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Energy consumption and economic growth in Korea: testing the causality relation

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Abstract

The causal relationship between energy consumption and economic growth is investigated applying two multivariate time series models: a demand side model of energy, GDP and real energy price and a production side model of GDP, energy, capital, and labor. To test for Granger causality in the presence of cointegration among the variables, we employ a VECM rather than a VAR model. Empirical results from the two models for Korea over the period 1981:1–2000:4 suggest no causality between energy and GDP in the short run and a unidirectional causal relationship running from GDP to energy in the long run. It implies an energy conservation policy may be feasible without compromising economic growth in the long run. It also implies that a sustainable development strategy may be feasible with lower level of CO₂ emissions from fossil fuel combustion.

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1. Introduction

As pressure is growing to mitigate carbon dioxide (CO₂) emissions, the main sources of global warming, so too are worries increasing over the negative

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impact on economic growth caused by the restricted use of fossil fuels. Various economic policies and options have been studied in order to attempt to practice energy conservation without impinging on economic growth. The relationship between energy consumption and economic growth has been the subject of intense research over the past three decades. Recently, numerous studies have investigated the causal relationship between the two variables by using time-series analysis, in particular by using the concept of Granger causality. However, empirical evidences from these studies seem to be diverged rather than converged.

A recent advance in this area is to use a multivariate approach rather than a bivariate approach. Stern (1993, 2000) motivated by the fact that energy can be substituted for capital and labor, investigated Granger causality between energy and GDP in a multivariate model by adding capital and labor for the USA in the post-war period. Following Stern, Oh and Lee (2004) also looked at the relationship but in a vector error correction model (VECM). Masih and Masih (1997, 1998) and Asafu-Adjaye (2000) examined the relationship with a trivariate model by adding a price variable to the conventional energy-GDP bivariate model.

Another methodological development is to use a vector error correction model instead of a vector autoregressive (VAR) method in the presence of cointegration among variables. VAR models may suggest a short run relationship between the variables because long run information is removed in the first differencing, while a VECM can avoid such shortcomings. In addition, a VECM can distinguish between a long run and a short run relationship among the variables, and can identify sources of causation that cannot be detected by the usual Granger causality test. Moreover, the VAR method may be improper in the presence of cointegration. Previous studies that applied this development include Yu and Jin (1992), Masih and Masih (1997, 1998) and Asafu-Adjaye (2000).

Following these developments, this paper investigates the Granger causal relationship between energy consumption and economic growth for Korea in the past two decades in a multivariate setting using VECM instead of a VAR or Sims technique. We construct two multivariate models – a demand side model and a production side model. We look at both sides to see if the causal relationships between the two sides are different.

The demand side model follows Masih and Masih (1997) and Asafu-Adjaye (2000) in that a VECM is used for the trivariate variables of energy, GDP and consumer price index (CPI) as a proxy for real energy price. The model, however, uses real energy price instead CPI.

The production side model follows Stern (1993, 2000). We employ the same four variables (energy, GDP, capital, and labor) in our multivariate model. This paper, however, does not follow his time series methodology, VAR, but uses VECM as we find cointegration among variables.

Finally, as we suspect temporal aggregation of either quarterly or monthly data into annual data may weaken causal relationships between the variables, quarterly

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