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Coal consumption and economic growth: Evidence from a panel of OECD countries

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ABSTRACT

This study examines the relationship between coal consumption and economic growth for 25 OECD countries within a multivariate panel framework over period 1980–2005. The Larsson et al. (2001) panel cointegration test indicates there is a long-run equilibrium relationship between real GDP, coal consumption, real gross fixed capital formation, and the labor force. The respective coefficients for real gross fixed capital formation and the labor force are positive and statistically significant whereas the coefficient for coal consumption is negative and statistically significant. The results of the panel vector error correction model reveal bidirectional causality between coal consumption and economic growth in both the short- and long-run; however, the bidirectional causality in the short-run is negative.

1. Introduction

It is well documented that coal is in global abundance and the most economical of fossil fuels. As such, coal has been considered a reliable energy source. Moreover, the political instability of some major oil producing countries and corresponding volatility of oil prices has resulted in a greater reliance among industrialized countries on secure domestically produced energy sources such as coal. However, the reliance on coal has generated concerns over the environmental consequences of its use in terms of greenhouse gas emissions. Such concerns have resulted in international actions such as the Kyoto Protocol to curb greenhouse gas emissions, a substitution toward alternative energy sources for electricity generation, and the promotion of renewable energy sources and sustainable development initiatives through various government tax credits and subsidy programs. In light of the changing energy composition mix toward alternative energy sources, further investigation of the implications of coal consumption for economic growth is relevant in the broader discussion of the current and future economic and environmental issues surrounding the world's energy supply. To this end, this study will examine the implications of coal consumption for economic growth among OECD countries which comprise approximately 35% of coal consumption worldwide.

Specifically, the study extends the existing literature on the causal relationship between coal consumption and economic growth on several fronts. First, the study will include a larger set of countries in the analysis than previous studies; a sample of 25 OECD countries is used in the analysis.[1] Second, nearly half of the published studies on the causal relationship between coal consumption and economic growth, as discussed in Section 2, have been conducted within a bivariate framework. However, a shortcoming of bivariate analysis is the possibility of omitted variable bias (Lütkepohl, 1982). Recognizing the omitted variable problem, this study examines the relationship between coal consumption and economic growth within a multivariate framework by including measures of capital and labor. Third, with the exception of the studies by Hu and Lin (2008), Sari et al. (2008), and Wolde-Rufael (2010), the sign and magnitude of the respective coefficients will be discussed in relation to the various hypotheses on the coal consumption–growth nexus. Fourth, while previous studies of the coal consumption–growth nexus have focused on time series techniques to infer the causal relationship, this study will utilize panel cointegration techniques. While we cannot overlook the merits of time series techniques, the main disadvantage of these techniques is that such approaches do not take into consideration the presence of heterogeneity among the economies included in the sample under investigation. This study employs panel cointegration techniques which take into account the presence of heterogeneity in the estimated parameters and dynamics across countries. Furthermore, the panel unit root and

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[1] Due to the availability of data, only 25 of the 30 countries that comprise the OECD is included in the analysis. In an earlier study, Jinke et al. (2008) explore the different trends between OECD and non-OECD countries with respect coal consumption and economic growth using a limited sample of countries.

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cointegration tests will provide additional power by combining the cross-section and time series data while allowing for heterogeneity across countries (Harris and Tzavalis, 1999).

Section 2 discusses the hypotheses related to the causal relationship between coal consumption and economic growth along with a summary of the previous studies on the causal relationship between coal consumption and economic growth. Section 3 discusses the data, methodology, and empirical results. Concluding remarks are given in Section 4.

2. Coal consumption–growth literature

The causal relationship between coal consumption and economic growth can be synthesized into four testable hypotheses. First, the growth hypothesis argues that coal consumption has a significant impact on economic growth directly and/or as a complement to labor and capital in the production process. The growth hypothesis is confirmed if an increase in coal consumption causes an increase in economic growth. In this scenario, energy conservation policies which reduce coal consumption may adversely affect economic growth. On the other hand, a number of explanations may be presented in which an increase in coal consumption has a negative impact on economic growth. Such a negative impact of coal consumption on economic growth could be attributed to an inefficient and excessive use of coal consumption. As pointed out by Wolde-Rufael (2010), it is possible that industries that use coal are becoming less efficient. In addition, the lack of legislative restrictions on the growth of carbon dioxide emissions may contribute to the excessive use of coal as well.

Second, the conservation hypothesis postulates that coal consumption is driven by economic growth. The conservation hypothesis is supported if there is unidirectional causality from economic growth to coal consumption. In this case, energy conservation policies oriented toward the reduction of coal consumption may not have an adverse impact on economic growth. However, it is possible that an increase in economic growth may actually reduce coal consumption which may indicate that an economy is becoming less coal intensive, for instance, electricity production from coal as a proportion of total electricity production may be actually declining (Wolde-Rufael, 2010).[2]

Third, the feedback hypothesis highlights the interdependent relationship between coal consumption and economic growth. The feedback hypothesis is substantiated by the presence of bidirectional causality between coal consumption and economic growth. This complementary relationship opens the possibility that energy conservation policies which reduce coal consumption may, in turn, impact economic growth. Likewise, such fluctuations in economic growth will be transmitted back to coal consumption. Fourth, the neutrality hypothesis asserts that coal consumption serves a relatively minor role in economic growth. The neutrality hypothesis is supported by the absence of causality between coal consumption and economic growth. Under this scenario, the reduction in coal consumption through energy conservation policies will not impact economic growth.

As shown in Table 1, the empirical literature on the causal relationship between coal consumption and economic growth has employed a variety of econometric approaches with the analysis concentrated on a relatively limited number of countries. With the exception of the studies on the US, Turkey, South Africa, India, and the former Soviet Union, the majority of the studies have focused on Asian and Pacific Rim countries. In the case of Taiwan, Yang (2000a) finds unidirectional causality from economic growth to coal consumption while Yang (2000b) and Lee and Chang (2005) provide evidence of bidirectional causality between coal consumption and economic growth. With respect to China, Jinke et al. (2008) and Wolde-Rufael (2010) find unidirectional causality from economic growth to coal consumption whereas Yuan et al. (2008) show bidirectional causality between coal consumption and economic growth.[3] In the case of Korea, Yoo (2006) finds bidirectional causality between coal consumption and economic growth; the absence of a causal relationship by Jinke et al. (2008); and unidirectional causality from economic growth to coal consumption by Wolde-Rufael (2010). For Japan, Jinke et al. (2008) reveal unidirectional causality from economic growth to coal consumption whereas Wolde-Rufael (2010) provides evidence of unidirectional causality from coal consumption to economic growth. The results also vary for India with the absence of a causal relationship between coal consumption and economic growth reported by Jinke et al. (2008) while Wolde-Rufael (2010) finds unidirectional causality from coal consumption to economic growth. With regard to the Pacific Rim countries of Australia and New Zealand, Fatai et al. (2004) indicate unidirectional causality from economic growth to coal consumption for Australia using both the Johansen–Juselius and the Toda–Yamamoto methodologies; however, the absence of a causal relationship when using the autoregressive distributed lag (ARDL) model. In the case of New Zealand, Fatai et al. (2004) do not find a causal relationship between coal consumption and economic growth using either the Johansen–Juselius or Toda–Yamamoto approaches in testing for causality.

For the remaining countries examined in the literature, the results also vary as well. Sari and Soytas (2004) employ generalized forecast error variance decomposition analysis to find that coal consumption explains up to 8% of the forecast error variance in real GDP for Turkey. In the case of the former Soviet Union, Reynolds and Kolodziej (2008) find unidirectional causality from economic growth to coal production. With regard to South Africa, Jinke et al. (2008) do not find a causal relationship between coal consumption and economic growth whereas Wolde-Rufael (2010) finds a bidirectional causal relationship. Though Ziramba (2009) does not find a causal relationship between coal consumption and industrial production, evidence does suggest unidirectional causality from coal consumption to employment in South Africa. Finally, in the case of the US, Ewing et al. (2007) utilize the generalize forecast error variance decomposition analysis to show that coal consumption explains up to 10% of the forecast error variance of industrial production. In a similar study, Sari et al. (2008) provide support for unidirectional causality from coal consumption to industrial production. On the other hand, Payne (2009b) fails to find a causal relationship between coal consumption and economic growth for the US while Wolde-Rufael (2010) finds bidirectional causality.

The next section describes the data, panel unit root and cointegration tests along with the results of a panel error correction model in terms of the causality associated with coal consumption and economic growth within a multivariate framework.[4]

[2] Wolde-Rufael (2010) provides a good discussion of the possibility of negative causality from coal consumption to economic growth as well as negative causality from economic growth to coal consumption.

[3] While Shanghai is not a country, Wolde-Rufael (2004) finds unidirectional causality from coal consumption to economic growth.

[4] See recent studies by Apergis and Payne (2009a, b) and citations therein for additional studies on the use of panel cointegration and error correction modeling within the context of the energy consumption–growth nexus.