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IMPACT OF THE OPTIMAL ENERGY MIX WITH RENEWABLE RISK ON INDUSTRIAL GREENING

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Overview

Installment capacity of renewable energy for electricity generation has been increasing substantially in the last decade due to targeting policy (for instance, renewable share in Taiwan accounts for 4.8% in 2010 and is targeted at 8.2% and 9.5% in 2025 and 2030, respectively) and the introduction of the feed-in-tariff (FIT) with reverse auction. Great concerns over the impacts on industrial transformation or greening, stability of electricity supply, intergenerational cost burden, as well as electricity price arise in policy making.

Peculiar phenomena were observed as follow. (1) The national average productivity (AP) of windpower has been declining with installment capacity, while AP of the private generators outweighs TaiPower, the only nationally owned and operated power company. (2) The financial deficit of TaiPower, the monopolist in electricity market, is reaching the edge of bankruptcy. (3) The discount rate offered by private generators under the reverse auction increases while the announced FIT adjusted downward annually.

Some technical problems remain in literature when modeling the optimal bundles of energy sources (e.g., coal, natural gas, and windpower) for electricity generation. (1) How to incorporate in the producer's decision behavior the supply uncertainty with renewable of that electricity generation is characterized by significant seasonal variation? (2) The determination of the adequate generation reserve margin for the Taipower System, while very controversial as the realized margin has been consistently far below the regulated one for decades, is further complicated by the addition of the renewable. How to design a realistic mechanism to formulate the practical dispatch between fossil and renewable? (3) While the impact on industrial transformation or greening is of great concern, the traditional indicator such as the ratio of value added is not satisfactory. How to design an innovative indicator system capable of describing the structural change toward industrial greening?

Methods

In brief, a dynamic optimization model is formulated to determine the optimal bundle of energy sources for electricity generation that allows us to address the following policy issues: (1) Are the targeted share of renewable and the generation reserve margin optimal? (2) To what extent will the targeted share of renewable affect the optimal solution as the associated uncertainty is taken into account? (3) What are the factors contributing to the monopolist's financial crisis? (4) How the renewable will contribute to the industrial greening?

The model is characterized by incorporating the following features:

(1) The uncertainty of renewable is measured and built into the supply decision.
(2) FIT with reverse auction is modeled with an incentive mechanism for truthful reporting of production cost.
(3) A constant-elasticity-of-substitution function is specified for dispatch among energy sources to determine the optimal generation reserve margin.
(4) An innovative indicator of industrial transformation is constructed that is characterized by a density function of emission intensity and energy intensity.

Results

(1) The optimal bundles depend on the natural risk as well as the risk attitudes of producer and decision maker.
(2) The financial crisis originates from such factors as FIT scheme, electricity distortion, the

decreasing average productivity of renewable, etc.

(3) The contribution of renewable *per se* to industrial greening is limited unless the industry is competitive enough not only against fossil but also the like industry in the international market.
(4) Although the targeted generation reserve margin will decline over time to avoid excessive investment, it diverges from the optimal level for several reasons, including risk attitudes, social cost of electricity shortage, pattern of industrial transformation, etc.
(5) The dispatch among energy sources is hindered, to a great extent, by the seasonal variation of windpower.
(6) The overall industrial structure is driven green in the sense that the parameters of the density function move toward greener.

Conclusions

(1) The new indicator to measure the Industrial transformation /greening is much more precise, comprehensive and visually reportable.
(2) Among other things, price distortion must be removed and flexible enough to eradicate of financial crisis.
(3) The TIF with reverse auction could be improved by more accurate estimation of the technically efficient production cost through an incentive mechanism for truthful reporting.
(4) Power storage is indispensible for facilitating the dispatch of energy resources and reducing the supply risk.
(5) Environmental regulations are more effective than renewable energy development for industrial greening since the domestic renewable industry heavily depends import of equipments and technology and the electricity is produced only for domestic consumption.

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