel data are employed (see Shafiei, 2013; Scarrow, 2010; Fang et al., 2012; Nouri et al., 2012). Along with its advantages, there are some shortcomings of panel studies (Kasprzyk et al., 1989; Dietz and Rosa, 1994; Hsiao, 2003). For example, it is difficult to produce reliable policy implications for individual countries, as country specific features are usually omitted in panel framework. In this regard, individual country based time series analyses can provide much more adequate representations of reality by discovering country specific features and thus can produce more reliable policy recommendations. To the best of our knowledge, an individual country base analysis of energy consumption using time series data and cointegration and error correction methods in the STIRPAT framework has not been conducted for Azerbaijan, Kazakhstan and Russia.[1]

In addition, many STIRPAT studies consider the effect of total population on energy use. However, other demographic variables, such as population age structure, might have significant influence on energy use (O'Neill and Chen, 2002). This is because individuals in different ages behave differently in their energy consumption. For example, energy consumption of young individuals are not the same that of older and elder individuals. While several studies have looked at the impacts of broad age groups, such as 15-64 (Shi, 2003; Cole and Neumayer, 2004; York, 2007), few provide further decomposition of age groups (except for Liddle and Lung, 2010; Liddle, 2011; Menz and Welsch, 2012). Such omission may lead to incomplete estimation of the energy effects of population change, as there might be significant correlation between life cycle stages and particular energy consumption activities (Liddle, 2014). Liddle and Lung (2010) and Liddle (2011) suggest that more disaggregated population age groups should be preferred to any other broader age groups in terms of their effect on energy use.

Still, another shortfall is that although most existing studies have utilized panel data, they have not considered potential problems that may arise from non-stationarity. According to Liddle (2014), economic and population data are usually non-stationary, and studies without considering this property might potentially suffer from spurious regression results.[2] Among existing studies, Liddle and Lung (2010); Poumanyvong and Kaneko (2010) and Liddle (2011, 2013, 2014, 2015) have considered the non-stationary properties of datasets. However, while these papers deal with such issue by conducting unit root and cointegration tests and estimating long-run elasticities, they have not investigated error correction properties of data. This property (estimations of speed of adjustment (SoA) coefficients) provides information about how much time is needed to converge to an equilibrium path after having a shock in the relationship, and therefore is useful for policymakers in taking effective measures on energy use. None of the previous STIRPAT studies, except Shafiei (2013), has addressed this issue for the countries under consideration.[3]

The objective of this study is to address these issues and start filling the corresponding research gaps. In doing so, we investigate the role of disaggregated population age groups in long-run behavior and short-run dynamics (including equilibrium adjustment process) of energy use employing the STIRPAT modeling framework for Azerbaijan, Kazakhstan and Russia.

One interesting feature of these countries is that they are high-income (Russia) and upper-middle-income (Azerbaijan and Kazakhstan) economies with a significant amount of oil and gas resources.[4] As illustrated in Fig. 1, these countries, specifically Azerbaijan and Kazakhstan, have demonstrated tremendous economic growth since 2000s and have been experiencing significant demographic dynamics (WB, 2015; ECOKSI, 2011; Nouri et al., 2012). Furthermore, Nouri et al. (2013) project a significant increase in energy consumption of Azerbaijan and Kazakhstan in the backdrop of growing population and income level. Thus, these three countries pose an interesting case to investigate how growing affluence and population would affect energy use in the given socio-economic set-up.

We apply time series cointegration and error correction modeling approach of the Autoregressive Distributed Lags Bounds Testing (ARDLBT) to the data of the countries over the period 1990–2012. Since we have small number of time series observations, in order to get robust results and make proper conclusions, we also analyze integration, cointegration and convergence properties of the panel data by pooling the three CIS countries' data with those from nine OPEC members.

The results from the time series data and panel data are consistent with each other. According to the results, there is evidence of cointegration among the variables. The estimations show that the population age groups as well as affluence and oil price have statistically significant impact on energy use in the selected countries in the long run. In addition, we find that the magnitude of SoAs depend on the specific country and the population age group being considered.

Our study may contribute to the existing literature by a number of ways. First, to the best of our knowledge, this is the first time series study that investigates each country's (Azerbaijan, Kazakhstan and Russia) energy use effects within the STIRPAT modeling framework. Second, even in the panel context, there are very few studies (Shafiei, 2013; Scarrow, 2010; Fang et al., 2012; Nouri et al., 2012) investigating energy use of the CIS oil-exporting economies in the STIRPAT framework. In this regard, our analysis adds to existing studies of the CIS countries. Third, none of the previous studies for the CIS oil-exporting economies considers more disaggregated age groups of population.[5] We provide a finer decomposition of the population age structure. In particular, we follow Liddle and Lung (2010) and study the energy impacts of the share of population age groups 20–34, 35–49, 50–64, and 65–79 respectively.[6] A fine categorization of age structure enables us to uncover the energy consumption behavior by specific age cohort groups. Fourth, we carefully test for integration and cointegration, explore the error correction properties of the data and estimate long- and short-run elasticities as well as SoAs for Azerbaijan, Kazakhstan and Russia in both time series and panel data analyses. Finally, we address small sample issue by employing the ARDLBT approach (Pesaran and Shin, 1999; Pesaran et al., 2001)[7] and using critical values calculated for the small samples by Narayan (2005).

Finding of this research may have useful implication for guiding policymaking and energy use projection in the selected countries. The policymakers should particularly consider the age group of 35–49 and

[1] For example, Pao et al. (2011) investigate Russian CO_2 effects of energy use and economic growth. In terms of econometric methodology, they use Cointegration and Error correction modeling, what we are going to employ in our analysis here. However, they do not include either population or its age groups in the analysis and the study does not employ the STIRPAT framework. More importantly for our study, they explore CO_2, but not energy use.

[2] Econometric theory postulates that obtained regression results are spurious if a linear combination of non-stationary variables is not stationary, i.e. if there is no cointegrating relationship among them (see Engle and Granger, 1987 inter alia).

[3] Only Russia but not Azerbaijan and Kazakhstan have been included in Shafiei (2013), since she has analyzed the panel data of OECD countries. Moreover, this has been a panel analysis where again, country specific features are usually omitted (for example, it was not known what the long- and short-run elasticities and SoA coefficient for Russia were).

[4] The income categories of the countries are based on the World Bank classification (http://data.worldbank.org/about/country-and-lending-groups#Upper_middle_income).

The countries have a certain subsidy policy on domestic energy use (IEA, 2006; OECD, 2013; Whitley, 2013). However, we are not investigating the impact of subsidy policy on energy use in this study and it would be an interesting topic for future research in this area.

[5] Nouri et al. (2012) consider the population age groups of 0–14, 15–64 and 65–79 while Scarrow (2010) takes age group of 15–64. However, as an anonymous referee commented to the earlier version of our paper, broad age groups, such as 15–64 cannot provide useful implications on energy consumption. Moreover, Liddle and Lung (2010) and Liddle (2011) discuss usefulness of considering more disaggregated age groups such as 20–34, 35–49, 50–64, and 65–79.

[6] We thank an anonymous referee for suggesting us to do so.

[7] The ARDLBT approach outperforms other alternative cointegration methods in small samples produce much more consistent and unbiased estimates.

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