# Product Switching and Firm Performance in Japan − Empirical Analysis Based on the Census of Manufacturers

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**Abstract**

Following Bernard, Redding and Schott (2010), we have constructed product and firm level data on Japanese manufacturing firms using the Census of Manufacturers. Our empirical analysis based on the constructed data shows that multiple-product firms perform better than single-product firms and their labor productivity growth rates are higher. Empirical studies at the industry level show that an unregulated, competitive environment stimulates product switching. At the firm level, product switching behavior improves firm performance, including employment, while the firms that reduce the number of their products see a decline in labor productivity, due to output reduction exceeding the magnitude of the reduction in employment.

Keywords: Entry, Exit, Multiple-Product Firm, Product Switching, Labor Productivity, TFP, Propensity Score Matching Model
JEL Classification Numbers: L11, L21, L25, L60

## 1. Introduction

Resource allocation is one of the most important issues in the field of economics. Reallocation of resources from a less productive industry to a more productive industry improves productivity at a macroeconomic level. A number of economists attribute the stagnation of the Japanese economy to slow resource reallocation from less productive industries to more productive industries.

Many economists have focused on the entry and exit decisions made by firms when considering resource allocation. On the theoretical side, firm entry and exit models have been developed by researchers like Jovanovic (1982), Hopenhayn (1992) and later extended to address international trade issues, as seen in the monopolistic competition model by Melitz (2003). On the empirical side, Baily, Hulten and Campbell (1992), Good, Nadiri and Sickels (1997), Aw, Chen and Roberts (2001), and Foster, Haltiwanger and Krizan (2006) have used firm and establishment level data to empirically test how firm entry and exit affects industry level productivity. Nishimura, Nakajima and Kiyota (2005) and Fukao and Kwon (2006) employed a similar methodology and used firm and establishment level data to investigate how firms' entry and exit decisions affect productivity growth in Japan. The results of their studies also showed that firms' entry and exit rates in Japan are lower than those in other developed countries. Resource allocation mechanism through firms' entry and exit is not efficient in Japan.

Based on these empirical results, this paper attempts to conduct a more comprehensive analysis of the resource allocation mechanism. We focus not only on firm entry and exit margins but also changes in production composition and product switching within a firm. In other words, we study not only firms' entry and exit decisions but entry and exit decisions on products. In the real world, we see occurrences of product switching within firms in many Japanese firms. For instance, Toray's sales mainly come from chemical products now but used to come from textile products 30 years ago. Canon used to mainly produce film cameras but mainly produces office equipment now.

Studies of within firm resource allocation started with research on industry switching. Industry switching refers to firm's behavior of switching its main product and being categorized into a different industry.[1] Greenaway, Gullstrand and Kneller (2008) studied the manufacturing sector in Sweden and showed that the probability of industry switching is higher when firms are in a relatively disadvantaged situation. Chen and Chu (2005) and Newman, Rand and Trap (2007) also studied industry switching using the data from Taiwan and Vietnam, respectively.

Bernard, Redding and Schott (2003, 2006, 2010; hereinafter referred to as "BRS") introduced the concept of product switching, which is at a more micro level than industry switching. Unlike industry switching, product switching includes not only change in production composition across industries, but within industries. BRS (2003) incorporated firm behavior of adding new products and eliminating existing products into the model of firms' entry and exit. They extended the two-sector model by Melitz and assumed that a representative household consumes differentiated goods produced in these two sectors. Furthermore, the fixed cost differs between the two sectors. In Melitz (2003), entry and exit behavior was determined by the zero profit cutoff and free entry conditions. In BRS (2003), product switching behavior was also determined by the product indifference cutoff condition, in addition to the aforementioned two conditions.

However, while the model developed by BRS (2003) can explain product switching behavior, it fails to explain why some firms produce multiple products. They later introduced a model incorporating firms that produce multiple-products, as well as entry, exit, and product switching in BRS (2010). In BRS (2010), shocks in consumer tastes determine the product composition of a firm that selects products among a continuum of products. Productivity shocks, on the other hand, increase the range of products that each

[1] Fukao and Kwon (2006) consider occupation switching, a concept which dates back further than industry switching, as part of entry and exit behavior and lists it as one of the factors affecting macro-level productivity.

firm can produce. Based on this model, they empirically examine how firm performance affected their product switching behavior, using data on the U.S. manufacturing sector between 1987 and 1997.

BRS's model can explain several features of productivity growth through product switching by Japanese firms. In other words, we can construct firm level data on product switching based on the *Census of Manufacturers* and can estimate the effects of product switching on firm performance at the establishment, industry, and sector level.[2]

This paper is organized as follows. The next section explains the establishment and firm level data based on the *Census of Manufacturers*. In Section 3, we shed light on product switching in Japan between 1998 and 2005 by comparing the performance by single-product firms and multiple-product firms. We also decompose the factors for industry level productivity growth into productivity switching, firms' entry and exit, among others, and how each firm behavior contributes to the macro level productivity. In Section 4, we study why firms engage in product switching and how such behavior affects a firm's performance. In the conclusion, we summarize our paper and discuss the unresolved issues.

## 2. Construction of product and firm level database in the Japanese manufacturing sector[3]

We use the *Census of Manufacturers* conducted by the Ministry of Economy, Trade and Industry to examine product switching behavior in the Japanese manufacturing industry.[4] The Japanese government publishes the survey results of the *Census of Manufacturers* in the following six types of compilation: "commodity," "industry," "city, town and village," "industrial site and water," "industrial district," and "enterprise." Enterprise-level data has been reported since 1997. We first construct product-establishment level data by using establishment identity codes. We aggregate product-establishment data up to product-firm level data by using the corresponding address, telephone numbers, and names of firms.

The *Census of Manufacturers* is conducted annually, but it only covers all Japanese manufacturing establishments in years that end in 0, 3, 5, and 8. All these relevant years, except the years that end in 0, are based on sample survey. As a result, although the survey has been conducted since 1909, we can aggregate establishment level data into firm level

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[2] As for the related studies of product switching, Shimizu and Miyagawa (2003) studied the diversification of Japanese firms using Input-Output Tables. Broda and Weinstein (2007) studied product differentiation using the scanned price data. Sasaki and Watanabe (2009) studied the same issue using the online price data.

[3] Product and firm level data contain 6 digit level output data.

[4] In our study, we examined product switching using not only the *Census of Manufacturers* but also the *Basic Survey of Japanese Business Structure and Activities* which covers enterprises with 50 or more employees. However, we do not show the results obtained from the *Basic Survey of Japanese Business Structure and Activities*, and we cannot obtain data of products in the six-digit level from the *Basic Survey of Japanese Business Structure and Activities*.

data only from the 1998 survey. Our study of firm entry and exit requires the survey that covers the sample universe, and this limits the data samples into the following four years, 1998, 2000, 2003, and 2005. The data in 2005 covers 498,841 establishments and valid responses to the questionnaires were received from 468,841 (a response rate of 94.2%). Products are classified into 1,812 categories.

The *Census of Manufacturers* consists of three types of surveys by establishment size. Form A ("Kou-hyou" in Japanese) is for establishment with 30 or more employees, Form B ("Otsu-hyo" in Japanese) is for those with 4 to 29 employees, and Form C ("Hei-hyou" in Japanese) is for those fewer than 4 employees.[5] For our study, we used the survey of the first two forms. 276,686 establishments responded to the survey in the year 2005, accounting for 55.5% of all Japanese manufacturing establishments.

*The Census of Manufacturers* contains data on the number of employees, raw material costs, fuel and electricity costs, value of shipments of manufactured goods and tangible fixed assets. Using this data, we estimate multilateral TFP (total factor productivity) at the establishment level as suggested by Caves, Christensen and Diewert (1982) and expanded by Good, Nadiri, and Sickeles (1997).[6] We also estimate capital intensity, labor productivity, and PCM (price cost margins) at the establishment level. We assume that product switching decisions are made not at the establishment level but at the firm level, and aggregate the establishment-level TFP, capital intensity, labor productivity and PCM up to firm level values using as the weights the value of shipment at the establishment level. Since *the Census of Manufacturers* does not report the tangible fixed assets for the firms with less than 10 employees, we can only calculate TFP and capital intensity for firms with equal to or more than 10 employees.

BRS (2006, 2010) referred to two-digit SIC categories as sectors, four-digit SIC categories as industries, and five-digit SIC categories as products. Following their example, we define two-digit JSIC categories as sectors, four-digit JSIC categories as industries, and six-digit JSIC categories as products using the *Census of Manufacturers*.[7] Table 1 shows some examples of sectors, industries, and products in the *Census of Manufacturers* in Japan.

[5] Because we are not allowed to use Form C, it remains a problem that firms that employ over 4 employees but then reduce employees to fewer than 4 are counted as an "exit firm," and vice versa with entry.

[6] The detailed calculation process is explained in Appendix A.

[7] Industry classifications in the *Census of Manufacturers* follows the Japan Standard Industry Classification (JSIC) in the case of 2-digit and 4 –digit levels. JSIC which started in 1949 is revised every five years. Every version of JSC is adjusted to adhere to the International Standard Industry Classifications (ISIC). However, in the case of the 6-digit classification, the *Census of Manufacturers* adopts its own classification.

Table 1. Examples of Sectors, Industries and Products based on the Census of Manufacturers

| Sector | | Industry | | Product | |
|---|---|---|---|---|---|
| 2-digit SIC | | 4-digit SIC | | 6-digit SIC | |
| 18 | Manufacture of Petroleum and Coal Products | 1811 | Petroleum refining | 181111 | Gasoline |
| | | | | 181112 | Naphtha |
| | | | | 181113 | Jet fuel oil |
| | | | | 181114 | Karosene |
| | | | | 181115 | Light oil |
| | | | | 181116 | Heavy fuel oil A |
| | | | | 181117 | Heavy fuel oil B |
| | | | | 181118 | Heavy fuel oil C |
| | | | | 181121 | Lubricating oil, including grease |
| | | | | 181122 | Paraffin |
| | | | | 181123 | Asphalt |
| | | | | 181124 | Liquefied gas |
| | | | | 181125 | Stock oil for refining and mixing |
| | | | | 181126 | Petroleum gas |
| | | 1821 | Lubricating oils | 182111 | Lubricating oils made of mineral, animal and vegetable oil purchased |
| | | 1822 | Greases | 182211 | Greases made of mineral, animal and vegetable oil purchased |
| | | 1831 | Coke | 183111 | Coke |
| | | | | 183112 | Fuel gases, including blast furnace gas and coke oven gas |
| | | | | 183113 | Crude coal tar |
| | | | | 183114 | Pitch coke |
| | | 1841 | Paving materials | 184111 | Asphalt paving admixture and tar paving admixture, including asphalt block and tar block |
| | | 1891 | Briquettes and briquette balls | 189111 | Briquettes and briquette balls |
| | | | | 189911 | Recovered sulfur |
| | | 1899 | Miscellaneous petroleum and coal products | 189919 | Miscellaneous petroleum and coal products |

Note: This classification of goods conforms to the Census of 2005. The Japan Standard Industrial Classifications (4-digit SICs) were revised in 2002 and 6-digit SICs were revised in 2001. We convert the revision in 2002 by using the converter made by METI (http://www.meti.go.jp/statistics/tyo/kougyo/gaiyo/sonota/bunrui/txt/h-cnv14.txt) and convert the revision in 2001 using our own methods.

Table 2. Number of Products per Industry and Product Characteristics by Sector

| Sector | Industries | Products | Industries/Products | Goods Shipments (million yen) | Tangible Fixed Assets (million yen) | Number of Employees | Shipment per Employee (million yen) | Tangible Fixed Assets per Employee (million yen) |
|---|---|---|---|---|---|---|---|---|
| 09 FOOD | 40 | 95 | 2.38 | 22,677,541 | 18,445,550 | 1,104,292 | 20.54 | 61.12 |
| 10 BEVERAGES, TOBACCO AND FEED | 13 | 28 | 2.15 | 9,665,997 | 8,474,552 | 103,010 | 93.84 | 198.78 |
| 11 TEXT MILL PRODUCTS, EXCEPT APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS | 39 | 114 | 2.92 | 2,231,736 | 1,083,821 | 136,425 | 16.36 | 16.81 |
| 12 APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS | 32 | 72 | 2.25 | 2,108,709 | 899,930 | 243,927 | 8.64 | 6.89 |
| 13 LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE | 20 | 37 | 1.85 | 2,497,913 | 1,302,225 | 126,404 | 19.76 | 15.92 |
| 14 FURNITURE AND FIXTURES | 10 | 21 | 2.10 | 2,161,703 | 1,294,248 | 129,238 | 16.73 | 17.48 |
| 15 PULP, PAPER AND PAPER PRODUCTS | 19 | 59 | 3.11 | 7,089,182 | 5,938,938 | 210,460 | 33.68 | 84.54 |
| 16 PRINTING AND ALLIED INDUSTRIES | 5 | 9 | 1.80 | 6,945,444 | 4,586,789 | 340,890 | 20.37 | 30.60 |
| 17 CHEMICAL AND ALLIED PRODUCTS | 40 | 214 | 5.35 | 25,027,125 | 23,344,170 | 342,481 | 73.08 | 613.14 |
| 18 PETROLEUM AND COAL PRODUCTS | 7 | 24 | 3.43 | 13,429,286 | 12,899,217 | 23,824 | 563.69 | 1582.92 |
| 19 PLASTIC PRODUCTS, EXCEPT OTHERWISE CLASSIFIED | 23 | 43 | 1.87 | 10,905,871 | 8,484,976 | 436,897 | 24.96 | 55.85 |
| 20 RUBBER PRODUCTS | 13 | 41 | 3.15 | 3,098,894 | 2,719,091 | 124,613 | 24.87 | 89.10 |
| 21 LEATHER TANNING, LEATHER PRODUCTS AND FUR SKINS | 10 | 34 | 3.40 | 477,770 | 209,207 | 31,972 | 14.94 | 10.33 |
| 22 CERAMIC, STONE AND CLAY PRODUCTS | 49 | 112 | 2.29 | 7,480,109 | 4,599,058 | 293,013 | 25.53 | 33.86 |
| 23 IRON AND STEEL | 23 | 65 | 2.83 | 16,896,431 | 14,925,976 | 213,056 | 79.31 | 368.57 |
| 24 NON-FERROUS METALS AND PRODUCTS | 20 | 56 | 2.80 | 6,711,626 | 5,865,296 | 132,753 | 50.56 | 240.27 |
| 25 FABRICATED METAL PRODUCTS | 31 | 104 | 3.35 | 14,015,901 | 8,136,214 | 657,942 | 21.30 | 25.46 |
| 26 GENERAL MACHINERY | 47 | 236 | 5.02 | 31,210,883 | 25,508,113 | 983,449 | 31.74 | 84.52 |
| 27 ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES | 24 | 114 | 4.75 | 18,812,387 | 17,017,662 | 559,413 | 33.63 | 156.27 |
| 28 INFORMATION AND COMMUNICATION ELECTRONICS EQUIPMENT | 11 | 52 | 4.73 | 11,534,270 | 11,010,647 | 205,331 | 56.17 | 561.05 |
| 29 ELECTRONIC PARTS AND DEVICES | 9 | 41 | 4.56 | 18,720,153 | 17,577,130 | 492,512 | 38.01 | 376.90 |
| 30 TRANSPORTATION EQUIPMENT | 16 | 77 | 4.81 | 53,999,911 | 51,957,071 | 944,352 | 57.18 | 506.62 |
| 31 PRECISION INSTRUMENTS AND MACHINERY | 22 | 62 | 2.82 | 3,784,716 | 3,211,756 | 151,188 | 25.03 | 85.50 |
| 32 MISCELLANEOUS MANUFACTURING INDUSTRIES | 37 | 102 | 2.76 | 4,316,743 | 3,284,490 | 171,922 | 25.11 | 39.50 |

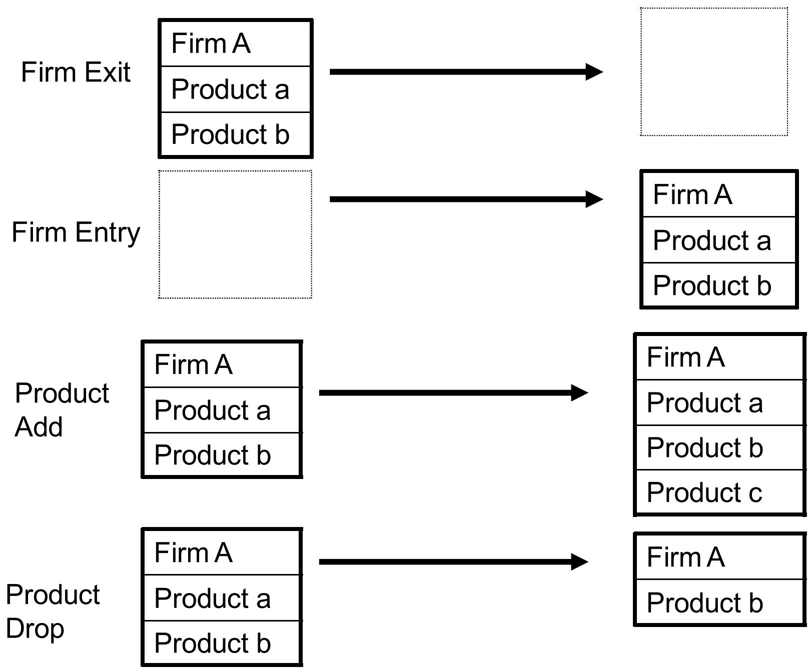
Note: We calculate these values using the report by industry of the 2005 Census. However, tangible fixed assets and their per employee values are calculated for establishments with 30 employees or more.

Table 2 shows the share of products in an industry and product characteristics by sector. We find the Japanese distribution of products to be similar to that in the US.[8] There are many varieties of products in the food, chemical products, general machinery, and electric machinery sectors. We find that the value of shipments per employee is higher in industries with high capital intensity such as the coal and petroleum products sector.[9]

## 3. Features of product switching in Japanese manufacturing firms

We outline the concepts of product switching in multiple product firms in Figure 1. Firm entry and firm exit in traditional firm dynamics are defined as follows in our data. "Firm exit" means when a firm which exists at year *t* no longer exists at year *t+j*.[10] On the other hand, we define "firm entry" as when a firm that does not exist in year *t* enters the market by year *t+j*. We define "product add" as when a product that did not exist in year *t* starts being produced by year *t+j*, while we call it "product drop" when a product that exists in year *t* stops being produced by year *t+j*.

Figure 1. Definition of Product Switching




Based on the definitions above regarding product switching, we study 1) the difference

[8] All the following values for the U.S. are from BRS (2006).
[9] However, we use book values of tangible fixed assets, and the calculation is based on the establishments with more than 30 employees.
[10] Since the sample is limited to 1998, 2000, 2003, and 2005, the value of *j* is not fixed.

in performance between multiple-product firms and single-product firms, 2) the effect of product switching on economic growth, and 3) the factor decompositions of labor productivity growth at the industry and firm level.

### *3-1. Multiple-product firms vs. single-product firms*

In Table 3, we categorize firms into multiple-product firms and single-product firms, not only at the product level but also at the industry and sector levels. We find that single-product firms account for 60% of the total firms in Japan, which is similar to the corresponding share in the U.S. (59%) reported in BRS. Likewise, the share of firms producing multiple products in multiple sectors is 13%, which is the same as the corresponding share in the U.S. (13%). However, the share of real output [11] in single-product firms in the entire sample is 9% in the U.S., while the corresponding share is 22% in Japan. The average number of products in multiple-product firms in Japan is 2.8 while the corresponding number is 4 in the U.S.[12] In the IT sector and the export sector, the fraction of multiple product firms is higher than that in the total manufacturing sector. As the number of products in these sectors is greater than that in the total manufacturing sector, products in these sectors are more diversified than those in other sectors.

[11] We deflate the variables using the deflator from the JIP database. The estimation methods are detailed in Appendix A.

[12] The export share of the industries that export comprise 63% of the economy.

Table 3. Share of Firms Producing Multiple Products, and Activity in Multiple Industries and Sectors

| | | Percent of Firms | | | | Percent of Real Output | | | | Average Number of Products Produced per Firm (Products, Industries, or Sectors) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Single-Product | Multiple-Product | Multiple-Industry | Multiple-Sector | Single-Product | Multiple-Product | Multiple-Industry | Multiple-Sector | Single-Product | Multiple-Product | Multiple-Industry | Multiple-Sector |
| 27,28 | IT Sector | 54.0 | 46.0 | 33.2 | 26.3 | 13.6 | 86.4 | 79.7 | 68.7 | 1.0 | 3.0 | 3.3 | 3.4 |
| 26-31 | Export Sector | 54.4 | 45.6 | 34.7 | 24.2 | 17.5 | 82.5 | 74.8 | 60.0 | 1.0 | 2.9 | 3.2 | 3.3 |
| 9 | FOOD | 60.3 | 39.7 | 27.5 | 2.4 | 30.7 | 69.3 | 57.6 | 18.9 | 1.0 | 2.7 | 2.9 | 3.8 |
| 10 | BEVERAGES, TOBACCO AND FEED | 45.5 | 54.5 | 23.1 | 14.4 | 11.6 | 88.4 | 80.0 | 55.8 | 1.0 | 2.6 | 3.3 | 3.4 |
| 11 | TEXTILE MILL PRODUCTS, EXCEPT APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS | 73.7 | 26.3 | 13.9 | 5.2 | 37.2 | 62.8 | 48.0 | 22.6 | 1.0 | 2.5 | 2.8 | 3.1 |
| 12 | APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS | 73.3 | 26.7 | 16.7 | 4.2 | 53.6 | 46.4 | 32.1 | 12.4 | 1.0 | 2.6 | 2.8 | 3.0 |
| 13 | LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE | 35.0 | 65.0 | 34.4 | 7.8 | 29.3 | 70.7 | 57.1 | 18.2 | 1.0 | 3.5 | 3.6 | 3.2 |
| 14 | FURNITURE AND FIXTURES | 56.6 | 43.4 | 27.0 | 12.3 | 43.0 | 57.0 | 44.2 | 30.6 | 1.0 | 2.8 | 2.8 | 3.1 |
| 15 | PULP, PAPER AND PAPER PRODUCTS | 59.5 | 40.5 | 27.1 | 9.9 | 24.7 | 75.3 | 69.3 | 23.1 | 1.0 | 2.8 | 3.0 | 3.2 |
| 16 | PRINTING AND ALLIED INDUSTRIES | 71.6 | 28.4 | 12.0 | 3.2 | 49.7 | 50.3 | 35.5 | 26.4 | 1.0 | 2.4 | 2.7 | 2.9 |
| 17 | CHEMICAL AND ALLIED PRODUCTS | 43.3 | 56.7 | 39.7 | 16.1 | 19.6 | 80.4 | 72.5 | 42.2 | 1.0 | 3.7 | 4.2 | 4.8 |
| 18 | PETROLEUM AND COAL PRODUCTS | 67.4 | 32.6 | 29.3 | 24.7 | 1.7 | 98.3 | 98.1 | 97.6 | 1.0 | 3.5 | 3.6 | 3.9 |
| 19 | PLASTIC PRODUCTS, EXCEPT OTHERWISE CLASSIFIED | 59.3 | 40.7 | 27.0 | 14.1 | 30.6 | 69.4 | 62.7 | 46.5 | 1.0 | 2.6 | 2.9 | 3.1 |
| 20 | RUBBER PRODUCTS | 64.2 | 35.8 | 19.4 | 10.8 | 18.7 | 81.3 | 74.4 | 64.5 | 1.0 | 2.8 | 3.2 | 3.4 |
| 21 | LEATHER TANNING, LEATHER PRODUCTS AND FUR SKINS | 76.3 | 23.7 | 12.6 | 5.8 | 54.3 | 45.7 | 30.8 | 22.9 | 1.0 | 2.5 | 2.8 | 3.0 |
| 22 | CERAMIC, STONE AND CLAY PRODUCTS | 70.7 | 29.3 | 17.5 | 4.3 | 40.4 | 59.6 | 49.8 | 30.5 | 1.0 | 2.5 | 2.7 | 3.3 |
| 23 | IRON AND STEEL | 56.2 | 43.8 | 30.0 | 17.6 | 11.3 | 88.7 | 78.0 | 60.5 | 1.0 | 2.8 | 3.1 | 3.4 |
| 24 | NON-FERROUS METALS AND PRODUCTS | 55.2 | 44.8 | 34.1 | 17.9 | 13.9 | 86.1 | 79.2 | 65.9 | 1.0 | 3.0 | 3.2 | 3.7 |
| 25 | FABRICATED METAL PRODUCTS | 63.6 | 36.4 | 23.7 | 15.9 | 40.1 | 59.9 | 49.9 | 42.7 | 1.0 | 2.6 | 2.9 | 3.0 |
| 26 | GENERAL MACHINERY | 51.8 | 48.2 | 36.5 | 21.2 | 24.7 | 75.3 | 63.9 | 43.7 | 1.0 | 2.9 | 3.2 | 3.4 |
| 27 | ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES | 54.8 | 45.2 | 30.9 | 23.7 | 17.6 | 82.4 | 73.1 | 63.1 | 1.0 | 3.0 | 3.2 | 3.3 |
| 28 | INFORMATION AND COMMUNICATION ELECTRONICS EQUIPMENT | 49.5 | 50.5 | 45.7 | 40.2 | 9.1 | 90.9 | 87.2 | 75.2 | 1.0 | 3.4 | 3.5 | 3.6 |
| 29 | ELECTRONIC PARTS AND DEVICES | 63.9 | 36.1 | 30.4 | 24.5 | 23.1 | 76.9 | 70.3 | 57.2 | 1.0 | 2.8 | 3.0 | 3.1 |
| 30 | TRANSPORTATION EQUIPMENT | 57.3 | 42.7 | 33.8 | 30.1 | 9.5 | 90.5 | 84.8 | 70.5 | 1.0 | 2.9 | 3.1 | 3.2 |
| 31 | PRECISION INSTRUMENTS AND MACHINERY | 56.5 | 43.5 | 32.5 | 25.0 | 20.4 | 79.6 | 73.2 | 60.0 | 1.0 | 2.9 | 3.2 | 3.3 |
| 32 | MISCELLANEOUS MANUFACTURING INDUSTRIES | 65.4 | 34.6 | 17.2 | 13.8 | 45.0 | 55.0 | 43.5 | 31.6 | 1.0 | 2.5 | 2.8 | 2.9 |
| | Total: Japan (2005) | 60.3 | 39.7 | 26.0 | 13.1 | 22.1 | 77.9 | 69.5 | 51.1 | 1.0 | 2.8 | 3.1 | 3.3 |
| | U.S. (1972-1997) | 59.0 | 41.0 | 29.0 | 13.0 | 9.0 | 91.0 | 87.0 | 76.0 | 1.0 | 4.0 | 3.1 | 2.5 |

Note: The results for the U.S. (1972-1997) are from BRS (2006). The “Percent of Firms” indicates the fraction of firms that produce single (or multiple) products. The columns under "Percent of Output" show the fraction of the total shipment value in the sample produced by a single (or multiple) product firms.

In Table 4, we examine differences in the output, employment, wages and labor productivity between single-product and multiple-product firms, conditional on the industry fixed effect. Furthermore, since a firm's performance is also affected by the number of establishments that the firm owns, due to the economies of scale, we include in our regression the number of establishments, a dummy variable for multiple-products, and their interaction term. We use the logarithms of output, the number of employees (employment), wage, and labor productivity as the measurement of firm's performance and report the coefficients on the dummy variable for multiple-products with and without interaction term with the number of establishments. Since we look at the effect of multiple-products on firm's performance at the product, industry, and sector levels, we have 24 regression results.

Based on the regression results, we find that multiple-product firms tend to show better performance in terms of output and employment levels than single-product firms. At product level, output of multiple-product firms is 0.527 log points higher than that of single product firms, and employment of multiple-product firms is 0.303 log points higher than that of single-product firms. Based on these two results, we can see that labor productivity is also higher for multiple-product firms than that of single-product firms. However, the estimates using the U.S. data show that output, employment, and labor productivity are 0.66, 0.58, and 0.08 log points higher in the multiple-product firms than those in the single-product firms, implying a greater effect of multiple-products on firm performance in the U.S. manufacturing sector. Furthermore, the coefficients on the interaction term between multiple-products and the number of establishments are all statistically significant and positive, and this indicates that economies of scale are enhancing the effect of multiple-products on firm performance.

Table 4. Mean Difference of Firm Characteristics between Single and Multiple Product, Industry and Sector

| Dependent Variables | Multipleproduct | Interaction Term with the Number of Establishments | Multiple-industry | Interaction Term with the Number of Establishments | Multiple-sector | Interaction Term with the Number of Establishments |
|---|---|---|---|---|---|---|
| Output (Shipment Value) | 0.527 | | 0.582 | | 0.655 | |
| | 0.483 | 0.040 | 0.542 | 0.037 | 0.610 | 0.041 |
| Employment | 0.303 | | 0.383 | | 0.452 | |
| | 0.268 | 0.031 | 0.351 | 0.028 | 0.419 | 0.030 |
| Wage | 0.421 | | 0.499 | | 0.567 | |
| | 0.380 | 0.037 | 0.462 | 0.033 | 0.529 | 0.035 |
| Labor Productivity | 0.216 | | 0.193 | | 0.203 | |
| | 0.206 | 0.009 | 0.183 | 0.009 | 0.190 | 0.011† |

Note: Using industry fixed effects, we studied the characteristics of single-producing and multiple-producing firms. Output and wages are in real terms. For the estimation results, † indicates statistical significance at the 5% level, and the others are statistically significant at the 1% level. We also include year dummy and number of establishments as regressors.

## 3-2. Product-switching in Japanese manufacturing firms

In Table 5, we show the trend in product switching in the Japanese manufacturing sector. We find that 67% of Japanese manufacturing firms did not change the composition of their products for the period between 1998 and 2003. This share is higher than that in the U.S. (32%).[13] This tendency still holds in terms of output. This result implies that Japanese manufacturing firms are more conservative than U.S. firms. This result also holds at the industry and sector levels.

Table 5. Product Switching between Single- and Multiple-Product Firms in Japan

| | | Japan | | | U.S. | | |
|---|---|---|---|---|---|---|---|
| | | All Firms | Single-Product Firms | Multiple-Product Firms | All Firms | Single-Product Firms | Multiple-Product Firms |
| Percent of Firms (%) | None | 67 | 79 | 49 | 32 | 46 | 11 |
| | Add Product(s) Only | 7 | 7 | 7 | 11 | 13 | 8 |
| | Drop Product(s) Only | 7 | n.a. | 17 | 12 | n.a. | 30 |
| | Both Add and Drop Products | 19 | 14 | 28 | 45 | 41 | 50 |
| Percent of Firms (%) weighted by Shipment Value | None | 54 | 82 | 37 | 7 | 49 | 3 |
| | Add Product(s) Only | 13 | 9 | 15 | 5 | 20 | 3 |
| | Drop Product(s) Only | 9 | n.a. | 14 | 7 | n.a. | 8 |
| | Both Add and Drop Products | 25 | 9 | 34 | 81 | 31 | 86 |

Note: Japanese values are the aggregated surviving firms' product switching between 1998 and 2003. The U.S. values are from BRS (2006) and aggregated surviving firms' switching profiles between *t* and *t+5* from 1972 to 1997.

In Table 6 we decompose the total output growth in the manufacturing sector into the following three factors: 1) a firm's entry and exit effects; 2) the effects of additions and reductions in the number of products (product add and product drop defined as extensive margin); and 3) the effects of increases and decreases in output for existing products (intensive margin). By doing so, we attempt to measure the effect of product switching on output growth. Among these three factors, the firm's extensive margin by product switching is the major factor in total output growth. On the other hand, the net effect of a firm's entry and exit on output growth is negative.

We also divide the sample into three periods: 1998-2000, 2002-2003, and 2003-2005. In the first sub-period (1998-2000), the Japanese economy had recovered from the financial crisis, but financial institutions in Japan still held huge non-performing loans. In the second period, the Japanese economy suffered from a recession resulting from the burst of the IT bubble in the U.S. In the last period, the Japanese economy recovered again due to increased exports. Entry and exit behavior and product switching in Japanese

[13] However, BRS (2010) studies product switching for the period between 1987 and 1997. Therefore, the comparison of these values between Japan and US is not accurate.

manufacturing firms were more active in the first period than in the last period. This implies that Japanese manufacturing firms actively searched for optimal product compositions through the restructuring periods until 2003 and maintained the product compositions since then.

Table 6. Decomposition of Total Shipment Growth

| | Aggregate Output Growth | Extensive Margin | | | Firm Entry and Exit | | | Intensive Margin |
|---|---|---|---|---|---|---|---|---|
| | | Net | Added Products | Dropped Products | Net | Firm Entry | Firm Exit | Net |
| (million yen) | | | | | | | | |
| 1998-2000 | 7.3 | 15.9 | 53.8 | 37.8 | 9.9 | 42.0 | 32.1 | -18.5 |
| 2000-2003 | -13.8 | 19.1 | 48.2 | 29.1 | -10.6 | 40.8 | 51.4 | -22.2 |
| 2003-2005 | 5.8 | 13.0 | 26.4 | 13.4 | -19.4 | 27.2 | 46.6 | 12.2 |
| (%) | | | | | | | | |
| 1998-2000 | 100 | 218.7 | 737.6 | 518.9 | 135.3 | 575.4 | 440.2 | -254.0 |
| 2000-2003 | 100 | 138.4 | 349.3 | 211.0 | -77.1 | 295.7 | 372.7 | -161.3 |
| 2003-2005 | 100 | 223.5 | 452.9 | 229.3 | -333.5 | 465.9 | 799.4 | 210.0 |

Note: Table 6 shows the decomposition of the change in total shipment in the Japanese manufacturing firms into extensive margins, intensive margins and firm entry and exit. Extensive margins indicate the sum of change by product adding less the change by product dropping in each firm. Intensive margins indicate the sum of changes as increases less the decrease of continuing the same products in each firm.

## 3-3. *Decompositions of labor productivity growth*

How much has product switching contributed to resource allocations in Japan? In this section, we examine the effect of product switching on productivity, by using the equation below to decompose labor productivity, which is calculated as the ratio of output and labor.

$$\Delta LP = \sum_{PS=1}^{9}\{\sum_{i\in C} s_{PSit-j}\Delta LP_{PSit} + \sum_{i\in C}(LP_{PSit-j} - \overline{LP_{PSit-j}})\Delta s_{PSit} + \sum_{i\in C}\Delta LP_{PSit}\Delta s_{SPit}\} + \sum_{i\in E} s_{it}(LP_t - \overline{LP_{t-j}}) + \sum_{i\notin X} s_{it-\tau}(\overline{LP_{t-\tau}} - LP_{it-j})) \tag{1}$$

$\Delta LP = \ln LP_t - \ln LP_{t-j}$ is the labor productivity growth in the manufacturing sector. $PS$ is the index for a firm's product switching behavior. It is equal to 1 if there is no product switching, 2 if there is an addition of a new product (Product Add) within the industry, 3 if there is an addition of a new product across industries, 4 if there is an elimination of a product (Product Drop) within the industry, 5 if there is an elimination of a product across industries, 6 if there is both an addition and an elimination of a product within industries, 7 if there is both an addition and an elimination of a product across industries, 8 if there is both an addition of product across industries and an elimination of a product within the industry, 9 if there were both an addition of product within the industry and an elimination of product across industries. $C$ denotes the existing firm. $N$ denotes a new firm that entered in period $t$ and $X$ indicates a firm that exited. $s_i$ is the share of firm $i$ of the total output within the Japanese manufacturing sector. Bars above the variables indicate the mean of the variables.[14]

The first term in parentheses on the right hand side of the equation indicates the within effect. The second term indicates the between effect, and the third term indicates the covariance effect. We estimate the three effects separately for the nine subsamples based on the types of product switching behavior. The sum of the three effects for the existing firms for which the *PS* index is between 2 and 9 is the aggregate effect of product switching. The second term in the right hand side of equation is the entry effect and the third term is the exit effect. We estimate this equation for the following two periods: between 1998-2000 and between 2003-2005.

Table 7 shows a significant impact of product switching on labor productivity in Japan. For the period between 1998 and 2000, the effects of product addition and elimination contributed to the labor productivity most, while the effect of production addition was the largest for the period between 2003 and 2005. When we decompose the effect of product switching into within, between, and covariance effects, we find that the impact of the between-effect of product addition is the largest. Fukao and Kwon (2006) defined product switching across industries as a “switch-in” effect and “switch-out” effect and treat them as the entry and exit effect of entry and exit.[15] Although we include product switching across industries as part of the product switching effect, product switching contributes greatly to labor productivity growth, as shown in the last row in Table 7.

Entry effect contributed most to labor productivity growth in the two sub-sample periods. However, since the exit effect is negative and its magnitude is large, the net entry and exit effect contribute negatively to labor productivity growth. The result that the effect of existing firms’ productivity changes with an increase in macro-level labor productivity is greater than those of net entry and exit is consistent with Fukao and Kwon (2006). We also find that resource reallocation through product switching among the exiting firms in particular contributed greatly to labor productivity growth.

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[14] Although we could estimate the TFP growth rate using equation (1), we estimated labor productivity instead of TFP, because the firms in the sample were limited to ones with more than 10 employees.

[15] Strictly speaking, Fukao and Kwon (2006) define “Switch-in” and “Switch-out” as the entry from a different industry into a target industry through the switching of the major product and analogous exit into other industries. On the other hand, in this paper, we do not define “Switch-in” and “Switch-out” as the switching of the major product, but instead define them based on whether a new product added or dropped belongs to another 2 digit level industry.

Table 7. Decomposition of Labor Productivity Growth, Output Growth, and Employment Growth

| | 98-00 | | | 03-05 | | |
|---|---|---|---|---|---|---|
| | Effect | Number of Observations | Effect per Firm | Effect | Number of Observations | Effect per Firm |
| Total | 4.16% | | | 5.97% | | |
| Within Effect | -2.50% | 255217 | -0.000010% | -2.64% | 216368 | -0.000012% |
| Firms without Product Switching | -2.09% | 171296 | -0.000012% | -1.71% | 158997 | -0.000011% |
| Effect of Product Switching | -0.41% | 83921 | -0.000005% | -0.92% | 57371 | -0.000016% |
| Effect of Product Add Only | -0.20% | 18369 | -0.000011% | -0.47% | 12529 | -0.000038% |
| Product Add within Sector | -0.12% | 14140 | -0.000008% | -0.47% | 9407 | -0.000050% |
| Product Add across Sectors | -0.09% | 4229 | -0.000020% | 0.00% | 3122 | -0.000001% |
| Effect of Product Drop Only | -0.88% | 16758 | -0.000052% | -0.79% | 13688 | -0.000058% |
| Product Drop within Sector | -0.52% | 12834 | -0.000040% | -0.31% | 10557 | -0.000030% |
| Product Drop across Sectors | -0.36% | 3924 | -0.000092% | -0.48% | 3131 | -0.000154% |
| Product Add and Drop | 0.67% | 48794 | 0.000014% | 0.34% | 31154 | 0.000011% |
| Product Add and Drop within Sector | 0.89% | 32476 | 0.000027% | 0.67% | 20411 | 0.000033% |
| Product Add and Drop across Sectors | -0.11% | 8558 | -0.000013% | 0.03% | 5592 | 0.000006% |
| Product Add across Sectors and Product Drop within Sector | 0.00% | 3907 | 0.000000% | -0.26% | 2632 | -0.000097% |
| Product Add within Sector, Product Drop across Sectors | -0.11% | 3853 | -0.000028% | -0.11% | 2519 | -0.000042% |
| Between Effect | -2.63% | 255217 | -0.000010% | 11.71% | 216368 | 0.000054% |
| Firms without Product Switching | -0.76% | 171296 | -0.000004% | 3.92% | 158997 | 0.000025% |
| Effect of Product Switching | -1.87% | 83921 | -0.000022% | 7.79% | 57371 | 0.000136% |
| Effect of Product Add Only | -0.12% | 18369 | -0.000006% | 5.13% | 12529 | 0.000410% |
| Product Add within Sector | 0.35% | 14140 | 0.000025% | 1.75% | 9407 | 0.000186% |
| Product Add across Sectors | -0.47% | 4229 | -0.000112% | 3.38% | 3122 | 0.001083% |
| Effect of Product Drop Only | -0.77% | 16758 | -0.000046% | -0.32% | 13688 | -0.000024% |
| Product Drop within Sector | -0.09% | 12834 | -0.000007% | -0.05% | 10557 | -0.000005% |
| Product Drop across Sectors | -0.69% | 3924 | -0.000175% | -0.27% | 3131 | -0.000087% |
| Product Add and Drop | -0.98% | 48794 | -0.000020% | 2.98% | 31154 | 0.000096% |
| Product Add and Drop within Sector | 0.81% | 32476 | 0.000025% | 4.23% | 20411 | 0.000207% |
| Product Add and Drop across Sectors | -0.14% | 8558 | -0.000016% | 0.07% | 5592 | 0.000013% |
| Product Add across Sectors and Product Drop within Sector | -0.25% | 3907 | -0.000064% | 0.37% | 2632 | 0.000139% |
| Product Add within Sector, Product Drop across Sectors | -1.40% | 3853 | -0.000364% | -1.69% | 2519 | -0.000673% |
| Covariance Effect | 8.38% | 255217 | 0.000033% | 8.02% | 216368 | 0.000037% |
| Firms without Product Switching | 1.94% | 171296 | 0.000011% | 2.94% | 158997 | 0.000018% |
| Effect of Product Switching | 6.44% | 83921 | 0.000077% | 5.08% | 57371 | 0.000089% |
| Effect of Product Add Only | 1.63% | 18369 | 0.000088% | 1.98% | 12529 | 0.000158% |
| Product Add within Sector | 0.96% | 14140 | 0.000068% | 1.04% | 9407 | 0.000111% |
| Product Add across Sectors | 0.66% | 4229 | 0.000157% | 0.93% | 3122 | 0.000299% |
| Effect of Product Drop Only | 2.07% | 16758 | 0.000123% | 1.55% | 13688 | 0.000113% |
| Product Drop within Sector | 1.72% | 12834 | 0.000134% | 0.84% | 10557 | 0.000079% |
| Product Drop across Sectors | 0.35% | 3924 | 0.000088% | 0.71% | 3131 | 0.000228% |
| Product Add and Drop | 2.74% | 48794 | 0.000056% | 1.56% | 31154 | 0.000050% |
| Product Add and Drop within Sector | 1.60% | 32476 | 0.000049% | 0.99% | 20411 | 0.000048% |
| Product Add and Drop across Sectors | 0.28% | 8558 | 0.000033% | 0.16% | 5592 | 0.000029% |
| Product Add across Sectors and Product Drop within Sector | 0.50% | 3907 | 0.000127% | 0.24% | 2632 | 0.000089% |
| Product Add within Sector, Product Drop across Sectors | 0.36% | 3853 | 0.000094% | 0.17% | 2519 | 0.000068% |
| Net Entry and Exit Effect | 0.91% | | | -11.12% | | |
| Entry Effect | 28.08% | 45733 | 0.000614% | 22.14% | 32614 | 0.000679% |
| Exit Effect | -27.17% | 53382 | 0.000509% | -33.27% | 53486 | 0.000622% |
| Net Entry and Exit Effect (including Switch-in and Switch-out Effect) | -0.34% | | | -8.50% | | |
| Entry Effect (including Switch-in and Switch-out Effect) | 28.68% | | | 26.44% | | |
| Exit Effect (including Switch-in and Switch-out Effect) | -29.02% | | | -34.94% | | |
| Effect of Existing Firms | 3.24% | | | 17.09% | | |
| Firms without Product Switching | -0.91% | 171296 | -0.000005% | 5.15% | 158997 | 0.000032% |
| Product Add Only | 1.31% | 18369 | 0.000071% | 6.64% | 12529 | 0.000530% |
| Product Drop Only | 0.41% | 16758 | 0.000025% | 0.43% | 13688 | 0.000032% |
| Product Add and Drop | 2.44% | 48794 | 0.000014% | 4.88% | 31154 | 0.000014% |
| Effect of Product Switching | 4.16% | | | 11.94% | | |

Note: We decomposed labor productivity growth into within-effect, between-effect, and covariance effect, net entry and exit effect following the method by Foster, Haltiwanger and Syverson (2005). We decomposed the first three effects into types of product switching using equation (1).

## 4. The effect of product switching behavior on firm performance

### *4-1. Effects of product switching at industry level*

In this section, we study the mechanism through which product switching improves productivity. First, we estimate the following equation to understand in what type of industries we see a prevalence of product switching behavior.

$$\begin{aligned} PSrate_{t+j,m} &= const. + \alpha_1 \Delta REG_{t,m} + \alpha_2 PCM_{t,m} + \alpha_3 \Delta y_{t,m} \\ &\quad + \alpha_4 \ln(K_{t,m} / L_{t,m}) + \sum year_t + u_{t+1,m} \end{aligned} \tag{2}$$

$PSrate_{t+j,m}$ denotes the fraction of firms that had a product addition between period *t* and *t+j* (product adding rate), the fraction of firms that had dropped products (product dropping rate), the fraction of new entrant firms (entry rate), and the fraction of firms that exited (exit rate) in industry *m*. Product adding rate and entry rate are measured based on the sample in period *t+j*, while product dropping rate and exit rate are measured based on the sample in period *t*. $\Delta REG_{t,m}$ denotes the change in regulatory index from *t* to *t+j*. measured by industry compiled by the Cabinet Office, Government of Japan. A high value for this term indicates that the regulations became stricter in that industry.[16]

$PCM_{t,m}$ represents the price cost margin in industry *m* to measure the competitiveness of the industry. Baldwin and Geroski (1985) shows that firm entries decrease and firm exits increase when a market becomes more competitive. We therefore expect $\alpha_2$ to be positive when the product adding dummy is the dependent variable and $\alpha_2$ to be negative when the product dropping dummy is the dependent variable.

$\Delta y_{t,m}$ represents the growth rate in gross output in industry *m* in period *t*. Capital intensity, $\ln(K_{t,i}/L_{t,i})$, shows fixed costs when a firm enters a market or switches products. In BRS (2003, 2010), an increase in fixed entry costs makes firm entry difficult and product switching of incumbent firms easy. On the other hand, an increase in fixed switching costs makes product switching in incumbent firms difficult.

Table 8 shows the OLS regression results of equation (2). The coefficients on the regulatory measure variable are negative and statistically significant in all equations, and this implies that product switching (product adding rate and product dropping rate) is not prevalent in highly regulated industries. On the other hand, the coefficients on the price cost margin are negative and statistically significant. This implies that less competitive industries tend to see less firm entry and exit and less product switching behavior. The coefficients on capital intensity were all negative and significant. These estimation results show that product switching behavior is constrained by fixed cost and product switching costs. We can also see that there tends to be a greater number of firm entries in growing

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[16] The regulatory index level is normalized to 1 in 1995 and thus does not reflect the differences in the regulatory level across industries. Therefore, we include changes in the regulatory index as an explanatory variable. Please refer to Appendix B for the measurement method for regulatory index.

industries and a greater number of firm exits in declining industries. While the product adding behavior has the same pattern as firm entries, the product dropping behavior did not show the same pattern as firm exits. This may be due to the fact that product dropping is equivalent to firm exit for single-product firms, and the effect of market competitiveness is reflected in the firm exit behavior.

Table 8. Characteristics of Industries that Affect Product Switching and Firm Entry and Exit Behavior based on Industry-Level Data

| | Add Rate $_{t-i,t}$ | | Entry Rate $_{t-i,t}$ | | Drop Rate $_{t-i,t}$ | | Exit Rate $_{t-i,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | coefficient | coefficient | coefficient | coefficient | coefficient | coefficient | coefficient | coefficient |
| ⊿REG $_{t-1,t}$ (Regulation) | −0.1697 *** | −0.1611 *** | −0.0092 ** | −0.0091 ** | −0.5952 *** | −0.6023 *** | −0.2175 *** | −0.2166 *** |
| | (−4.540) | (−4.360) | (−1.960) | (−1.970) | (−6.110) | (−6.310) | (−4.160) | (−4.150) |
| ln(K/L) $_{t-i}$ (Log of Capital Intensity) | −0.0178 *** | −0.0155 *** | −0.0060 *** | −0.0055 *** | −0.0090 * | −0.0053 | −0.0369 *** | −0.0365 *** |
| | (−5.510) | (−4.810) | (−3.970) | (−3.640) | (−1.810) | (−1.080) | (−13.720) | (−13.470) |
| ⊿lnY $_{t-1,t}$ (Growth of Market Size) | 0.0804 *** | 0.0850 *** | 0.0266 *** | 0.0249 *** | 0.0301 | 0.0333 | −0.0802 *** | −0.0798 *** |
| | (4.070) | (4.350) | (2.770) | (2.620) | (0.910) | (1.030) | (−4.510) | (−4.480) |
| PCM $_{t-i}$ (Price Cost Margins) | | −0.2484 *** | | −0.1169 *** | | −0.3792 *** | | −0.0790 * |
| | | (−5.070) | | (−4.820) | | (−5.110) | | (−1.780) |
| constant | 0.3536 *** | 0.4093 *** | 0.1528 *** | 0.1818 *** | 0.2979 *** | 0.3756 *** | 0.4165 *** | 0.4346 *** |
| | (18.740) | (18.860) | (17.590) | (17.390) | (10.370) | (11.750) | (26.940) | (23.620) |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Observations | 1080 | 1080 | 1076 | 1075 | 540 | 540 | 539 | 538 |
| R-squared | 0.1413 | 0.1623 | 0.0645 | 0.0832 | 0.0743 | 0.1157 | 0.3272 | 0.3286 |
| F-value | 44.2321 | 41.6052 | 18.4667 | 19.4042 | 14.3479 | 17.5081 | 86.7173 | 65.2234 |

Note. All regressions use industry level data that we created by aggregating firm-level samples of the *Census of Manufacturers*. All estimations include year dummies as control variables. The asterisks (*,**,***) represent statistical significance levels at 10%, 5%, and 1% respectively. Each value in parentheses below the coefficients is the t-value.

## *4-1. Effects of product switching at firm level*

We study determinants of product switching using the firm level data.

$$PS_{t+j,i} = const. + \beta_1 PRO_{t,i} + \beta_2 PCM_{t,i} + \beta_3 RSIZE_{t,i} + \beta_4 \ln(K_{t,i}/L_{t,i}) + e_{t,i}$$
$$PRO_{t,i} = \gamma_1 \sum_{k}^{2} B_{t,i,k} + \overline{PCM}_t \tag{3}$$

In the first line of equation (3), $PS_{t+j,i}$ represents a product switching dummy in firm *i* from *t* (1998, 2001, or 2003) to *t+j* (2001, 2003, or 2006). We consider three kinds of dummies: a dummy that shows that firm *i* adds products, a dummy that shows that firm *i* drops products, a dummy that shows that firms both add and drop products.

$PRO_{t,i}$ represents productivity of firm *i* in period *t*. We consider two types of productivity measures: TFP and labor productivity. According to BRS (2010), a highly productive firm adds products in order to increase the types of products that the firm can produce. Therefore, we expect the sign of the coefficient $\beta_1$ to be positive. $PCM_{t,i}$ represents the price cost margin in firm *i* indicating the competitiveness of firm *i*.

The estimation equation above has an endogeneity problem, as discussed in BRS (2003, 2010). Therefore, we estimate equation (3) with the instrument variable method and include sector and year dummies. $PRO_{t,i}$ and the product switching dummy are endogenously determined, and we use as the instrument the form of business dummy (in the *Census of Manufacturers*, firms are asked if they are public, unionized or private; we use the public form of business as the reference group), a previous period's regulatory index, and the industry average of price cost margin.[17] Firm size, capital intensity, and price cost margin of the firm are exogenous variables. The estimation results with the production adding dummy in Table 9 shows that the coefficient on the labor productivity is positive and statistically significant. This result implies that labor productivity promotes product addition. On the other hand, we also find that the coefficient on labor productivity is positive and significant when the dependent variable is product dropping. This is inconsistent with the pre-analysis hypothesis. However, this result is consistent with the estimation results in Table 7 and the results shown in Nishimura, Kiyota and Nakajima (2005) and Fukao and Kwon (2006): relatively high-performing firms tend to exit in Japan. Furthermore, as we predicted, high fixed costs protect incumbent firms and therefore, capital-intensive firms tend to neither eliminate products nor exit.

In both product adding and dropping estimations (columns (3) and (5)), the coefficients on labor productivity are positive and significant, implying that more productive firms tend to switch products more aggressively. In the estimations with the firm fixed effects, while the coefficients on labor productivity are positive and significant, the coefficients on TFP are also positive but not statistically significant.

Coefficients on price cost margin are negative. These results imply that a competitive market condition stimulates product switching. An alternative interpretation proposed by BRS (2003, 2010) is as follows: price cost margins are equivalent to fixed costs under the zero profit condition. Therefore, the low price cost margin means low fixed costs that encourage firms to enter or add new products.

[17] However, we change the instrument variables depending on estimation equations. Please refer to Table 9 for details.

Table 9. Effect of Labor Productivity on Product Switching

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Estimation Method | IV | IV | IV | IV | IV−FE | IV−FE |
| Dependent Variable | $Add_{t,\,t+i}$ | $Drop_{t,\,t+i}$ | Both Add and $Drop_{t,\,t+i}$ | Both Add and $Drop_{t,\,t+i}$ | Both Add and $Drop_{t,\,t+i}$ | Both Add and $Drop_{t,\,t+i}$ |
| | coefficient | coefficient | coefficient | coefficient | coefficient | coefficient |
| $lnLP_t$ | 0.003 *** | 0.006 *** | 0.011 *** | | 0.014 *** | |
| (Log of Labor Productivity) | (2.68) | (7.47) | (9.66) | | (10.82) | |
| $TFP_t$ | | | | 0.482 | | 0.665 |
| (Total Factor Productivity) | | | | (0.92) | | (1.13) |
| $PCM_t$ | −0.068 *** | −0.039 *** | −0.050 *** | −0.172 *** | −0.029 | −0.187 *** |
| (Price Cost Margin) | (−8.24) | (−6.30) | (−6.60) | (−6.04) | (−1.44) | (−3.18) |
| $ln(K/L)_t$ | 0.006 *** | 0.004 *** | 0.010 *** | −0.001 | 0.014 *** | 0.006 |
| (Log of Capital Intensity) | (6.17) | (5.85) | (12.73) | (−0.17) | (9.44) | (1.21) |
| $RSIZE(lnL)_t$ | 0.017 *** | 0.010 *** | −0.002 *** | 0.028 | −0.006 *** | 0.035 |
| (Log of Employees) | (27.78) | (23.14) | (−3.82) | (1.37) | (−10.68) | (1.46) |
| constant | −0.018 ** | −0.037 *** | −0.071 *** | −0.017 | | |
| | (−2.51) | (−7.50) | (−10.45) | (−0.32) | | |
| Number of Observations | 520294 | 684232 | 867983 | 110894 | 867982 | 110889 |
| R−squared | 0.011 | 0.009 | 0.031 | 0.027 | 0.002 | 0 |
| Sargan Statistics | | | | | 5.08 | 0.463 |
| | | | | | 0.079 | 0.793 |

Note: IV indicates the instrumental variable model estimation and IV-FE indicates the fixed effect with the instrumental variable model. The level of fixed effect is firm-level industry classification. All estimations include a sector dummy and a year dummy. Here, we omitted the estimation results based on the random effect model. However, the Hausman test indicated that the fixed effect model is more relevant. The instrumental variables are the business form dummy and the lag of the regulation index in (1)-(2), business form dummy in (3)-(4), business form dummy and industry-level price cost margin in (5)-(6). Dependent variable Add is 1 when the firms add new product(s) between t and t+j, 0 when they do not add or drop products between t and t+i vice versa for the dependent variable Drop. On the other hand, dependent variable Both Add and Drop is 1 when the firms both add and drop product(s) between t and t+i, and is 0 otherwise. The asterisks (*,**,***) represent significance levels at 10%, 5%, and 1% respectively. Each value in parentheses below the coefficients is the t-value.

Lastly, we examine the effects of product switching on firm performance by estimating the following equation. We split the sample into a treatment group and a control group based on whether or not a firm is engaged in product switching. We create three dummies for product switching: product add dummy, product drop dummy, and product drop and add dummy. We then examine whether there is a difference in change in performance. Ideally, we would want to include in the treatment group a sample that engaged in product switching and ones that did not. However, the treatment group does not include a sample that did not engage in product switching behavior. Therefore, we employ the Propensity

Score Matching Model to find a sample that did not engage in product switching but has similar characteristics as corresponding firms that engaged in product switching.

The Propensity Score Matching Model is described as follows. We create a dummy variable, which is equal to 1 if the firm engaged in product switching in year $t$ and 0 otherwise. A change in performance due to product switching, $FP_{t,t+j,i}$, can be described by the following equation:

$$\delta = E(FP^{1}_{t,t+j,i} \mid d_{t,i} = 1) - E(FP^{0}_{t,t+j,i} \mid d_{t,i} = 1) \tag{4}$$

We call the firms with $d_{t,i} = 1$ treatment group, the ones with $d_{t,i} = 0$ the control group, and $\delta$ Average Effect of Treatment on Treated (ATT). The first term on the right hand side of the equation is the expected change in performance for a firm that switches products. However, the second term on the right hand side of equation is the expected change in performance if a firm that engaged in product switching did not switch product. Since this is counterfactual and not observed in the data, we replace the second term in the equation (4) with the expected change of the firms that did not engage in product switching.

$$\delta = E(FP^{1}_{t,t+j,i} \mid d_{t,i} = 1) - E(FP^{0}_{t,t+j,i} \mid d_{t,i} = 0) \tag{5}$$

Comparison between the treatment group and the control group requires random sampling. However, in reality, as we showed in the previous section, the selections into the two groups are determined by various factors. As Rubin (1977) showed, if we assume that firms' selection into a treatment group and a control group and their outcome are independent given that the firms have similar characteristics, we can estimate ATT. If we denote the independence of the firm characteristics $X_{it}$ as $X_{it} = x_{it}$, we can rewrite equation (5) as follows:

$$\delta' = E(FP^{1}_{t,t+j,i} \mid d_{t,i} = 1, X_{it} = x_{it}) - E(FP^{0}_{t,t+j,i} \mid d_{t,i} = 0, X_{it} = x_{it}) \tag{5}$$

In other words, we compare the effects of product switching on firm performance between the firms that have similar characteristics. The Propensity Score Matching Model is a method for choosing firms that have similar characteristics. Firstly, we estimate propensity score which is a predicted probability of product switching using the logistic model. We then match the firms that have similar values of propensity score and estimate ATT by comparing the effect of product switching on firm performance between the firms in the treatment group and corresponding firms in the control group. We can estimate ATT using the following equation. We estimate the logistic model using capital intensity, price cost margin, employment, industry dummy, and labor productivity based on the estimation results in Table 9.

$$\delta'' = \frac{1}{N}\sum_{i \in T} FP^{1}_{t,t+j,i} - \sum_{j \in C} W\left(\Pr(X_{t,i})\Pr(X_{t,j})\right)FP^{0}_{t,t+j,i}\Big) \tag{6}$$

Table 10. Effect of Product Switching on Firm Performance based on the Propensity Score Matching Model

| | | Logit Estimation including Labor Productivity with 2 and 3 period lags | | | | | Logit Estimation excluding Labor Productivity with 2 and 3 period lags | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Treatment Group | Control Group | ATT | Standard Errors | t-Value | Treatment Group | Control Group | ATT | Standard Errors | t-Value |
| **Product Add Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | 0.090 | −0.069 | 0.159 | 0.002 | 64.26 | 0.090 | −0.069 | 0.159 | 0.002 | 64.26 |
| | PSM | 0.090 | −0.070 | 0.161 | 0.005 | 35.30 | 0.090 | −0.073 | 0.164 | 0.005 | 36.36 |
| Employment Growth Rate | Unmatched | 0.042 | −0.035 | 0.077 | 0.002 | 49.13 | 0.042 | −0.035 | 0.077 | 0.002 | 49.13 |
| | PSM | 0.042 | −0.041 | 0.083 | 0.003 | 31.90 | 0.042 | −0.038 | 0.080 | 0.003 | 30.62 |
| Labor Productivity Growth Rate | Unmatched | 0.049 | −0.034 | 0.083 | 0.002 | 35.21 | 0.049 | −0.034 | 0.083 | 0.002 | 35.21 |
| | PSM | 0.049 | −0.033 | 0.082 | 0.004 | 19.30 | 0.049 | −0.039 | 0.088 | 0.004 | 20.78 |
| TFP Growth Rate | Unmatched | 0.008 | 0.002 | 0.006 | 0.000 | 18.98 | 0.008 | 0.002 | 0.006 | 0.000 | 18.98 |
| | PSM | 0.008 | 0.002 | 0.006 | 0.001 | 11.02 | 0.008 | 0.002 | 0.007 | 0.001 | 12.40 |
| **Product Drop Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | −0.183 | −0.048 | −0.134 | 0.003 | −50.99 | −0.183 | −0.048 | −0.134 | 0.003 | −50.99 |
| | PSM | −0.183 | −0.073 | −0.110 | 0.004 | −25.41 | −0.183 | −0.064 | −0.119 | 0.004 | −27.30 |
| Employment Growth Rate | Unmatched | −0.098 | −0.023 | −0.074 | 0.002 | −44.02 | −0.098 | −0.023 | −0.074 | 0.002 | −44.02 |
| | PSM | −0.098 | −0.026 | −0.071 | 0.003 | −24.95 | −0.098 | −0.028 | −0.070 | 0.003 | −24.71 |
| Labor Productivity Growth Rate | Unmatched | −0.084 | −0.025 | −0.059 | 0.003 | −23.41 | −0.084 | −0.025 | −0.059 | 0.003 | −23.41 |
| | PSM | −0.084 | −0.044 | −0.041 | 0.004 | −10.35 | −0.084 | −0.035 | −0.049 | 0.004 | −12.48 |
| TFP Growth Rate | Unmatched | −0.003 | 0.003 | −0.006 | 0.000 | −15.59 | −0.003 | 0.003 | −0.006 | 0.000 | −15.59 |
| | PSM | −0.003 | 0.000 | −0.003 | 0.001 | −5.22 | −0.003 | 0.002 | −0.005 | 0.001 | −8.79 |
| **Product Add and Drop Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | −0.049 | −0.058 | 0.010 | 0.002 | 5.20 | −0.049 | −0.058 | 0.010 | 0.002 | 5.20 |
| | PSM | −0.049 | −0.063 | 0.015 | 0.003 | 4.71 | −0.049 | −0.065 | 0.017 | 0.003 | 5.50 |
| Employment Growth Rate | Unmatched | −0.027 | −0.030 | 0.002 | 0.001 | 1.91 | −0.027 | −0.030 | 0.002 | 0.001 | 1.91 |
| | PSM | −0.027 | −0.039 | 0.012 | 0.002 | 6.28 | −0.027 | −0.037 | 0.010 | 0.002 | 5.12 |
| Labor Productivity Growth Rate | Unmatched | −0.022 | −0.029 | 0.007 | 0.002 | 4.19 | −0.022 | −0.029 | 0.007 | 0.002 | 4.19 |
| | PSM | −0.022 | −0.023 | 0.001 | 0.003 | 0.46 | −0.022 | −0.032 | 0.010 | 0.003 | 3.53 |
| TFP Growth Rate | Unmatched | 0.003 | 0.002 | 0.000 | 0.000 | 0.91 | 0.003 | 0.002 | 0.000 | 0.000 | 0.91 |
| | PSM | 0.003 | 0.003 | −0.001 | 0.000 | −1.31 | 0.003 | 0.002 | 0.001 | 0.000 | 1.49 |

Note: Matching used in this paper is single nearest-neighbor matching. Based on the estimation results in Table 9, we use capital intensity, price cost margin, firm sector dummy, and labor productivity as control variables for the logit model. We show the results both with and without labor productivity. For growth rate, we use 2 period lags for 98-00 and 03-05 and 3 period lag for 00-03 and simultaneously estimate both cases.

Table 10. Effect of Product Switching on Firm Performance based on the Propensity Score Matching Model (continued)

| | | Logit Estimation including Labor Productivity with 5 period lags | | | | | Logit Estimation excluding Labor Productivity with 5 period lags | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Treatment Group | Control Group | ATT | Standard Errors | t-Value | Treatment Group | Control Group | ATT | Standard Errors | t-Value |
| **Product Add Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | 0.015 | −0.163 | 0.177 | 0.004 | 44.08 | 0.015 | −0.163 | 0.177 | 0.004 | 44.08 |
| | PSM | 0.015 | −0.153 | 0.168 | 0.007 | 24.39 | 0.015 | −0.156 | 0.170 | 0.007 | 24.82 |
| Employment Growth Rate | Unmatched | −0.004 | −0.068 | 0.064 | 0.003 | 24.00 | −0.004 | −0.068 | 0.064 | 0.003 | 24.00 |
| | PSM | −0.004 | −0.071 | 0.066 | 0.004 | 16.13 | −0.004 | −0.070 | 0.065 | 0.004 | 16.01 |
| Labor Productivity Growth Rate | Unmatched | 0.019 | −0.095 | 0.114 | 0.004 | 31.60 | 0.019 | −0.095 | 0.114 | 0.004 | 31.60 |
| | PSM | 0.019 | −0.075 | 0.094 | 0.006 | 14.98 | 0.019 | −0.086 | 0.106 | 0.006 | 17.01 |
| TFP Growth Rate | Unmatched | 0.013 | 0.007 | 0.006 | 0.001 | 11.96 | 0.013 | 0.007 | 0.006 | 0.001 | 11.96 |
| | PSM | 0.013 | 0.006 | 0.007 | 0.001 | 8.35 | 0.013 | 0.007 | 0.006 | 0.001 | 7.48 |
| **Product Drop Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | −0.232 | −0.145 | −0.087 | 0.004 | −23.40 | −0.232 | −0.145 | −0.087 | 0.004 | −23.40 |
| | PSM | −0.232 | −0.170 | −0.063 | 0.006 | −10.86 | −0.232 | −0.159 | −0.073 | 0.006 | −12.63 |
| Employment Growth Rate | Unmatched | −0.107 | −0.058 | −0.049 | 0.002 | −19.83 | −0.107 | −0.058 | −0.049 | 0.002 | −19.83 |
| | PSM | −0.107 | −0.064 | −0.043 | 0.004 | −11.08 | −0.107 | −0.064 | −0.044 | 0.004 | −11.24 |
| Labor Productivity Growth Rate | Unmatched | −0.123 | −0.087 | −0.036 | 0.003 | −10.75 | −0.123 | −0.087 | −0.036 | 0.003 | −10.75 |
| | PSM | −0.123 | −0.101 | −0.023 | 0.005 | −4.60 | −0.123 | −0.098 | −0.025 | 0.005 | −5.06 |
| TFP Growth Rate | Unmatched | 0.003 | 0.008 | −0.004 | 0.000 | −8.96 | 0.003 | 0.008 | −0.004 | 0.000 | −8.96 |
| | PSM | 0.003 | 0.006 | −0.002 | 0.001 | −3.25 | 0.003 | 0.006 | −0.003 | 0.001 | −3.67 |
| **Product Add and Drop Dummy** | | | | | | | | | | | |
| Output Growth Rate | Unmatched | −0.100 | −0.149 | 0.050 | 0.003 | 16.73 | −0.100 | −0.149 | 0.050 | 0.003 | 16.73 |
| | PSM | −0.100 | −0.113 | 0.013 | 0.005 | 2.86 | −0.100 | −0.125 | 0.026 | 0.005 | 5.53 |
| Employment Growth Rate | Unmatched | −0.053 | −0.064 | 0.011 | 0.002 | 5.52 | −0.053 | −0.064 | 0.011 | 0.002 | 5.52 |
| | PSM | −0.053 | −0.067 | 0.014 | 0.003 | 4.74 | −0.053 | −0.065 | 0.012 | 0.003 | 4.09 |
| Labor Productivity Growth Rate | Unmatched | −0.047 | −0.086 | 0.039 | 0.003 | 14.61 | −0.047 | −0.086 | 0.039 | 0.003 | 14.61 |
| | PSM | −0.047 | −0.047 | 0.000 | 0.004 | −0.10 | −0.047 | −0.061 | 0.013 | 0.004 | 3.26 |
| TFP Growth Rate | Unmatched | 0.006 | 0.008 | −0.002 | 0.000 | −4.62 | 0.006 | 0.008 | −0.002 | 0.000 | −4.62 |
| | PSM | 0.006 | 0.007 | −0.001 | 0.001 | −1.81 | 0.006 | 0.005 | 0.001 | 0.001 | 1.14 |

Note: Matching used in this paper is single nearest-neighbor matching. Based on the estimation results in Table 9, we use capital intensity, price cost margin, firm sector dummy, and labor productivity as control variables for the logit model. We show the results both with and without labor productivity. For growth rate, we use 2 period lags for 98-00 and 03-05 and 3 period lag for 00-03 and simultaneously estimate both cases.

We employed the Nearest-Neighbor Matching method to match firms across the two groups. We match the firms with the smallest difference in the probability of product switching. $W\left(\Pr(X_{t,i})\Pr(X_{t,j})\right)$ is the weight between 0 and 1 that is measured using the probability of product switching of firms that switched products and those that did not.

Table 10 shows the output, the number of employees, log of labor productivity, ATT of a change in TFP using the method described above. The results suggest that firms that added products all see an increase in output, employment, labor productivity, and TFP. Within five years, these firms that added products increased their output by 16.8 percent and increased their labor productivity by 9.4 percent. On the other hand, the performance of the firms that dropped products declined in all aspects. For firms that added products, the growth rate of output was higher than that of employment, resulting in an increase in labor productivity. For firms that eliminated products, output decreased more than the decrease in employment, resulting in a decline in labor productivity. We can infer from the decline in the labor productivity of product-dropping firms that a reduction of employment through restructuring did not take place to the extent that labor productivity would increase. For firms that both added and dropped products, while there was an increase in the size of output and employment, there was not an efficiency improvement.

We can summarize the estimation results regarding product switching as follows. First, the industry level estimation results suggest that a more competitive and growing environment tends to promote product switching. The estimation results based on the firm level data supported the theory developed by BRS that firms with higher labor productivity are more likely to add products. At the same time, we also found that firms with high labor productivity are more likely to eliminate products. This can be interpreted as the same phenomenon as more productive firms exiting the market, as discussed in Nishimura, Nakajima, and Kiyota (2005) and Fukao and Kwon (2006).

Furthermore, the competitiveness index measured as the price cost margin has a negative effect on product switching. While an addition of a product improved firm performance in terms of output, employment, labor productivity, and TFP, an elimination of a product decreased labor productivity and TFP. Efficiency decreases because a decline in employment is relatively small compared to an elimination of products. Furthermore, when products are simultaneously added and dropped, while output and employment is increased, there is not an improvement in efficiency.[18]

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[18] A great deal of literature in Corporate Finance documents the diversification discount, which states that diversification reduces the value of a firm. Based on this line of logic, an addition of a product is predicted to reduce firm performance. However, most of such literature defines diversification as a change in structure of the firm based on the sales by division. Based on this definition, diversification may occur even with an increase in the production of an existing product even if the firm has neither added nor dropped product. In our studies, product switching happens only if the existing product changes into another kind of product, and therefore our results do not necessarily contradict the findings in Corporate Finance. In that sense, diversification as defined in the field of corporate finance does not necessarily correspond to product switching as defined in our paper. Furthermore, companies that are investigated in the field of Corporate Finance are limited to

## 5. Concluding remarks

Japanese empirical studies on firm dynamics have showed that productivity growth in incumbent firms played a major role in promoting aggregate productivity growth. Innovative products like the Prius and Walkman were produced by incumbent firms. Therefore, we focus on product switching in incumbent firms, as well as firm entry and exit. Following on from BRS (2003, 2006, 2010), who studied product switching in the US manufacturing firms, we construct product-firm level data from the *Census of Manufacturers*. This database covers 1812 kinds of products produced by 277,000 establishments.

Based on the database, we find that the share of multiple-product firms of all manufacturing firms in Japan is similar to that in the U.S. and that multiple-product firms perform better than single-product firms. By examining product switching behavior as well as exit and entry in Japanese manufacturing firms, we find that output growth from 1998 to 2005 can mostly be explained by the product switching behavior of incumbent firms, despite the fact that the share of firms that did not change their product composition was larger than that in the U.S.

We examine the determinants of product switching at both the industry and firm levels. The results of industry-level estimation show that competitive market environments stimulate product switching, and growth in industry output promotes entry and product adding behavior. At the firm level, improvements in labor productivity encourage product switching behavior. The positive effects of a competitive market environment on product switching are also observed at the firm level.

When we examine the effects of product switching on firm performance, product switching behavior improves firm performance measured by output, employment and labor productivity. An addition of a product improves labor productivity and TFP.

Our empirical results suggest that product switching of incumbent firms is a crucial factor to output growth and productivity improvement in the Japanese manufacturing sector. These results imply that policies that stimulate product switching on TFP growth could promote economic or productivity growth in the Japanese economy. For instance, our empirical results showed a greater prevalence of product switching behavior in industries with lower entry costs. This suggests that the initial fixed costs are necessary to engage in the process of inventing new products or diversifying products. Therefore, more financial support to lower the initial investment costs may be desirable to promote product

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public holding companies, as their definition of diversification requires data on firm value. On the other hand, in our paper, we include privately-held companies, and a direct comparison is not possible. As in Geringer, Tallman, Olsen (2000) and Campa and Kedia (2002), Aoki and Itami (1985) use Japanese firm data and show that diversification and firm performance have a U-shaped relationship or suggest the existence of a diversification premium after controlling for an endogeneity problem. Nonetheless, the task remains for future research to make our analysis consistent with diversification analysis studied in corporate finance.

switching. Deregulation is another effective way to lower entry costs. If deregulation is difficult, an alternative way to encourage product switching is to expand the second hand market of capital goods because this would decrease entry costs.[19]

The following are some of the remaining tasks for future research. First, in our study, we focused only on the domestic market. Table 6 shows that the effects of product switching on output growth in the Japanese manufacturing sector have been decreasing for years. This result suggests that many firms are transferring their product plants abroad. As the plants transferred abroad are indicated as being plants that have exited from the market, we should distinguish between plants which have been moved abroad and those that are simply exiting the market. Second, due to the limited availability of data, we focused on the manufacturing sector. However, as Morikawa (2007) has pointed out, firm dynamics in the service sector may be more important than in the manufacturing sector when we consider the low productivity growth in the Japanese economy.[20] Thus, we also need to apply our work to the Japanese service sector. Third, Toray Industries Inc. and Canon Inc. may have succeeded in product switching through huge R&D investments. Therefore, it is necessary to study the effect of product innovation on product switching.

[19] Fainas and Ruano (2005) studied how the second-hand market of capital goods affects the manufacturing sector.
[20] Morikawa (2007) used firm level data to show that the average labor productivity in the service sector is lower than that of the manufacturing sector.

## Appendix A. TFP Construction

To compute establishment-level TFP, we adopt the multilateral index introduced by Caves, Christensen and Diewert (1982) and expanded on by Good, Nadiri, and Sickeles (1983). This index compares the productivity between each firm and a representative firm calculated by the industry average. The equation to calculate TFP is below.

$$\begin{aligned}\ln TFP_{k,t} &= (\ln Q_{k,t} - \overline{\ln Q_t}) - \sum_{l=1}^{n} \frac{1}{2}(S_{k,l,t} + \overline{S_{l,t}})(\ln X_{k,l,t} - \overline{\ln X_{l,t}}) \\ &+ \sum_{s=1}^{t} (\overline{\ln Q_s} - \overline{\ln Q_{s-1}}) - \sum_{s=1}^{t} \sum_{l=1}^{n} \frac{1}{2}(\overline{S_{l,s}} + \overline{S_{l,s-1}})(\overline{\ln X_{l,s}} - \overline{\ln X_{l,s-1}})\end{aligned} \tag{A1}$$

$\ln TFP_{k,t}$ is a multilateral index of establishment $k$ at year $t$. The classification of industry for calculating TFP is the 4-digit classification. We also grouped the establishment into the industry to which the greatest share of its product belongs. $\ln Q_{k,t}$ indicates the natural logarithm of the real gross output of establishment $k$ in year $t$. The real gross output is measured by shipment deflated by output price in the Japanese Industrial Productivity database[21]. $X_{k,t}$ is the natural logarithm of input factors (labor capita, intermediate input). The overline on the variables indicates the geometric average of the variables across all establishments in the industry to which establishment $k$ belongs. $S_{klt}$ is firm $k$'s cost share of input factor $l$ in total cost. Labor is expressed in terms of the number of employees working in the establishment. We use tangible assets from the *Census of Manufacturers* as a proxy for capital. Because tangible assets are book values, we convert the book values to market values by multiplying it by the ratio of the market to book value, which is constructed from the Development Bank of Japan (DBJ) Database. Intermediate input is calculated as the sum of values of raw materials, fuels and electricity consumed.

We need real wages as labor cost, real intermediates, and the cost of capital for calculating cost share. Thus, we use real wages, as labor cost, by the establishment-level samples from the *Census of Manufacturers*. To calculate the cost of capital, we use the corporate income tax rate, the government bond rate, the long-term prime rate, the price of capital goods, and the consumption of fixed capital. The cost of capital is defined as follows:

$$c_{jt} = K_{jt} \frac{1 - u_t z_t}{1 - u_t} P_t \left\{ r_t + i_t + \delta - \frac{\dot{P}_t}{P_t} \right\} \tag{A2}$$

$c_{jt}$ is the cost of capital, while $u$ is the effective corporate tax rate from the *Ministry of Finance Statistics Monthly* by Minister of Finance Japan, $r$ is the bond rate from *Economic Statistics Annual* published by the Bank of Japan, $i$ is the long-term prime rate and $\delta$ is the consumption of fixed capital. $z$ denotes the expected present value of tax savings due to depreciation allowance ß on one unit of investment. We aggregate

[21] See details on the website (http://www.rieti.go.jp/en/database/JIP2008/index.html).

establishment-level TFP into firm-level TFP by summing the establishment TFP by using shipment share as weights.

## Appendix B. Regulation Index

Government regulations may have an important impact on the performance of an industry by affecting the allocation of resources and productive efficiency. In order to assess the impact of regulation on economic performance, we use a regulation index recently created by the Cabinet Office (2006). This regulation index is available for the period 1995 to 2005 and measures the degree of regulation in each industry by using information on the number of regulatory laws and rules pertaining to that industry. For the calculation of the index, laws and regulations are weighted by the extent to which they restrict activity. For example, regulations which completely prohibit particular business activities in an industry receive a weight that is 1,000 times greater than regulations that simply require firms to report to or inform the authorities.

Specifically, the index is calculated as follows:

$$RS_{mt} = \sum_{jk} \left\{ \left( WM_j \times WT_k \right) \times N_{jk}^{mt} \right\} \tag{A3}$$

$RS_{it}$ is the weighted number of laws and rules in industry $m$ in year $t$. $WM_j$ is the weight used for each regulation and the method of regulatory enforcement. There are 5 categories with increments of a factor of 10 representing the extent to which regulations restrict activity: $WM_1$=1 , $WM_2$=10 , $WM_3$=100 , $WM_4$=1,000 , $WM_5$=10,000. $WT_k$ denotes the weights based on 4 categories of regulations, each with its own weight: $WT_1$ denotes regulations based on ministerial announcements; $WT_2$ denotes regulations based on ministerial ordinance; $WT_3$ denotes regulations based on government ordinance; $WT_4$ represents regulations based on the law: the weight for each type is 1, 2, 3, and 4, respectively. $N^{mt}{}_{jk}$ is the number of regulations in industry $i$ in year $t$ by method $j$ and type $k$ of regulatory law and rules.

$$\mathrm{Reg}_{mt} = (\mathrm{RS}_{mt}/\mathrm{RS}_{m,1995}) \tag{A4}$$

Since the index for each industry differs and is not standardized, we normalize the index, $Reg_{mt,}$ using 1995 as the base year.

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