UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Will High Carbon Prices Reduce Fossil Fuel Use in China? Evidence from Price Elasticity Estimates using Firm Data

EPRG Working Paper EPRG2508

Cambridge Working Paper in Economics CWPE2527

Mei Lu

Michael G. Pollitt

China is shifting from traditional command-and-control approaches to a market-based carbon trading system in order to reduce CO_2 emissions more cost-effectively. This transition not only supports domestic climate goals but also helps replace implicit carbon pricing with explicit carbon pricing, a move that could mitigate the impact of the Carbon Border Adjustment Mechanism (CBAM). A key question, however, is whether higher carbon prices will actually lead to lower fossil fuel consumption in China. This is particularly important given the significant role of state-owned enterprises in China, where the incentive to maximize profits may be weaker than in private firms. In this study, we estimate both short-run and long-run price elasticities of demand for coal, oil, and electricity, as well as their respective intensities, across own-price and cross-price dimensions to investigate the impact of carbon pricing on firms.

Our empirical findings reveal that while manufacturing firms exhibit limited responsiveness to energy price changes in the short term—likely due to technological lock-in—they are significantly responsive over the long run.

In the long run, coal and electricity demand exhibit price responsiveness, with own price elasticity of coal demand estimated at -1.24 and own price elasticity of electricity demand at -0.98. Similarly, long-run own price elasticity of coal intensity is -1.55, and that of electricity intensity is -1.29. It is worth noting that elasticities which are lower than -1 mean energy costs fall as energy prices rise. These findings suggest that both coal and electricity are sensitive to price changes in the long run, with energy intensity exhibiting even greater responsiveness compared to physical energy consumption. The magnitude of the long-run price elasticity in our study is approximately in the same range as findings from other countries such as the United States, Australia, and Canada.

Conversely, in the short run, own price elasticities of coal and electricity, as well as coal intensity and electricity intensity, are found to be insignificant. Short-term adjustments in equipment and technology in response to energy price changes are deemed difficult and costly. Moreover, the technology lock-in effect limits firms' ability to alter specific energy use in response to price variations when output levels remain constant. Carbon pricing,

acting as an implicit energy price, may encounter challenges in inducing immediate CO_2 emissions reduction due to these constraints. However, in the long run, carbon pricing is expected to effectively reduce CO_2 emissions by stimulating energy efficiency improvements.

Cross-price elasticity estimations reveal a significant substitution effect of oil for electricity, particularly in the short run. A 1% increase in electricity prices leads to a 3.55% increase in oil demand and a 3.63% increase in oil intensity in the short run. Conversely, the evidence does not support electricity substituting for coal or oil, highlighting the limitations of relying solely on price signals for electrification efforts. In the long run, an increase in electricity prices results in decreased coal demand and coal intensity, implying that electricity and coal are complementary goods. Additionally, in the short run, an increase in oil prices leads to a decrease in both coal demand and coal intensity, indicating a complementary relationship between oil and coal in the short run. Relaxed financial constraints, measured by lagged profit, lead to increased energy use but decreased energy intensity in the short term, likely due to technological upgrades facilitated by improved financial conditions.

Private and foreign-owned firms exhibit a slightly higher sensitivity to energy price fluctuations compared to state-owned firms. This is likely due to the fact that state-owned firms, which bear greater social responsibilities and have more soft budgets, are less responsive to changes in energy prices. However, the gap in sensitivity is small, suggesting that even state-owned firms are sufficiently responsive to carbon price signals. The underlying mechanism may lie in the effectiveness of incentive structures within state-owned firms, which drive them to pursue profit maximization once their social responsibilities are fulfilled. Therefore, concerns about the lack of responsiveness to carbon price variations among state-owned firms should not pose a significant issue in the broader framework of utilizing market-based tools to achieve net-zero emissions. Meanwhile, only foreign firms show a heightened responsiveness in energy intensity. This may be attributed to their advantages in accessing advanced technologies and international resources, which have been particularly significant during China's technology catch-up process. However, as technological gaps between countries narrow, the greater sensitivity of foreign firms to energy intensity may gradually diminish.

Overall, these findings provide valuable insights into the dynamics of energy demand and intensity adjustments, highlighting the complexities and nuances involved in responding to energy price changes. They underscore the importance of considering both short-term and long-term implications in energy policy formulation and implementation. Importantly, our analysis reveals that, in the long run, energy-intensive manufacturing firms are responsive to price signals. This is encouraging news for the expansion and tightening of China's national carbon market and using it to reduce China’s CBAM liability in energy intensive manufacturing exports.

Contact	lumei2017@126.com
Publication	April 2025