Estimation of Rebound Effect in China's Industrial Sector: A Multi-subsector Analysis

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Overview

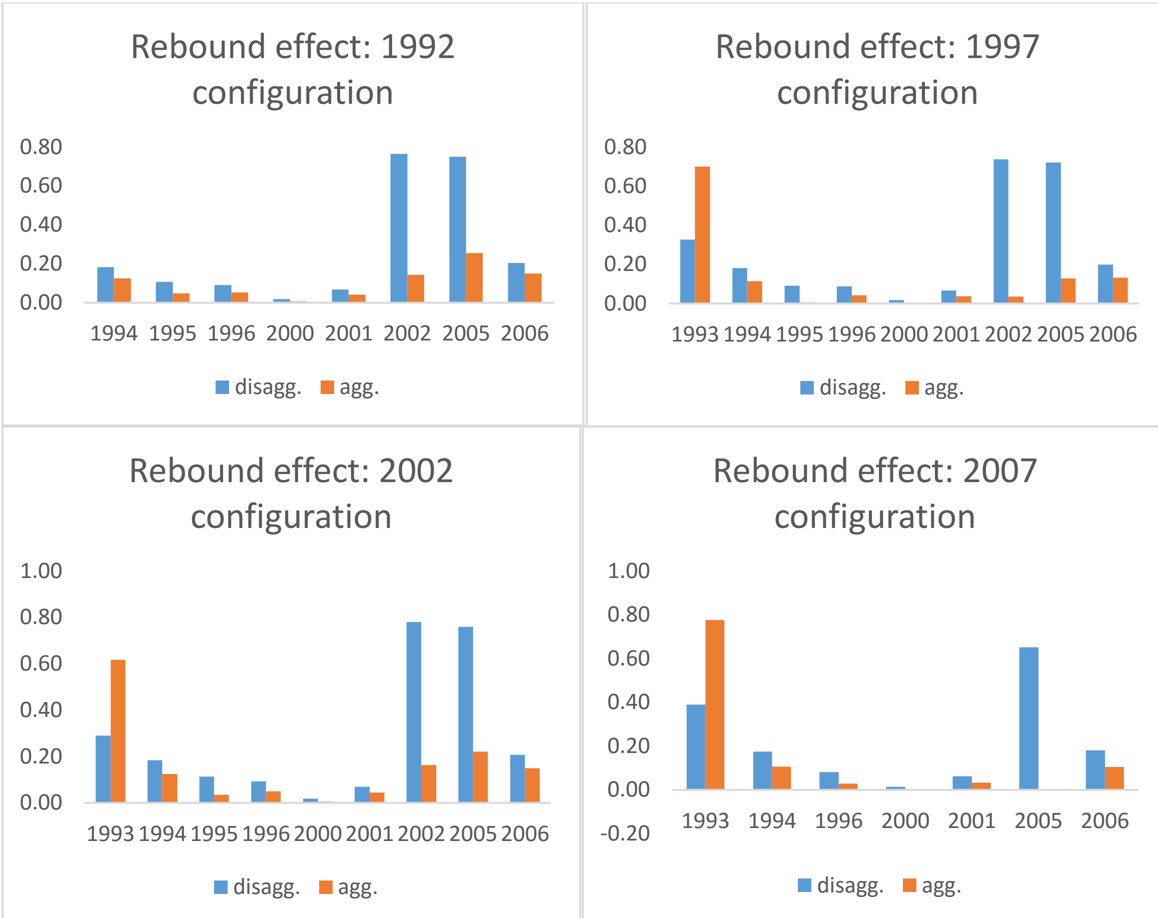
Saunders (1992) shows that when the real price of energy remains constant energy efficiency gains will lead to an increase in energy consumption in the Cobb-Douglas production function case and also in the nested CES production function case using the Manne and Richels' nesting scheme if the energy elasticity of substitution is greater than unity. Wei (2007, 2010) uses a general equilibrium analysis to demonstrate that an increase in energy production efficiency will lead to an increase in energy consumption. All of these studies present a macroeconomic and theoretical justification for the possible existence of the rebound effect, that is, productivity growth that results in improvement in energy efficiency will lead to higher energy consumption, provided energy prices remain constant. Those theoretical developments provide a paradigm for empirical studies using aggregated statistics either at a national or sector level. However, the Hogan and Jorgenson (1991) study demonstrates that productivity growth at a sector level can be more thoroughly modelled when disaggregate data are available in the sense that both the direct and indirect effects of technological progress on technical biases can be taken into account.

Methods

In view of Hogan and Jorgenson (1991)'s work, the present study estimates the rebound effect for China's industrial sector using disaggregate data for 11 subsectors. The Long and Plosser (1983) model was used to model the production function for the industrial sector, namely, $Y_{i,t+1} = \lambda_{i,t+1} L_{i,t}^{b_i} \prod_j^{11} X_{ijt}^{a_{ij}}$, where the parameters b_i and a_{ij} are elasticities of output Y with respect to labour and factor j, respectively. Although the LP model is intended to study business cycles, it incorporates sectoral/subsectoral relations in describing the time paths of their outputs and therefore productivity. Under constant returns to scale, they are also cost shares of labour and factor j in the total production cost of sector i. Therefore, these parameters correspond to the elements in an input-output matrix. The inputs, X_{ijt}, are determined by output in time period t, Y_t, the model can be written in an AR(1) form, $y_{t+1} = Ay_t + k + \eta_{t+1}$, where y is an 11×1 vector of logs of the Ys and η_{t+1} is productivity shock. A is a 11×11 matrix of input-output coefficients. Having estimated the productivity shocks over the period 1992-2006, the rebound effects by subsector are calculated by the method proposed by Shao et al (2014). The estimated rebound results are presented for both aggregated and disaggregated cases and for each of the latest 4 input-output tables which provide 4 different input-output configurations.

Results

Energy rebound: aggregated VS disaggregated



Conclusions

The goals of China's energy policy have been: "giving priority to conservation, relying on domestic resources, encouraging diverse development, protecting the environment, promoting scientific and technological innovation, deepening reform, expanding international cooperation, and improving the people's livelihood."(China's Energy Policy 2012). These policy goals foster an economic environment that lends itself to the Khazzoom-Brookes postulate coined by Saunders (1992). Similar to existing studies on the rebound effect, the present research saught to model the relationship between productivity growth and energy consumption, with the data for China's industrial sector for period 1992-2006. However, the present study recognised the advantage of disaggregated data in modelling productivity trends as illustrated by Hogan and Jorgenson (1991). The empirical results as summarised by the four graphs show that the rebound effect existed in China's industrial sector over the study period, with the maximum magnitude of 12 percent when only the aggregated data were used; this figure rose to nearly 80 percent when the disaggregated data were used.

Because the subsector relationships were only captured 4 times in the form of an input-output table during the 25-year period, the rebound effect was calculated each year for 4 times, each corresponding to a different input-output table, using the LP model as a vehicle to compute productivity trends. It is clear that different subsector relationships, other things held constant, will lead to different magnitudes of rebound estimates and occurrences of the rebound effect. A policy implication for China's energy policy makers is that the country energy's policy need be designed together with relevant industry policy aiming at adjusting inter-industry/sector relationships.

References