博士論文（要約）

Empirical Analyses of R&D Subsidy and Demand Response Programs
(研究開発補助金およびディマンドリスポンスに関する実証分析)

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1 Introduction

In view of population aging and tight state finances in many developed countries, we are strongly required to develop a new strategy for sustainable economic growth. In particular in Japan, we have been exposed to a distinctly different environment since the Great earthquake and tsunami in 2011.

For creating new demand continuously under difficult circumstances, more attentions have been placed upon private-sector product innovation. It has been argued that a private firm cannot obtain full benefit from its new products due to R&D spillovers, which leads to under-provision of private-sector R&D investment (Nelson, 1959, Arrow, 1962). Theoretically, governments can deal with this concern by subsidizing private R&D expenditures (e.g. Spence, 1984). It is, however, an empirical issue how to achieve an efficient allocation of subsidies. Moreover, product innovation can be classified by its novelty (or height). New-to-market product innovation probably has a distinct effect on society from new-to-firm one. We have not yet fully understood as to what type of innovation encourages firm growth and what factors determine innovation height.

In addition, for long-term growth, it is obvious that securing stable energy supplies is crucially important. Since the Great earthquake, we are more required to build a diversified flexible energy supply-demand structure for reducing the escalating energy cost. In particular, the development of demand response (DR) is positioned as a significant goal for the nation (Council on Economic and Fiscal Policy, 2015). For considering desirable DR programs, we need to accumulate knowledge about the effects of them as soon as possible. Recently, it is gradually becoming easy to use data on electricity customers with various DR programs. For example, the Japanese Ministry of Economy, Trade, and Industry (METI) initiated the Smart Community Pilot Projects in four cities in Japan (Yokohama, Toyota, Keihanna, and Kitakyushu).

With these backgrounds, this paper focuses on private-sector product innovation and DR programs. Chapter 2 evaluates the effect of public R&D subsidies by taking into consideration R&D spillovers. The estimation and simulation results obtained by use of Japanese firm-level data from an innovation survey indicate that existing subsidies encourage firm's R&D activities, which does not increase its profits due to a negative business stealing effect. Chapter 3 complements the previous chapter by considering innovation height. The same survey data reveals that new-to-market product innovation is likely to increase firm's sales without cannibalizing those of existing products and generate more technology spillovers to other firms. Moreover, such innovation is more likely to emerge from firms which collaborate with academic institutions.

The following chapters address issues on DR programs. Chapter 4 estimates the effect of load adjustment contracts offered by electric utilities in Japan. They are kinds of incentive-based DR programs targeting commercial and industrial electricity customers. Using unique data on electricity usage of individual plants, it is found that these contracts lower their electricity bills on average. In particular, plants with higher capital equipment ratio are more likely to save their bills and reduce their peak demand by the contracts. Chapter 5, on the other hand, investigates how residential customers respond to price-based DR programs. A simulation analysis is conducted to examine whether customer's response changes with predictive accuracy in future electricity prices. The results show that the higher predictive accuracy increases consumer surplus.

2 Effects of Government Subsidies on Private R&D Activities

This chapter evaluates the effect of public R&D subsidies by taking into consideration R&D spillovers: a positive effect from knowledge spillovers and a negative business steal-

ing effect from product market rivals.[1] Because the presence of spillovers makes it difficult to find control experiments and use a program evaluation approach, we perform a counter-factual analysis with structural estimates. The estimation results obtained by use of Japanese firm-level data from an innovation survey show that both knowledge and product market spillovers are present across firms. Simulation exercises based on the obtained estimates indicate that existing subsidies encourage firm's R&D activities, which does not increase its profits due to the presence of negative spillovers.

3 Innovation Height and Firm Performance

This chapter evaluates the economic impact of product innovation by using firm-level data from an innovation survey conducted in Japan.[2] It accounts for possible technology spillovers from innovation activities and examines the extent to which new-to-market product innovations contribute to firm performance. Econometric analysis using a simultaneous equation model reveals that new-to-market product innovation is likely to increase a firm's sales without cannibalizing those of existing products and generate more technology spillovers to other firms. Moreover, such innovation is more likely to emerge from firms which collaborate with academic institutions.

4 Effects of Load Adjustment Contracts on Industrial Electricity Use

This chapter estimates the effect of load adjustment contracts offered by electric utilities in Japan on the industrial demand for electricity usage. Using unique data on the electricity usage of individual industrial users, we find that the contracts lower their electricity bills on average. In particular, plants with higher capital equipment ratio are more likely to save their electricity bills and reduce their peak demand by the contracts.

5 Impact of Dynamic Pricing on Residential Customers

This chapter empirically investigates how residential customers respond to dynamic electricity pricing through a randomized field experiment in Japan. By performing a counter-factual analysis with structural estimates, we quantitatively evaluate the consumption and welfare effects of dynamic pricing programs. In addition, we conduct a simulation analysis to examine whether customer's response changes with predictive accuracy in future electricity prices. Estimation results show that the higher predictive accuracy increases consumer surplus.

[1] This chapter is based on joint research with Hiroshi Ohashi. Isogawa and Ohashi (2013) is an earlier version of this research.

[2] This chapter is joint work with Kohei Nishikawa and Hiroshi Ohashi, which was published as Isogawa, Nishikawa and Ohashi (2015).

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