# *EVALUATION OF ENERGY EFFICIENCY REBOUND EFFECTS：*

# *HISTORICAL EVIDENCE AND COMPARABLE ANALYSIS*

# *OVER 2000-2016*

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## Overview

Energy efficiency rebound effect makes expected energy savings taken back to some extent. Ignoring the magnitude of rebound effect will lead to a systematic overstatement of forcasted energy demand and associated emissions. The literature diverges on theoretical methods and quantitative measurement of rebound effect given various cost and production functions, as well as future technology gains and projected energy prices (Wei and Liu 2017).

This study aims to estimate magnitude of historical rebound effects in 18 productive sectors across 60 economies over the period 2000-2016. In addition, the study will conduct the analysis by using translog, Cobb-Douglas and CES cost functions respectively in response to the literature debate on function forms. By comparing cross-country historical evidence, the findings will also test the hypothesis that the economic growth and improving living standards in developping countries may cause a larger rebound effect compared to industrialised countries.

## Methods

By extending the methods of Jorgenson (2000) and Saunders (2013), this study will conduct the econometric measurement of a four-factor ( capital, labour, energy and material) translog unit cost function for each new increment of capacity, including measured technology gain parameters for each factor. The study will also rely on Cobb-Douglas and CES cost functions to extend the econometric models and clarify the changes in rebound effects attributed to the chosen function forms and theoritical assumptions.

To evaluate historical energy efficiency rebound, the study will simulate two trajectories of energy consumption with the measured cost functions to explore what would have happened to energy demand had energy efficiency gains ceased in 2000. One trajectory is derived from the 100% rebound scenario, which means rebound effect completely offset energy efficiency gains. The other is zero rebound scenario, in which efficiency gains have realized full enginnering potetnial of energy savings. Rebound effects are evaluated by comparing actual and estimated energy consumption trajectories. For testing the robustness of results, the study will carry out stress test with extreme sensitivities of magnitude and variability around energy prices.

With respect to data issues, the researchers construct an unique dataset of incremental value shares for capital, labour, energy and material over the study period on the basis of WIOD database (Timmer et al., 2012), ADB Input-Output tables, and IEA energy balances. The research will compare the cross-country outcomes of rebound effects in productive sectors across 60 economies over the peirod 2000-2016.

## Results

Energy efficiency rebound effects remain high and greatly vary across economies dependent on measured factor subsitution elasticities. However, low substitution elasticity between energy and other goods does not systematicaly lead to low rebound effect. By comparing outcomes across economies at different development stages, the research shows energy efficiency rebound effects exhibit a larger magnitude and variability in a fast development context.

## Conclusions

By estimating historical rebound effects in productive sectors across 60 economies over 2000-2016, this analysis provides further evidence on the magnitude and variablity of rebound effects associated with chosen cost functions, estimated substitution elasticities and energy prices in the context of different development stages. Rebound effects increase markedly as the economoy activity grows strongly and energy prices show stronger variability. Our preliminary results show that failure to take account of rebound effects will pose the risk of underestimating forcasted energy consumption by around 70%.

## References


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