Feed-in-Tariff backfires: implicit carbon pricing and inter-fuel substitution in manufacturing

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１． Introduction

While carbon pricing is becoming increasingly popular around the world, some policymakers are also introducing other forms of energy taxation, which are thought to have similar effects on global emissions and the fight against climate change. Specifically, partial energy taxation (fuel or electricity tax) are gaining momentum. While fuel costs may indirectly affect electricity prices in economies with heavily carbonated power mix, the effect of electricity taxes on emissions is not as straightforward. In fact, previous studies showed that, for certain energy-intensive sectors, there exists a possibility to replace electricity with fossil fuel (substitution effect), through increased electricity generation on site. This research examines the effect of an electricity tax on emissions by providing a case study on the Japanese Feed-in-Tariff (FIT) levy and distinguishes between sectors with and without substitution capacity. We also strive to explain the driving mechanisms behind these results, by considering changes in energy efficiency, on site power generation and fuel mix.

２． Methodology and Data

This study uses micro-data on Japanese energy-intensive plants between April 2004 and March 2020 and apply a Poisson regression analysis to identify the effect of the FIT levy. We first examine the effect of the levy on CO_2 emissions, and then proceed to analyze the mechanisms behind the change in emission by proposing a modified Kaya decomposition of CO_2 emissions based on emission intensity of fuel, substitution between fuel and electricity, electricity efficiency and production. Our identification method is based on the existence of a partial exemption from the levy offered to certain electricity-intensive plants, following Martin et al. (2014). While this method is useful to entangle the effects of the levy from those of the year fixed effect, it might introduce some form of endogeneity into our variable of interest, as exempted plants might be inherently different from non-exempted ones. To correct for this source of endogeneity, we also use a comprehensive set of instruments to increase the precision of our results. We also use a comprehensive set of control variables at the plant level such as capital, labor, production, as well as a plant and time (month, fiscal year) fixed effects.

３． Results of analysis

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Our results show that implicit and incomplete carbon pricing had undesirable consequences, as it led to a rebound in CO_2 emissions among certain manufacturing sectors that can replace electricity with fossil fuel. For instance, we find that iron & steel and pulp & paper plants experience a rebound in emissions, estimated around 52.20% and 13.43%. We explain this rebound by fuel switching behavior, as iron & steel replace gas with coal, and pulp & paper with oil. Iron & steel plants also increases electricity generation, powered by fossil fuel. Chemicals plants also experience a rebound in emissions in the long-term, five and six years after the levy's introduction (12.05% and 14.93%, respectively), also explained by replacing gas with oil. In contrast, the levy has the opposite effect on machinery, a sector without substitution capacity: machinery plants see a a reduction in their emissions in the medium to long-run (-34.66% at its peak). Overall, our results show that implicit carbon pricing can have the opposite effect of what one would expect from an energy tax, due to the existence of inter-fuel substitution. This study acts as a cautionary tale for policymakers considering the introduction of electricity taxes, and highlight the need for explicit and complete carbon pricing in industrialized economies.

4. Conclusion

This study considered the effect of an implicit and incomplete carbon pricing on the EI manufacturing industry in Japan. The country introduced the FIT levy in 2012, as an additional electricity tax to finance its transition to renewable energy. This framework is thus an appropriate case study for the effect of partial energy taxation on emission. Our findings show that, for some sectors with substitution capacity, a tax on electricity is associated with a rebound in emissions, an effect we trace to their increased fuel consumption to generate electricity on site. In addition, these plants also increased their consumption of dirty fuels such as coal or oil, replacing gas. The unexpected rebound in emissions associated with the levy in some energy-intensive industries may bring us to reconsider the labeling of partial energy taxes (especially electricity ones) as 'implicit carbon pricing'. While the levy is associated with gains in electricity and energy efficiency, it triggered additional consumption of fossil fuel, and even acted as an incentive to switch from relatively clean fuel (gas) to dirtier ones (coal or oil). From emission rebound to fuel switching, many of the FIT levy's effects are the opposite ones as those of an explicit carbon price, and lead to undesirable outcomes, in the form of a rebound in CO_2 emissions. The results of this study suggest the need for explicit and transparent carbon pricing instead of partial energy taxation in the form of implicit pricing.

Reference

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