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製造や販売管理の技術革新がもたらす製品サイクルの短期化と デフレの関係 一大規模な製品価格データを用いた検証—

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Short Product Cycles by Innovations in Production and Sales Management and Japanese Deflation

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まず本研究では、大規模ミクロデータである日経 POS データを用いて、日本の製品市場についての4つの事実 を提示した。その上で、これらの事実と整合的な理論価格モデルの構築を行った。この新しいモデルは、従来の 価格モデルを特殊型として内包する、より一般的な価格モデルとして位置付けることができる。次に、日経 POS データを用いてモデルをベイズ推計することで、モデルが日本の製品市場の価格の動きを正確に捉えることを示 した。

We use the Nikkei POS scanner data, a product-level data set from Japanese supermarkets, to document a set of stylized facts regarding product cycles and price cycles in Japan. Based on the stylized facts, we develop a new price model embedding product cycles with search frictions in the product market. Products have new prices upon entry and experience staggered price setting after entry. Our model generates a generalized version of the New Keynesian Phillips curve that incorporates the effects of product cycles on price dynamics. We estimate the model using the Nikkei data. The estimation results show that search frictions exist in the product market for food products and daily necessities.

1. 研究内容

Product entry and exit indicate the existence of product cycles. The behaviour of prices during a product cycle forms a price cycle. Recent observations from micro data reveal interesting facts about these product cycles and price cycles. Broda and Weinstein (2010) document, when using product-level data, that the product turnover rate in the US is about 25 per cent annually. They find that these product replacements have a significant effect on the aggregate price index. Nakamura and Steinsson (2012) highlight that product turnover is a key mechanism for explaining price changes using micro data on trade price indices in the discussion of the so-called product replacement bias. The first price has a nontrivial effect on price dynamics. They also show that 40 per cent of products are replaced without any price change after being introduced into markets. Ueda et al. (2019) confirm the same facts for Japan using matched samples of Nikkei point of sale (POS) scanner data. Their calculation shows that the product turnover rate is 30 per cent annually. Price adjustments occur in times of product turnover and more than half of products do not seem to experience price changes until their exit from the market. For Japanese data, Abe et al. (2017) show that first prices have a significant effect on the price index for daily necessities and foods in Japan. They find that, on average, a product's price declines after the first price and that price increases occur when new products replace existing products. This is another pattern of the price cycle during a product cycle. Abe et al. (2016) also find that prices decline after first prices using data from the most popular price comparison website in Japan. Their data include home electrical appliances and digital consumer electronics.

When we focus on product cycles, we cannot ignore the role of search frictions in the product market. Empirical studies, such as Barrot and Sauvagnat (2016), show that search and matching frictions exist in production networks using firmlevel data. They find that the occurrence of natural disasters reduces productions when these products are made of specific input goods. This implies that specific input goods are not traded in a centralized market where search frictions are absent. Carvalho et al. (2021) also show that individual firms cannot quickly find suitable alternatives in a decentralized goods market with search frictions when firms experience a supply-chain disruption caused by a natural disaster in Japan.

Using a unique data set of the Nikkei POS scanner data for Japan, we document a set of stylized facts about product cycles, price cycles, and search frictions. In the data, a product cycle of an individual product can be clearly observed through its entry into and exit out of the product market. The number of products and the ratio of new products in the data frequently change. We can also observe a price cycle, by which we refer to how the individual product's price changes over its life cycle. We find that the product cycle at the product level is about 9 quarters. During the product cycle, prices generally decline, and first prices are 40 per cent higher than average prices. When we calculate a ratio of the number of retail shops selling a certain product to the total number of retail shops, the ratio is sufficiently smaller than one. This observation implies the existence of search frictions in trading food products and daily necessities sold in supermarkets in Japan.

Based on these facts, we propose a new model that embeds features of product and price cycles with search frictions. We explicitly model entry and exit in a frictional product market where retailers search for products to form a match. Each new match represents a new product. We endogenize entry decisions and leave exits as exogenous. Products enter the market when the benefit from selling the new product can cover the entry cost. As the number of new matches determines the number of new products, the total number of products in the market is endogenously determined.

As for price cycles, we assume that first (new) prices are set optimally upon matching and that the subsequent prices in a match experience staggered price setting as in Gertler and Trigari (2009), where prices can adjust only with a certain probability. Since the aggregate price index includes both new prices and existing prices, the fraction of new products has an important role in determining the aggregate price index. The model naturally links product cycles with price dynamics. The aggregate price index can change through extensive margin and intensive margin effects. For example, in response to a positive demand shock, more products enter the market, which leads to more matches in the product market. This makes the aggregate price more flexible, owing to more new prices. Moreover, in each new match, the positive demand shock raises the total trading surplus, which leads to a higher new price. Overall, both entry and prices can be positively correlated with demand. The endogenous product cycles allow our model to generate rich price dynamics. Then, we can evaluate how much new prices and subsequent prices contribute to the aggregate price in estimation. The flexible pricing for new products and sticky pricing for existing products characterize price cycles in our model.

Using the aggregate price index, the number of products, and the sales of new products calculated from the Nikkei data, we estimate our model by the Bayesian method and explore the model's quantitative implications through variance decomposition and impulse responses. The estimation results indicate that search frictions exist in the product market for food products and daily necessities. A retailer has more bargaining power on prices. Variance decomposition results reveal that a shock related to product cycles, i.e., a matching efficiency shock and a free entry shock, explains 37.88 and 11.02 per cent of price variations, respectively. Conventional shocks, such as a cost-push shock and a demand shock, explain 9.96 and 41.49 per cent of price variations, respectively. The staggered price setting probability is only about 4.4 per cent on average after the first price. It implies that the first price plays a major role in the aggregate price since the 11.5 per cent product sets the first price every quarter through product entry. The impulse responses demonstrate that endogenous product entry and search frictions, which give rise to the extensive margin effects and an increased intensive margin effect, increase price variation by 90 per cent. These

features of product and price cycles hold even when we estimate the model for each of the 17 product categories using disaggregated data where each category includes only similar types of products. We find that among the 17 product categories, there exists non-trivial heterogeneity in the degree of search frictions and the frequency of price adjustments after the first price.

2. 発表(研究成果の発表)

[1] 寺西 勇生、Product Cycle and Phillips Curve、 オーストラリア・メルボルン大学、セミナー発表、2023 年 7 月

[2] 寺西 勇生、Product Cycle and Phillips Curve、
米国・ハワイ大学、セミナー発表、2024年2月
[3] 寺西 勇生、Product Cycle and Consumer
Price Index、日本・慶應義塾大学、セミナー発表、
2024年5月