Directed Technical Change, Capital Intensity Increase and Energy Transition: Evidence from China

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Executive summary

Every stage of the energy life cycle - exploration, extraction, conversion and consumption - is associated with technologies that require different types and grades of fuel. Energy production technology is mainly determined by the capital and labor conditions in the economy, which can be measured by the capital-labor ratio or capital intensity. Energy transition from one form of energy to another depends on the available technology and technical change involves shifts in capital intensity.

For energy production technical change is biased towards the capital. Thus an increase in capital intensity in the economy will induce technical change directed towards modern energy which is capital intensive. This implies that the technical change, that is essential to energy transition, is biased towards capital accumulation. This would suggest a relationship between capital intensity in the economy and the adoption of modern energy.

The purpose of this paper is to determine what has driven China's energy transition since the economic reform policy launched in 1978, from the perspectives of capital deepening and directed technical change. The main feature of China's recent energy transition is an increase in traditional energy consumption, accompanied by a rapid expansion of investment in modern energy. For instance, China has expanded coal-fired power generation at an unprecedented rate; as well as renewable energy power generation. The question addressed in the paper is: how do we explain China's 'grand energy transition'? Is it increasing capital intensity in the economy which is driving energy transition or *vice versa*?

Our empirical model is based on the national level time series from 1978 to 2015. An energy transition indicator is measured by the relative share of modern energy to traditional energy production and the capital-labor ratio of the economy measures the capital intensity. The results show that the long-run equilibrium relationship and short-run dynamic effects between the two variables are both significant.

The result from time series modeling show that capital intensity has a long-run effect on China's energy transition and the dynamical adjustment period is around five years which is in line with the National Five-year Plan.

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The policy implications of our results are that both capital-enhancing policies and price-regulations can be used to promote energy transitions. However, price-regulation solutions may distort efficient resource allocation, and feed-in tariffs can be inefficient leading to an increase in social cost. In terms of policy recommendations, we favor measures that include tax relief, technology standardization and foster financial security and fair competition between technologies. In the long run, this will promote the wide-scale adoption of modern energy technology and displace polluting traditional energy. We refer to this process as *'Greening capital while greening energy'*.

Keywords: Energy Transition; Capital Intensity; VECM; Granger Test
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