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Electricity and growth nexus dynamics in Singapore : Fresh insights based on wavelet approach

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ABSTRACT

This study examines the empirical relationship of electricity generation (EGEN) and economic growth (IPI) in Singapore by using the flexible properties of the wavelet approach. This innovative technique allows the decomposition of time-series across time scales. In this study, we used continuous wavelet transform, cross wavelet and wavelet coherence ratios to investigate the relationship between EGEN and IPI by using the monthly data from 1983(1) to 2016(1). Results of autoregressive distributed lag and Johansen Juselius cointegration tests show that there is a significant long-run relationship the mentioned variables in Singapore. Furthermore, results indicate that there is a unidirectional causal relationship running from EGEN to IPI in the long run while a bidirectional causal interplays are depicted between the of EGEN on IPI in medium run. Thus it can be recommended that government needs to increase electricity generation and further providing and nurturing the expansion of electricity supply in country which will ultimately benefits the economic growth.

1. Introduction

Last years, various studies tried to investigate the connection between electricity consumption and Economic growth. The whole outcomes explain that electricity consumption has a positive and significant relationship with economic growth (Ferguson et al., 2000). Additionally, there are numerous evidences supporting the hypothesis of a bi–directional causality between the mentioned variables while some other results underlined the existence of a uni-directional causal relationship (Yoo, 2005; Shiuand Lam, 2004; Ghosh, 2002).

Only few empirical works focalized literature on the causal interplays between electricity generation and economic growth. Each one of these variables can be the leading index as the causality may be significant at both directions. Consequently, the arising question could be is there any significant causality between in the EG-growth nexus, if yes, what is the leading/following index?

The omnipresence of intense unidirectional or bidirectional reciprocal effects between the electricity generation and economic growth will certainly attract both policy makers and investors as they will push them to renew their former points of view (among others). In the landscape of new reforms and globalization of the neighboring countries (including among others China), Singapore Government will not remain unresponsive especially that is becomes essential to reformulate new rules aiming to improve all the key sectors of the economy. In doing so,policy makers in Singapore are very much involved and shown an extreme interest on the role played by the EG sector to boost the economic growth. Nowadays, the set-up of electricity is becoming a progressively essential factor of the economy. According to the report of Energy from the Association of South East Asian Nations (ASEAN) Center, consumption of energy is projected to enhance from 280 million tons of oil equivalent (MTOE) to 583 MTOE in period from 2000 to 2020 respectively. Accordingly, there is a need to invest 323 billion US $ to be injected into the electricity sector by the end of 2020 in order to sustain economic growth of ASEAN countries. The major investment will be injected in Singapore because this country has the highest economic growth rate and also a highest economic growth per capita among the other 10 member nations of the ASEAN.

As far as we are, generation of electricity increase the labor, productivity of capital and numerous other components of production.

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Furthermore, more usage of communications and information machineries is instigating global evolution toward a digital culture that might need more electricity generation (Baer et al., 2002). To deal with the progressively electricity demand associating economic growth, it becomes crucial that Singapore industry to re-examine and reveal the causal connection among electricity generation and economic growth and to propose a suitable electricity generation policies. This assignment is presently one of the vital concern that Singaporean government needs to address (Karki et al., 2005; Yong, 2004).

The main objective of this study is, thus, to examine the causal relationship between electricity generation and economic growth in Singapore, and propose an effective policy suggestion which will depends on the obtained results. Given that the most challenging task is to offers a credible and clear vision on the Future evolution of the relationship (to further define the plausible and effective strategies that will help both policy makers and investors to better oriented their actions based on true expectations), the present work differs from the pioneer works and the previous jargon in term of the approaches used to further assess the complex behavior underlying the electricity-growth nexus. Considerable attention was given to the choice of the most appropriate method that can circumvent all hurdles or gaps.

On the practical side and contrary to the previous empirical works who focalized their attention on standard and well known methodologies to explore the causality links or may be simple correlation between the mentioned sectors, without distinguishing between the different time horizons, the present work implement a more sophisticated and flexible approach that may improve the analysis by offering fresh insights to the electricity –growth nexus. We rely on both wavelet approaches to explore the underlying intrinsic characteristic of the industrial production and electricity generation prices from 1983 to 2015. The mentioned period is particularly interesting given that it registered several extreme events including the Asian crisis, the global financial crisis, the electricity crisis among other times of turmoil which certainly impacted the development process. The wavelet method widely differs from the previous techniques because it is very advantageous comparatively to the usual approaches: firstly, the wavelet approach have some advantages that are not involved in the standard model. Given the nature of the IPI and EG indices almost governed by nonlinear and chaotic behavior; it's become rather difficult to capture the dominant properties of their fluctuations. In recent years, unprecedented interest emerged on the decomposition methods in order to capture drifts or spikes relatively to this type of data. The motivation behind the use of the former method is that noises and erratic behavior often appeared at the edge of the signal, can affect the quality of the shock and thus increase erroneous results of the shock transmission between the mentioned indicators. As pointed by Jammazi (2012a,b): An interesting question can arise when exploring an enormously complex nexus: *what is the most productive technique that can be used to get unbiased, meaningful and more reliable results.?*

Obviously, by adopting a standard model, we may lose the real data features or the real intrinsic characteristic governing the IPI and EG prices as the major drawback of the usual models like (VAR or granger causality, regression specifications) is that they can only be applied to the stationary time series!!! (in other words, the accurate estimates are conditional on the data transformation). Any model that requires specific data transformation can leads to the deficiencies of empirical result analysis and cause lacking in policy recommendation in the case of the statistical signs and the magnitude of coefficients (mostly due to the specific characteristics). Therefore, no final economic policy implications can be adopted based on conflicting and unreliable findings.

The wavelet approach is more flexible since it can be applied to both stationary and non-stationary time series thus preserving entirely the main driving forces or processes contained inside the data. The major advantage of wavelet method is to be applied without imposing any restriction to the signal.

One major advantage afforded by wavelets analysis is the ability to perform local analysis that is, to analyze a localized sub image area of a larger image (or signal). Therefore, wavelet analysis is capable of revealing aspects of data that other signal analysis techniques usually miss. In this vein, it is well recognized that the analysis of the co evolution of economic and electricity time series is key issue that has been long postured challenge to academicians and practionners. For, Kyrtsou and Vorlow (2009), this is due to the fact that historical data are resulting from complex systems including several stylized facts including structural changes, policy shifts behavior, volatility shocks, asymmetries, crises, political tensions, and wars. These events result in some main stylized facts in financial time series including the presence of extreme observations, asymmetries, fait tails and non-linearity. Disregarding these irregularities during the statistical modeling tasks may lead to misleading conclusions (see, among others, Duan et al.). Other researchers including Haven et al. (2012), Sun and Meinl (2012) claim that most data generating processes convey noises that are generated by the complex structure of irregularities and coarseness. For these authors, the wavelet methodology is a suitable tool for denoising the data and capturing the various irregularities along with both time and different measuring scales.

Such evidences legitimate the choice of the wavelet approach to circumvent these lacks of consensus thus encompassing all the mentioned gaps. The current study is to apply the continuous wavelet transmute to reexamine the association among electricity generation and economic growth. Precisely, the current study applies three cross-wavelet tools and the continuous wavelet power spectrum. The three cross wavelet tools included wavelet transform, cross-wavelet power spectrum and coherency of cross-wavelet to identify fleeting impacts. The applied method exhume the real intrinsic patters of co movement and causality across time-frequency that have not been apprehended so far. The outcomes is to offer fresh insights and new understanding about the causal linkage among electricity generation and economic growth in Singapore.

Finally, the remaining of paper is organized as follows: Section 2 elaborates the related literature, Section 3 give detailed description of wavelet approach,the fourth section exposes the main results and the major finding that can be drawn. Finally, Section 5 describes the conclusion and the policy implications.

2. Literature review

Very limited studies were devoted to investigate the relationship between electricity generation and economic growth. The previous works leads to misleading conclusions against the relationship between electricity generation and economic growth. Some studies provided evidence on a unidirectional causal relationship between the given data whereas some studies revealed bidirectional feedbacks. Yoo and Kim (2006) investigated the causal relationship among electricity generation and economic growth by taking annual data from 1972 to 2002. Their results suggest the existence of unidirectional causal interplays where causality the economic growth is leading the electricity generation variable but not vice versa.

On the other hand, Marques and Fuinhas (2015) investigate the relationship electricity generation on industrial production index of Portugal by taken monthly time series data from 2007(M1) to 2010(M10). Industrial production and electricity generation from special regimes, electricity generation from ordinary regimes are the variables used for this study. Outcomes of the VDM model suggested that there is only a unidirectional causal relationship exists between industrial production and electricity generation from special regimes. Moreover, Al-mulali et al. (2014) examined the impact of renewable and non-renewable electricity production on economic growth of 18 Latin American countries. They found that renewable electricity generation plays a significant role in promoting economic growth as compare to the non-renewable electricity generation.