



# Structural breaks, energy consumption, and economic growth revisited: Evidence from Taiwan

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## Abstract

This paper studies the stability between energy consumption and GDP for Taiwan during 1954–2003. We use aggregate as well as various disaggregate data of energy consumption, including coal, oil, gas, and electricity, to employ the unit root tests and the cointegration tests allowing for structural breaks. Our main findings are: First, though gas consumption seems to have structural breaks in the 1960s, after considering the structural breaks, the series is a stationary variable when Taiwan adopted its expansionary export trade policy. Second, we find that different directions of causality exist between GDP and various kinds of energy consumption. The empirical result shows unanimously in the long run that energy acts as an engine of economic growth, and that energy conservation may harm economic growth. Third, the cointegration between energy consumption and GDP is unstable, and some economic events may affect the stability. Overall, we do find the structural breakpoints, and they look to match clearly with the corresponding critical economic incidents.

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## 1. Introduction

Many production and consumption activities involve energy as a required input, making it a key source of economic growth. At the same time, economic growth may induce the use of more

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energy. However, the aspect of owing to structural breaks is a common problem in macroeconomic series as they are usually affected by exogenous shocks or regime changes in economic events. Therefore, this relationship is likely to be subject to variation as a result of changes in the economy's structure like changes in energy policy or economic development regime, reforms in energy regulation, or institutional developments. The direction, strength, and stability of the relationship between energy consumption and GDP have occupied central importance in the conduct of energy policy. For these reasons, this paper fills the gap in the empirical literature on the stability between energy consumption and GDP, by studying the situation of Taiwan.

In the course of its whole economic development, within the period 1954–2003, Taiwan has successively experienced quite a few momentous economic incidents, including adopting an expansion export trade policy in the 1960s, and encouraging exporting and expanding into the international market, which established the foundation for its economic development taking off later on. The first oil crisis in the 1970s caused international raw materials and the price of petroleum to soar. The second oil crisis in the 1979 caused an international imbalance of supply and demand of crude oil. Taiwan then carried out financial liberalization and an internationalization policy in the middle part of the 1980s, which liberalized finance controls by a wide margin. Economic incidents in the 1990s included the military crisis across the Taiwan Strait due to the threat from China, the Asian financial crisis (1997–1999), and oil countries' agreement to drop their production to increase oil prices.

Although economic structures and economic development stages are not the same for various countries, most empirical research studies show that energy consumption changes have a high correlation with economic growth. However, the information content of energy consumption and GDP is subject to change over time and so far there has been no empirical work for the possible variations and instability in Taiwan. Especially over the past 50 years, Taiwan has developed its economic development miracle with a steady and abundant energy supply playing an important role.

Previous works for discussing the relationships between various kinds of energy consumption and economic growth in Taiwan are started by Yang (2000) and show that there are different directions of causes that exist between GDP and various kinds of energy consumption for the period 1954–1997. He finds evidence of bi-directional causality between energy consumption and GDP. Differently, Cheng and Lai (1997) report the unidirectional causality running only from GDP to energy consumption for the period 1955–1993. Hence, like Yang's (1999) revelation that there is a unidirectional causality from GDP to coal consumption with no repercussions, but Hwang and Gum (1992) indicate a bi-directional causality is observed in Taiwan for the period 1955–1993.

Based on these mixed or conflicting results, we categorize it as follows: If there does exist a causality running from energy consumption to GDP, then this denotes an energy-dependent economy such that energy is an impetus for GDP (Kraft and Kraft, 1978; Shiu and Lam, 2004). On the other hand, if there is a reverse chain of causality from GDP to energy, then this denotes a less energy-dependent economy such that energy conservation policies may be implemented with little adverse or no effect on GDP (Oh and Lee, 2004). Finally, the finding of no causality in either direction, the so-called 'neutrality hypothesis' (Yu and Choi, 1985; Altinay and Karagol, 2004), means that energy conservation policies do not affect GDP.<sup>1</sup>

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<sup>1</sup> Recently, the new panel approach has already been applied in the study of this subject. For instance, Lee (2005) shows that long-run and short-run causalities run from energy consumption to GDP, but not vice versa in 18 developing countries by panel cointegration test.

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