New Evidence on Electricity Consumption and Economic Growth Nexus from the Four East Asian Economies

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Abstract

Overviews:

Relationships between energy consumption and economic growth can be dated back to the paper by Kraft and Kraft (1978) over 30 years ago. Since then, the Granger causality models play a major role in the literature. Policy implementations are to a large extent based on the 4 possible causal relationships. First, if electricity consumption unilaterally leads economic growth, it is said electricity consumption gives rise to economics growth or the growth hypothesis. Second, if economic growth unilaterally leads electricity consumption, it implies a modest level of electricity consumption cannot impede economic growth or the conservation hypothesis. Third, feedback relationships prevail between electricity consumption and economic growth. The policy implication in this case hinges upon the direction in which these 2 variables exert their impacts or the feedback hypothesis. Fourth, there exists no causal relationship between the two variables and hence it can be called the neutrality hypothesis. This hypothesis implies that reduced electricity consumption under government mandates is independent of economic growth.

Despite the abundance in the literature (Ozturk, 2010), a great majority of the literature applied bivariate models to different regions in order to explore the relationship of the 2 variables.[1] On the surface, electricity is a relatively clean energy but in reality it depends on the source it is generated. For example, 79.07% of China's electricity was generated from coal, 16.93% from hydraulic power and 1.98% from nuclear power in 2008. Well known in literature, coal-generated energy remits significant amount of carbon dioxide (CO_2). As such CO_2 emission should play a key role in such causality models. In addition, users of electricity consumption- industry, residence or transportation- have different impacts on economic growth. That is, industrial consumption is expected to have more impact on economic growth than do other users. As a result, we take sector consumptions of electricity into consideration in the model.

This research incorporates electricity consumption, economic growth, capital stock and CO_2 emission into the Pooled Mean Group (PMG) model by Pesaran et al. (1999). We then apply it to the four east Asian economies: Japan, China, Taiwan and South Korea in order to unravel the causality between electricity consumption and economic growth.

Methods：

Annual data of the 4 variable are available from 1972 to 2008, 37 observation each in total, which is insufficient and can produce biased results in unit root and cointegration tests. To circumvent the problem, we opt for the pooled technique of the panel model. Traditional pooled panel models fail to take country-specific differences into consideration. As such, we apply the PMG model by Pesaran et al. (1999) to allow for identical long-term coefficients but different

[1] With the exception of (i) Apergis and Payne (2011a, b) who employed 4 variables including capital and labor force, (ii) Quédraogo (2010) who included capital formation in the three variable model and (iii) Odhiambo (2009) who included employment in the 3-variable model.

short-term coefficients across different countries. The strength of the PMG model lies in its efficiency in estimation and it considers across-country differences as well. Furthermore, the PMG approach, an extension of the ARDL model, does not require variables to be I (0) or I (1). Besides, the ARDL model has the advantage over the Johansen's cointegration test with the use of the bound test in the case of small samples. Let $elec_{it}$ be the average electricity consumption per capita for country i at time t, y_{it} be the corresponding real GDP per capita, $CO2_{it}$ be carbon dioxide emission per capita and K_{it} be capital stock. The PMG model is formulated in terms of y_{it} as shown below.

$$\Delta y_{it} = \phi_{1i}(y_{it-1} - \theta_0 - \theta_1 elec_{it-1} - \theta_2 CO2_{it-1} - \theta_3 K_{it-1}) + \sum_{j=1}^{p1} \delta_{11j} \Delta y_{it-j} + \sum_{j=0}^{p2} \delta_{12j} \Delta elec_{it-j} + \sum_{j=0}^{p3} \delta_{13j} \Delta CO2_{it-j} + \sum_{j=0}^{p4} \delta_{14j} \Delta K_{it-j} + \varepsilon_{1it} \quad (1)$$

Note that terms in parentheses are error correction terms representing long term equilibrating process. Hence, long-term coefficients θ_0, θ_1 θ_2 and θ_3 are the same across countries in the PMG model. In contrast, short-term coefficients $\phi_{1i}, \phi_{2i}, \phi_{3i}, \delta_{11j}, \delta_{12j}, \delta_{13j} \ldots$ can assume different values. To test the short term interactions among electricity consumption, economic growth and carbon dioxide emission, we first estimate the long term equilibrium process via error correction term in equation (1). We then construct the four-variable vector error correction (VEC) model to investigate the Granger causality among these four variables for each economy.

Expected Results:

It is expected that causal relationships across the 4 countries may not take the same direction with similar magnitudes in terms of electricity consumption, economic growth and carbon dioxide emission. The variations can be attributed to the sources where electricity is generated and different users in which electricity is consumed from each country.

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