Product Dynamics and Aggregate Shocks: Evidence from Japanese Product and Firm Level Data

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Abstract

We examine the effects of shocks to aggregate productivity, foreign output demand, government expenditures, and demand for foreign liquidity on dynamics of products and exports of heterogeneous firms. The framework is motivated by open economy general equilibrium models of Bilbie, Ghironi and Melitz (2012) and Dekle, Jeong and Kiyotaki (2014). We first construct unique firm level data on products and exports from the Japanese Manufacturing Census. The data are more disaggregated than comparable U.S. data and available at the annual frequency (while US product level data are only available at five year intervals), which makes our data more suitable for examining the interaction between the business cycle and firm-product heterogeneity. Our empirical results show that the development of new products is stimulated by improvements in not only firm level productivity but also aggregate productivity. We also find that an increase in foreign demand and a shock to depreciate the home real exchange rate increase product dynamics and exports.

Keywords: Add New Products, Drop Existing Products, Aggregate and Idiosyncratic Shocks to Productivity, Foreign Demand Shock, Exports, Real Exchange Rates.

JEL classification numbers: E32, F12, F14, F41, L11, L25, O31

1. **Introduction**

The entry and exit of products are one of the main drivers of productivity growth. The entry of new products can lower prices and spur productivity and real GDP growth. Earlier empirical work has shown that product dynamics are major sources of productivity movements over the medium- and long-run. [1] There is, however, scant theoretically grounded empirical work on how macroeconomic shocks affect the entry and exit of products at the business cycle frequency.[2]

This gap in knowledge is unfortunate, since policy makers in many countries are concerned about the new products produced within their borders. For example, the Abe administration in Japan has undertaken expansionary fiscal and monetary policies, partly in the hope of encouraging the introduction of innovative products.[3] The recent expansionary monetary policy in Euro area is related in part to the desire to stimulate innovation and introduction of better products (Bergin and Corsetti, 2014).

In this paper, we relate firm-level product dynamics to macroeconomic shocks such as aggregate productivity, foreign demand, government expenditures and real exchange rates at the business cycle frequency. Our empirical specifications are motivated by Dekle, Jeong and Kiyotaki (2014) (referred as DJK hereafter). DJK develop a macroeconomic model in which the products added and dropped at the firm level depends upon macroeconomic shocks[4] Firms are

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[1] See for example, Bernard, Redding, and Schott (2010).

[2] There are some studies that relate firm entry and exit to aggregate shocks. See Ghironi and Melitz, 2005; Corsetti, Martin, and Pesenti, 2007).

[3] In addition to improving overall productivity, new products increases consumer utility in a “love of variety” model.

[4]Bilbie, Ghironi and Melitz (2012) also relate product level dynamics to macroeconomic shocks. They do not, however, relate macroeconomic shocks to product adding and dropping (or to product churning) at

heterogeneous, facing recurrent firm-product specific shocks and aggregate shocks, such as shocks to aggregate productivity, foreign demand and liquidity preference. Each firm potentially can produce multiple products and decides whether and how much to produce each product in domestic and export markets. From their model, we can trace how certain macroeconomic shocks can determine product entry and exit, and thus the evolution of the number of products and product adding and dropping rates. The authors show that an aggregate productivity improvement lowers the costs of the entry of new establishments and products and raises the total number of products. Shocks to increase foreign demand and government expenditure also encourage entry and raise the total number of products.

Our focus is on estimating the impact of macroeconomic shocks on product entry and exit at the firm level. Our estimates in this paper are broadly consistent with the predictions of DJK. We show that aggregate productivity improvements and foreign demand expansions both increase the number of products, but the effects of foreign demand shocks are especially large. Likewise, positive aggregate productivity and foreign demand shocks increase the product adding rate (new products).

We obtain our product level data used in this paper from the Japanese Manufacturing Census. The Japanese Manufacturing Census is unique in that the value of shipments can be obtained all the way down to the 6-digit level (which we "products"), and the product level shipment data and establishment (and firm) level accounting data are available at the annual frequency, making the data suitable for analysis at the business cycle frequency. Moreover, to use the framework of DJK, we need to aggregate the product level data up to the firm level. The Manufacturing Census allows

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the firm level, since the authors model only single-product firms.

this aggregation. Products can be aggregated into establishments (plants), and plants can be matched to the parent firm using firm identifiers.[5] Aside from testing the mechanisms of product dynamics in macroeconomic models, this paper's regressions themselves are a contribution, since estimates of the impact of macroeconomic shocks on the number of products, and on product adding and dropping behavior are rare. To the best of our knowledge, our estimates below represent one of the first contributions to this area.

An important feature of macroeconomic models with product dynamics such as DJK and Bilbie, Ghironi, and Melitz (2012) is that much of the macroeconomic adjustment occurs through the extensive margin at the product level, the entry and exit of products. DJK (2014) use this feature to explain the puzzle of why exports at the aggregate level are not significantly correlated with the real exchange rate, while exports at the firm level are correlated (a version of the "exchange rate disconnect" puzzle). Their explanation relies on the heterogeneity of the product mixes of firms with large and small export sales. Because products with large export sales tend to have higher productivity (as in Melitz, 2003), a liquidity shock to appreciate their currency will not induce the dropping of such products from export market and will not greatly lower their total export sales. Since these high productivity products dominate total exports, total exports become insensitive to real exchange rate fluctuations.[6] On the other hand, products with marginal

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[5] In U.S. Census data, the usual product level data are only available down to the 5-digit level and are not available at the annual frequency (Bernard, Redding, and Schott, 2010). Also, although available at a high frequency, U.S. retail store scanner-type product data as used in Broda and Weinstein (2010) and others need to be first matched to firm level accounting data at the annual frequency before performing the kind of empirical as we do here.

[6] Berman, Martin, and Meyer (2011) develop a model in which high productivity firms are insensitive to exchange rate fluctuations. In their model, high productivity firms lower price-cost markups, thereby protecting their export market share (quantities). Using Brazilian customs data, Chatterjee, et. al. (2013)

productivities tend to 'drop like flies' from the export market with adverse shocks and their export sales tend to be sensitive to the exchange rate appreciation. Since products with marginal productivities are more common than products with very high productivity for a majority of firms, firm level exports are more sensitive than aggregate exports to shocks which move the exchange rate.

We find using our firm-product level data that firms with high productivity drop products at a slower rate than firms with lower productivity when the real exchange rate appreciates. We also find that export sales of more highly productive firms are less sensitive to real exchange rate fluctuations, thus lending support to DJK's (2014) explanation of the "exchange rate disconnect puzzle," that changes in aggregate exports are dominated by large firms, with high productivity.

Our paper is organized as follows. In the next Section, we motivate the empirical specifications in this paper. In Section 3, we explain the construction of our product-firm level dataset. We explain how we construct Total Factor Productivity at the firm and industry levels, and foreign demand, government demand and the real effective exchange rates at the industry levels. In Section 4, using our constructed data set, we provide an overview of product dynamics and exports in Japanese manufacturing firms. In Section 5, we present our estimates on the effects of shocks to aggregate productivity, foreign demand, government spending, and real exchange rate on the number of products, product adding and dropping rates, and exports at firm level.

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also focus on changes in firm-level markups in response to exchange rate fluctuations. In the DJK model, the adjustment in export quantities of high productivity firms are less because high productivity firms drop fewer products when their exchange rate appreciates.

2. Product Dynamics and Macroeconomic Shocks

Dekle, Jeong, and Kiyotaki (2014) construct a dynamic general equilibrium model of a small open economy with rich production structure. Firms are heterogeneous and potentially produce many differentiated products.

When a new firm or a new establishment of an incumbent firm pays a sunk cost to enter, it draws an opportunity to produce a new differentiated product with a certain probability of success. The productivity of a new product is heterogeneous and is distributed according to a Pareto distribution with success. The firm with the production opportunity must pay a fixed cost in order to produce the product and maintain the productivity. Firms who pays the maintenance cost may succeed or fail to maintain the productivity. In addition, independently from the success or failure of maintaining the existing product, each product that the firm pays the maintenance cost yields an opportunity to produce another new product with certain probability, and the productivities of new products are distributed according to a similar Pareto distribution.[7] Through these birth and death of differentiated products and entries of new establishments, the firm may add new products, maintain the existing products, replace the products, or drop the existing products. Let $N_i(t)$ be the number of products firm i produces and maintains at date t. It evolves according to

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[7] The idea here is that new products "spin-out" from old products. Say, Apple is working on the I-pod. Whether the I-pod will continue to be successful or not is stochastic, but only by working on the I-pod will there be a chance that the I-phone will be "spun-out" (they are based on similar technologies).

$$\Delta N_i(t) = N_i(t+1) - N_i(t) = entries + spinouts - unsuccessful\ maintenance \quad (1).$$

The first term is the adding of new products due to successful entries of new establishments; the second term captures the new products added by spinning out from existing products, and the last term is the drop of existing products due to unsuccessful maintenance. Here we extend the interpretation of DJK model so that both new and existing firms pay sunk costs to enter to draw new products. The firm is defined as a collection of differentiated products, each having heterogeneous productivity.

Firms also face recurrent aggregate shocks, including aggregate productivity, foreign demand, and liquidity preference shocks. Consumers supply labor, consume final goods (which is produced from many differentiated intermediate products), and hold home and foreign bonds to maximize expected utility. Free entry and aggregate market clearing conditions characterize the competitive equilibrium for the small open economy.

The entry of new firms and new establishments (of incumbent firms) depends on the free entry condition, where the firm or establishment enters when the costs of entry are lower than the expected present discounted value of profits. Macroeconomic shocks affect this firm or establishment entry through the free entry condition. Positive aggregate productivity shocks raise entry by lowering costs. Foreign demand and government expenditure shocks stimulate entry by raising expected revenues.

Equation (1) above can be estimated by firm level data with information on the number of products by firms. Note that $N_i(t+1) - N_i(t) = \Delta N_i(t)$ depends on the exogenous stochastic shocks to affect the firm's draws of maintenance and spinouts from the existing products as well as the endogenous choice of the firm to add new establishments and draw new products. We expect $\Delta N_i(t)$ to be a decreasing function of $N_i(t)$ as existing firms tend to have a smaller number of spinouts and innovation than the unsuccessful maintenance of existing products. Only through the entry of new firms, will the total number of products be maintained or increasing over time.

We also expect the change in the number of products of firm i, $\Delta N_i(t)$, to depend on the macroeconomic shocks that impact the entry of new firms and establishments (of incumbent firms) at time t. In our regressions, we include macroeconomic variables such as industry level aggregate TFP, foreign demand, and government expenditures that affect the path of $\Delta N_i(t)$ through the free entry condition. In DJK, these macroeconomic shocks are exogenous by construction. We also include the ratio of firm level TFP to aggregate TFP in the regressions. Firm level TFP depends on the history of productivity draws of the products of firm i and is predetermined. If a particular firm i has high TFP relative to other firms, then the firm is more likely to maintain the existing products to induce the spinouts and give birth to a new establishments that can satisfy the free entry condition.

We estimate (1) using Japanese firm level panel and industry level data. The number of products, $N_i(t)$ is available from the *Census* data, and the TFP by firm can be calculated using firm level balance sheets. Since firms enter and exit continuously, the panel data is unbalanced.

Aggregate shocks such as TFP, foreign demand and government expenditures are calculated at the industry level to increase the cross-section variation and the precision of the estimates. The assumption is that the industry level shocks depend upon aggregate shocks, with the sensitivity differing by industry.

3. The Japanese Census of Manufacturers Data and Measurement of Explanatory Variables.

We construct our firm-product data using *the Census of Manufacturers* conducted by the Japanese Ministry of Economy, Trade and Industry. The *Census* is in principle, a survey of all establishments (plants) in the Japanese economy. The data are now available in the format that we require from 1998-2009 annually. Importantly, unlike for example in the U.S., where usable product and establishment level data are available for only every 5 years (Bernard, Redding, and Schott, 2010), in Japan, we can collect product and establishment level Census data for every year, which is more conducive to analysis at the business cycle frequency, where peaks to troughs can occur in a period as short as 2 years. We examine versions of the Census that surveys establishments at and above 5 workers, since the data covering establishments below that number of workers are not made publicly available. In 2008 for example, 263,061 establishments of 5 or more employees responded to the Census, representing over 59 percent of all Japanese manufacturing establishments.

We define "Sectors" as goods at the 2-digit Japanese Standard Industry Classification (JSIC) level; "Industries" as goods at the 4-digit JSIC level, and "Products" as goods at the 6-digit JSIC level[8]. In the data, each establishment reports the usual accounting data, such as the number of

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[8] Industry classification in *the Census of Manufacturers* follows the Japan Standard Industry Classification (JSIC) in the case of 2-digit and 4 –digit levels. JSIC that started in 1949 is revised every five years. Every version of JSIC is adjusted to adhere to the International Standard Industry Classification (ISIC). However, in the case of the 6-digit classification, *the Census of Manufacturers* adopts its own classification. An example of sector, industry, and product level classifications are shown in Table 1.

employees, raw material costs, fuel and electricity costs, tangible fixed assets, and the value of shipments (output) of the different types of “products” that the establishment produces.

Given that decisions on adding and dropping products and on output volumes of each product are made at the firm level and not at the establishment level, both in reality and in the DJK (2014) model, we need to identify the “firm”. One problem with the Japanese Census data is that the data do not record a firm level identifier that would allow the grouping of establishments into firms (Bernard and Okubo, 2013). Abe et. al. (2012) developed a procedure to match establishments (plants) to their parents by using information on establishment codes, address codes, and industry classifications. Using their procedure, we aggregate establishment level data into firm-level data.

Stylized facts of the Census data concerning multiple product firms are documented in Kawakami and Miyagawa (2010). Briefly, according to Kawakami and Miyagawa (2010), in the Japanese Census, the share of multiple product firms in the total number of firms is about 40 percent, and the average multiple-product firm in Japan produces about 3 products (i.e., three different 6-digit JSIC level products). While multiple product firms represent a minority of firms, they account for 78 percent of total shipments by Japanese firms. The output (shipments) of an average multiple product firm is 50 percent higher than the average single product firm; and average employment is 28 percent higher than a single product firm. Output per worker is 30 percent higher in average multiple product firms than in single product firms.

In the Census, we also can identify whether a particular establishment is an exporter (export value>0) and the total value of their exports in that year. However, export values or quantities are only available at the establishment level, and not at the product level. At the product level, only total (not broken down into domestic and export) shipment quantities and values are available.

For our empirical analysis, we need to construct some variables using both the Census of Manufacturers and other, mostly industry-level data. We estimate a production function at the firm level by employing the method by Olley and Pakes (1996) to measure Total Factor Productivity. To obtain the necessary accounting data such as the number of employees and value added at the firm level, we simply aggregate the data for all the establishments that the firm manages. Using the estimated coefficients, we measure Total Factor Productivity at the firm and industry levels as described in the Appendix.

We construct industry level foreign demands by first obtaining exports from Japan to 4 of Japan's main export partners (in yen), the U.S., China, the European Union, and Russia in each industry (these countries account for over 90 percent of Japan's total exports). We then obtain the value added in each of Japan's export partners in each industry from International Financial Statistics (converted to yen at the prevailing exchange rate). For each industry, we then sum Japan's exports and value added over the 4 countries. Finally, for each industry, we take the ratio of Japan's summed exports to our summed value added measure, and use this ratio as our foreign demand variable.

The data on industry level government expenditures are obtained from the Input- Output Tables in Japan Industrial Productivity Database (JIP database). [9]

In some specifications, we include the aggregate Real Effective Exchange Rate as an explanatory variable. The Japanese Real Effective Exchange Rate is obtained from the Bank of Japan. Note that in general equilibrium models, the real exchange rate is usually endogenous.

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[9] Hitotsubashi University and Research Institute of Economy, Trade, and Industry have constructed this database to estimate productivity at the industry level. The concept of this database is consistent with other productivity database such as Jorgenson, Gollop, and Fraumeni (1987) and EUKLEMS database. The JIP database is published at the website; http://www.rieti.go.jp/en/database/JIP2014/index.html#04-1.

DJK suggest that actual real exchange rate movements may be dominated by aggregate liquidity shocks, so they include exogenous aggregate liquidity shocks in their model. However, it is difficult to find variables that capture the idea of aggregate exogenous liquidity shocks in the data. Also, there is a tradition in international finance starting from Meese and Rogoff (1981) that include exchange rates as exogenous variables in estimations. Meese and Rogoff (1981) and others justify this practice, by pointing out that exchange rates are a random walk process and fundamental variables such as productivity and monetary shocks have little explanatory power in predicting exchange rates. Below we include the real exchange rate interacted with relative TFP as an explanatory variable, being fully aware that this variable could be endogenous.

4. Stylized facts of Japanese Product Dynamics.

Using the firm-product level data as constructed above, here we provide an overview of product level dynamics in Japan. Table 1 shows examples of sectors, industries, and products in Japan. Table 2 shows how sectors can be divided into industries and products. For example, the food sector has 41 industries and 87 products, ships 24 billion yen worth of goods and has over a million workers. We find that the value of shipments (output) per employee is higher in industries with high capital intensity, such as the coal and the petroleum sector.

(Insert Tables 1 and 2 here)

Figure 1 depicts the decomposition over time in the change in the total number of products. The evolution of the total number of products can be decomposed into the addition of new products by incumbent firms, the addition of new products by the entry of new firms, the dropping of existing products by incumbent firms, and the exit of incumbent firms (when they drop their last existing product.)[10] Although the total number of products is very stable (solid black line), there are large simultaneous products added and dropped by the existing firms. Compared to the adding and dropping of products, the contribution of the entry of new firms and exits of existing firms is relatively modest. We also observe the adding of products and the entry of firms are pro-cyclical. Incumbent firms added new products especially strongly between 1998-99, 2001-02, and 2007-08. The entry of new firms also increased sharply for 2006-07. These were expansionary phases of GDP growth in Japan. In contrast, Figure 1 shows that product dropping and firm exit behaviors are relatively noncyclical. This asymmetry in response to macroeconomic shocks in product adding and dropping is a feature of our data and is also present in our estimates below.

(Insert Figure 1 here)

Figure 2 depicts the decomposition over time of the total change in shipments (output). The total change in shipments (blue line) is much more volatile than the total change in the number of products. The biggest contributor of total shipment movement is the shipment fluctuation of continuing products made by incumbent firms. Some continuing products expand their shipments while others contract, and the difference is pro-cyclical. This implies that Davis and Haltiwanger

[10] Here the addition of new products by incumbent firms is the sum of the new products of the incumbent firm’s new and existing establishments.

style gross job creations and destructions (Davis, Haltiwanger, and Schuh, 1996) occur at the product level (in addition to the establishment level), suggesting the importance of heterogeneity in product level productivity dynamics.

The second important contributor to total shipment movements is the adding and dropping of products by incumbent firms. Compared to the contribution of products added and dropped, the contribution of entries and exits of firms to total shipment fluctuation is small. With respect to the introduction of new products, the shipment of new products by incumbent firms dominates the shipment of new products by new firm entrants. In the DJK model, this would mean that the entry of new establishments by existing firms and the spinouts from the existing products dominate the entry of new firms for the movement of total shipments.

(Insert Figure 2 here)

Figure 3 shows that the average number of products per exporter is larger than that of all firms. Exporters produce a greater number of products than the average Japanese firm. The Figure also depicts average export values by firm. Compared to purely domestic firms, Japanese exporters are more likely to be multiproduct firms. The fluctuations in total shipments are also larger for exporters than the total shipment shown in Figure 2. Figure 4 shows the distributions of total sales of exporters and non-exporters. The sales of exporters are larger than those of non-exporters (as implied in the models of Melitz 2003 and DJK 2014).

The larger fluctuations in total shipments by Japanese exporters are not only because exporters have larger fluctuations in existing products. It is also because Japanese exporters add and drop products more rapidly than non-exporters. These facts highlight the importance of the export margin in the aggregate adjustment of product shipments and in aggregate product churning, particularly in product adding. In Figure 5, the average number of added products equals to 2 for exporters and 1.4 for non-exporters. The average number of dropped products is 1.9 for exporters and 1.3 for non-exporters. Moreover, the average numbers of added and dropped products fluctuate somewhat more for exporters, while the average numbers of added and dropped products are very stable for non-exporters.

(Insert Figures 3, 4, and 5 here)

Finally, we examine the relationship between extensive margins and exports. In Figures 6, share of firms adding products and share of entrants (both weighted by shipments) are positively correlated with movements in average export values by firm. Both shares increased when export growth accelerated in the period from 2002 to 2004, and decreased after 2009, when total Japanese exports collapsed, owing the global financial crisis. However, in Figure 7, share of firms dropping products and share of exit firms are only mildly negatively correlated with movements in exports, when they are weighted by the shipments. Again, we observe the asymmetry in product adding and dropping behaviors.

To sum up, these stylized facts show that a significant adjustment in Japanese output is comprised of the adding of new products, (in addition to the expansion and contraction of shipments of existing products). This adding of new products appears more pronounced for Japanese exporters. New product additions by incumbents and new firm entry are also highly pro-cyclical, while the dropping of products and firm exits are not very cyclical when weighted by shipments. These features are also present in U.S. data (Bernard, Redding, and Schott, 2010).

In addition, although we do not have product level exports by firm, we find that exporters tend to be multiproduct firms and that exporters add and drop products at a much more rapid rate than non-exporters. Finally, product adding rates are highly correlated with average firm exports. Thus, while the total cyclical change in shipments is dominated by the change in continuing products made by incumbent firms, the change in export sales is highly correlated with the entry of new products. Given the prevalence of product entry and exit at the business cycle frequency and the importance of new products for productivity and economic growth, below we relate product entry and exit rates to macroeconomic variables at the business cycle frequency.

(Insert Figures 6 and 7here)

5. Estimation of Product Dynamics

In product level general equilibrium models such as DJK (2014), common macroeconomic shocks such as aggregate productivity, government expenditure, and foreign demand shocks alter product dynamics and export behavior. In their impulse responses, DJK (2014) show that one standard deviation (0.9 percent) increase in aggregate productivity (with auto-correlation of 0.55 in annual data) raises output by 1 percent, and depreciates the real exchange rate by 0.9 percent. Exports increase by 0.7 percent, and correspondingly, the total number of products increases vigorously in 3 to 7 years to 0.4 percent. A 1.4 percent increase in foreign demand (with auto-correlation of 0.94) increases GDP by 0.2 percent and exports by 0.8 percent. The real exchange rate appreciates by 0.8 percent, the number of products increases slowly by 0.15 percent in 7 to 20 years. A 0.8 percent positive government expenditures shock (with auto-correlation of 0.95) raises GDP by 0.15 percent, depreciates the real exchange rate by 0.1 percent, and increases exports by 0.07 percent and the number of products by 0.08 percent.

Thus, quantitatively, DJK find that aggregate TFP shocks have the greatest impact on the number of products, followed by foreign demand and government spending shocks. Our estimates below are broadly consistent with these quantitative predictions, except that we find larger effects for foreign demand shocks.

In our estimates below, we focus on the extensive margin of adjustment, of the total number of products, and whether the firm adds a product or drops a product, or adds and drops a product at the same time (product churning). Besides the importance of the rise in the number of products for productivity growth and "love of variety" utility increases, the regression estimates themselves are a contribution, since estimates of the impact of macroeconomic shocks on product adding and dropping are rare.

Empirical Specifications

Our empirical specifications are as below:

$$\Delta N_i = a_1 * TFP_i / TFP_A + a_2 * TFP_A + a_3 * FD_j + a_4 * G_j + a_5 * TFP_i / TFP_A * REER + a_6 * N_i \quad (2)$$

$$PD_i = b_1 * TFP_i / TFP_A + b_2 * TFP_A + b_3 * FD_j + b_4 * G_j + b_5 * TFP_i / TFP_A * REER + b_6 * N_i \quad (3)$$

$$EXP_i = c_1 * TFP_i / TFP_A + c_2 * TFP_A + c_3 * FD_j + c_4 * G_j + c_5 * TFP_i / TFP_A * REER + c_6 * N_i \quad (4)$$

Dependent Variables

The dependent variable in Equation (2) is the change in number of products of firm i, ΔN_i. In Equation (3), PD_i represents several variables that are intended to capture product level dynamics such as the product adding dummy (takes a value of unity when the firm add a products), product dropping dummy (value of unity when the firm drops a product), product adding and dropping dummy (takes a value of unity when the firm adds and drops a product).

As we have seen above, exporters are particularly active in product adding. EXP_i in Equation (4) represents several variables representing changes in exports, such as whether the firm exports (export dummy), the ratio of exports to total shipments, and the log of exports.

Explanatory Variables

Explanatory variables are the same in all equations. N_i is the number of products of firm i, which is predetermined to product level dynamics at time t. TFP_i / TFP_A is the ratio of TFP in firm i to industry level aggregate TFP. As explained in DJK, N_i and firm level TFP are determined by the history of new products that the firm has produced up to time t, but this history is predetermined at time t. Given that aggregate TFP is by assumption exogenous, the ratio of firm level TFP to aggregate TFP is predetermined. FD_j indicates foreign demand in industry j. G_j represents government demand in industry j. *REER* denotes the aggregate real effective exchange rate.

Hypothesized Signs

In DJK (2014), firm level productivity is measured as the summation of product level TFPs, from the first to the last product produced and retained by the firm. An increase in firm level TFP to industry level TFP means that compared to the average firm in industry j, the firm possesses a higher mean level of productivity. This firm will then have a greater incentive to maintain the existing products and add new establishments, which leads to a larger likelihood of adding of products by spinouts and entry of new establishments. Thus, a_1 and b_1 should be positive. As the number of products increases, exports also increase. Then, c_1 in Equation (4) should be positive.

TFP_j represents industry level productivity. Shocks to TFP_j are akin to aggregate TFP shocks if industry shocks are proportional to aggregate shocks. The aggregate TFP shock increases the number of products because costs for new entrants will decline, and more new entrants will be able to meet the free entry condition. Thus, in Equations (2) and (4), a_2 and c_2 should be positive. In the case of Equation (3), the aggregate TFP shock stimulates product adding, making b_2 positive.

With regards to product dropping, the product dropping rate does not depend much on aggregate shocks in DJK model, making the sign of b_2 ambiguous. When the dependent variable is the product adding or dropping dummy variable, the sign of b_2 is positive. While a positive macroeconomic shock increases product adding, the shock has limited impact on product dropping, leading to an increase in the product adding and dropping dummy.

The positive foreign demand shock increases the number of products and exports. We expect a_3 and c_3 to be positive. In the DJK, foreign demand stimulates product adding through an increase in revenues, leading to greater establishment and firm entry. Then, b_3 will be positive when the adding dummy is the dependent variable. Similarly, the coefficient on the dropping dummy should be ambiguous, and the coefficient on the adding and dropping dummy should be positive.

An increase in government demand should increase number of products and exports. Thus, a_4 and c_4 are expected to be positive. In Equation (3), b_4 is expected to be positive when the adding dummy is the dependent variable. When the dropping dummy is the dependent variable, b_4 is expected to be ambiguous. As in the case of the government demand shock, the sign of b_4 is positive when the dependent variable is a dummy that takes a value of unity when the firm drops and adds a product.

In the DJK model, movements in the real effective exchange rate depend on aggregate productivity, foreign demand, government spending, and liquidity shocks. Thus, the real effective exchange rate is endogenous. If we take the real effective exchange rate as an explanatory variable, the estimated coefficient will be biased by other exogenous variables and the random error term.

While being aware of the possible endogeneity of the real effective exchange rate, we interact the real effective exchange rate with relative TFP, to see how the impact of exchange rate changes on product adding and dropping depends on firm level productivity. DJK (2014) show that firms with high productivity are relatively insensitive to shocks which cause real exchange rate fluctuations. To see this, assume for a moment that the change in the real exchange rate is exogenous - perhaps because exogenous liquidity shocks are the main driver of real exchange rate fluctuation as in the DJK model. Then the depreciation is akin to an increase in demand. By reducing the lower cutoff productivity for exports, the positive demand shock generally stimulates product (and establishment) adding. But for the highly productive firms, the increase in product adding could be smaller. If so a_5 and c_5 will have negative signs. The sign of b_5 depends on what kind of product dynamics variable is the dependent variable. If the adding dummy is the dependent variable, b_5 is likely to be negative. Again b_5 is likely to be ambiguous when the dependent variable is dropping dummy, and b_5 is likely to be negative when it is the product adding and dropping dummy.

We estimate Equations (2) (3) and (4) by fixed effects panel estimation. We assume that the error term follows an AR1 process.[11]

Estimation Results

Table 3 shows the estimation results of Equation (2). Consistent with the model, relative TFP, aggregate TFP, and foreign demand affect the number of products positively and significantly in Column (1). As hypothesized, the coefficient on the number of products is negative and significant. This last result indicates that the dropping rate of existing products is larger than adding rate of new products on average which is not affected by aggregate shocks for continuing firms.

Column (2) shows that adding the government spending variable results in a significantly negative coefficient on government spending, although the coefficients on the other variables are roughly the same as in Column (1). While in the DJK (2014) model, government spending is assumed to be exogenous, the government spending variable that we construct from the Japanese Input-Output Tables is plausibly correlated with other exogenous variables such as aggregate TFP and the unobserved error term (e.g., counter cyclical fiscal policy). This possible endogeneity of our constructed government spending variable may account for the wrong sign

[11] In pre-testing, we generally found that the AR(1) structure of the error term could not be rejected.

of the government spending variable in our estimates.

In Column (3), we add the real exchange rate interacted with firm level relative TFP to our specifications. The relative TFP term interacted with the real exchange rate is positive and significant, although its magnitude is small. This wrong sign on the interaction term may be a result of the endogeneity of the real exchange rate (as mentioned above). In Column (4), we again find that the number of products is positively and significantly affected by aggregate productivity and foreign demand shocks. In all columns, we generally find that foreign demand has the largest effect on the change in number of products, followed by industry TFP shocks.

(Insert Table 3 here)

Table 4-1 shows the results when we take the product adding dummy as a dependent variable. Consistent with the DJK model, Column (1) shows that the coefficients on relative TFP, aggregate TFP, and foreign demand are all positive with varying significance, and the coefficient on the number of products is negative and significant. When we add the government spending variable in Column (2), we find a positive but insignificant coefficient of government spending. The results adding the interaction term between the real effective exchange rate and relative TFP in Columns (3) and (4) shows a negative and significant coefficient on the interaction term, which is consistent with our hypothesis that the product adding rate of highly productive firms are less sensitive to real exchange rate fluctuations.

In Table 4-2, we examine the estimation results when the dropping dummy is the dependent variable. The results are mixed. In Columns (1) and (2), we find negative and marginally significant coefficients of relative TFP. The coefficients of aggregate TFP, foreign demand and government demand are not significant as DJK model suggests. In Columns (3) and (4), the interaction term between the real effective exchange rate and relative TFP is negative and significant, suggesting that high productivity firms are relatively insensitive to real exchange rate fluctuations in both adding and dropping products. These mixed findings when product dropping is the dependent variable suggests that actual dropping behavior by Japanese firms is more complicated than what is modelled by DJK. In particular, there appear to be Lucas-type managerial "span of control" cost structure. Given the limitation of managerial control, firms which add new and better products tend to drop older products, which makes adding and dropping of products to move in the same direction.

In Table 4-3, we examine product switching behavior. We find that many variables have inconclusive and ambiguous coefficients, except for the coefficient on the number of products. The significantly positive sign on the number of products variable suggests that firms with already many products (intangible capital) are likely to more actively restructure their product mix.

(Insert Tables 4-1, 4-2 and 4-3 here)

Finally, the estimation results of Equation (4) for export variables are shown in Tables 5-1, 5-2 and 5-3. In Table 5-1, we take the export dummy as the dependent variable (taking on a value of unity when the firm exports). In Columns (1) and (2), we find that aggregate TFP, foreign demand and government spending have positive and significant coefficients, while relative TFP has a positive but insignificant coefficient on exporting behavior. The coefficients on the existing number of products variable is positive and significant. When we add the interaction term of the real effective exchange rate and relative TFP in Columns (3) and (4), the sign of the interaction term is negative but insignificant, while all of the other variables have the same signs and significance as in Columns (1) and (2). Thus, as found in many earlier studies, more productive firms are exporting, and exporters tend to be multiproduct firms.

In Table 5-2, we take the export/shipments ratio of the firm as the dependent variable. We find that relative TFP is positive and marginally significant, but the coefficients on foreign demand are insignificant in Columns (1) and (2). As for the other variables, we have the similar results as in Table 5-1.

In Table 5-3, we take the log of exports as a dependent variable. Overall, the results in Table 5-3 are similar to those in Table 5-2. Although the coefficients on foreign demand are positive but insignificant, relative TFP, aggregate TFP, and government expenditures are all positive and significant as hypothesized. In addition, the interaction term between the real exchange rate and relative TFP is negative and significant in Columns (3) and (4), suggesting that export quantities of high productivity firms are relatively insensitive to real exchange rate fluctuations. In all estimations, the increase in the number of products is associated with an increase in export quantities.

(Insert Tables 5-1, 5-2 and 5-3 here)

We have examined the effects of several shocks on firm level product adding and dropping, including aggregate and firm level productivity shocks, foreign demand shocks and government expenditure shocks. In particular, we find significant evidence of firm level and aggregate productivity shocks and foreign demand shocks on product adding. We also find positive and significant effects of productivity shocks and government expenditures shocks on firm level exports. As for the impact of aggregate exchange rate fluctuations on product adding and dropping, we find that in general that high productivity firms are relatively insensitive to real exchange rate fluctuations.

6. Concluding remarks

Conceptually linking business cycles with product adding and dropping behavior at the firm level is not new; the idea goes back at least to Shumpeter. However, to the best of our knowledge, this paper is one of the first to estimate a model of product adding and dropping behavior for the multiproduct firm at the business cycle frequency. To estimate such a model, we need product level data that can be matched with firms at a minimum at the business cycle or annual frequency.

We construct a unique firm-product database in Japan using *the Census of Manufacturer*s by the Ministry of Economy, Trade, and Industry. The products in our database are classified down to six-digits, which is more detailed than what is available in the U.S. Census of Manufactures.

In Japan, firms change their product compositions quite frequently, although the average number of products per firm is very stable. This stability, however, hides some significant product adding and dropping behavior. The average number of products of exporters is larger and more volatile than non-exporting firms. Sales of exporters are larger than the sales of non-exporters. We also find that product adding and firm entry behavior are cyclical, while product dropping and firm exit behavior are less cyclical.

In our firm level estimates, we find that macroeconomic shocks-- industry level productivity and foreign demand shocks—strongly increase both the number of products and exports (consistent with Dekle, Jeong, and Kiyotaki, 2014).

Our empirical results suggest that creative destruction of adding new products and dropping old products by existing firms is an important contributor of aggregate fluctuations, and perhaps more important than the entry and exit of firms for business cycle fluctuations. This creative destructions of products is more active under favorable aggregate conditions of productivity and foreign demand. To revitalize the Japanese economy through creative destruction, it is perhaps important for the government to implement policies that raise aggregate productivity and foreign demand, such as improving education, research and development, and stimulating foreign direct investment and trade, in addition to reducing the structural obstacles to slow down the creative destruction process.

Appendix: Methodology of measuring firm level TFP

For the measurement of TFP, we employed a production function suggested by Olley and Pakes (1996)[12]. Olley and Pakes (1996) estimated a production function allowing for the endogeneity of inputs, selection bias, and unobserved permanent differences across firms. They specify a production function whose added values (Y_{it}) is dependent on capital stock (K_{it}), labor input (L_{it}), firm age (a_{it}) and productivity level (ω_{it}):

$$Y_{it} = F(K_{it}, L_{it}, a_{it}, \omega_{it})$$

[12] To estimate the production function suggested by Olley and Pakes (1996), we use the *opreg* command for STATA. The explanation of estimation in this appendix is following the manual of *opreg* (Yasar, Raciborski and Poi, 2008).

Y_{it} and L_{it} are firm i 's value added and labor input at t . To calculate TFP using the "Census of Manufactures", we assume that the Cobb-Douglas technology function applies:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_a a_{it} + u_{it} \text{ and } u_{it} = \omega_{it} + \eta_{it} \quad \text{(A-1)}$$

When $\omega_{it} \geq \underline{\omega}_t$, a firm continues its plant. As this survival rate depends on the past firm age (a_{t-1}), capital stock (k_{t-1}), and survival probability ($\hat{P}_{it}$), we rewrite (A-1) as follows,

$$y_{it} - \beta_l l_{it} = \beta_k k_{it} + g(\hat{\phi}_{t-1} - \beta_k k_{it-1} - \beta_a a_{it-1}, \hat{P}_{it}) + \xi_{it} + \eta_{it} \quad \text{(A-2)}$$

Equation (A-2) is an unbiased and consistent production function which we estimate. $g(\cdot)$ is approximated by the second-order polynomial in $\hat{\phi}_{t-1} - \beta_k k_{it-1} - \beta_a a_{it-1}$ and $\hat{P}_{it}$. ξ_{it} is TFP for the survived firms which are not affected by the investment and exit decisions at $t-1$. The definitions of the variables are described below.

Value added

Value added is defined as:

Value added=total shipment-cost of raw materials

-fuels and electricity consumed +value of depreciation

Total shipment and materials and fuels and electricity are real values deflated by industry level GDP deflators.

Labor input

Labor input is defined as man hours, which is the total number of workers multiplied by industry-level working hours.

Capital stock

For the calculation of the real value of the net capital stock, we multiplied the book value of tangible assets of each firm i at period t by the industry-level market-to-book ratio INK_{jt}/IBK_{jt} calculated from the “Census of Manufactures”.

$$K_{it} = BV_{it} * \frac{INK_{jt}}{IBK_{jt}}$$

To calculate the market values of tangible asset INK_{jt} in industry j , we take the following steps: 1) for the initial value, take tangible assets in the “Census of Manufactures” and 2) tangible assets after 1977 are calculated using the perpetual inventory method following the equation below:

$$INK_{jt} = INK_{jt-1} * (1 - \delta_{jt}) + I_{jt}$$

I_{jt} is the total investment of industry j deflated by JIP2013, δ_t is the depreciation ratio calculated from the Japanese input-output tables..

Because the capital stock is reported by establishments that employ 10 or more employees, we removed firms that employed fewer than fewer than 9 employees from the estimation sample. In the equation to estimate the production function, we added year dummies[13] as control variables. Table A1 shows the estimated result.

Table A1. Production function by Olley and Pakes (1996)

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[13] In order to use the average value of TFP in industry level estimations, we excluded industry dummies from the estimation to maintain the differences of TFP among industries.

	coefficient	z	
lnK	**0.124**	**23.04**	*******
lnL	**0.622**	**129.02**	*******
year dummy	**yes**		
sample size	**399794**		
number of groups	**70992**		

Note) *** indicates that the null hypothesis of estimated coefficient is rejected at a significant level 1%.

We measure firm-level TFP by using value added, capital and labor data in the Census by using the coefficients in production factors shown in Table A1. Firm-level TFP is defined as follows,

$$\ln TFP_i = y_i - \hat{\beta}_l l_i - \hat{\beta}_k k_i$$

We also measure industry-level TFP by using the coefficients in production factors shown in Table A1:

$$\ln TFP_j = \sum_{i \in j} y_i - \hat{\beta}_l \sum_{i \in j} l_i - \hat{\beta}_k \sum_{i \in j} k_i$$

The productivity of firms relative to their industry is given by:

$$RTFP_i = \ln TFP_i - \ln TFP_j$$

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Table 1

Sector 2-digit SIC		Industry 4-difgit SIC		Product 6-digit SIC	
30	Information and communication electronics equipment	3011	Communication equipment wired	301111	Telephone sets
				301112	Automatic telephone exchange switchboards
				301113	Auxiliary equipment of telephone exchange switchboards
				301119	Miscellaneous wired telephone sets
				301121	High-speed facsimiles, including ultra-high-speed ones
				301122	Facsimiles, except high-speed ones
				301129	Miscellaneous wired telecommunication equipment
				301131	Digital transmission equipment
				301132	Transmission equipment, except digital transmission equipment
		3012	Mobile phone and PHS	301211	Cellular telephone sets and PHS telephone sets
		3013	Radio communication equipment	301311	Radio and TV broadcasting equipment
				301312	Fixed-station communication equipment
				301313	Miscellaneous mobile-station communication equipment
				301314	Portable communication equipment
				301315	Radio applied equipment
				301319	Miscellaneous radio communication equipment
		3014	Radio and television set receivers	301411	Radio receivers
				301412	Plasma television receivers
				301413	Liquid crystal television receivers
				301419	Miscellaneous television receivers
		3015	Railway signal and safety appliances	301511	Railway signal and safety appliances
				301512	Parts, attachments and accessories of railway signal and safety appliances
		3019	Miscellaneous communication equipment and related products	301911	Fire alarm equipment
				301919	Miscellaneous communication related products
		3021	Video equipment	302111	Recording and duplicating equipment
				302112	Video cameras, except broadcast video cameras
				302113	Parts, attachments and accessories of video recording and duplicating equipment
		3022	Digital camera	302211	Digital cameras
				302212	Parts, attachments and accessories of digital cameras
		3023	Electric audio equipment	302311	Stereo sets
				302312	Car stereo sets
				302313	Tape recorders
				302314	Digital audio disc players
				302315	High fidelity (HI-FI) amplifiers
				302316	Speaker systems for HI-FI and cars
				302317	Hearing aids
				302319	Miscellaneous electric audio equipment
				302321	Finished speaker systems, microphones, earphones, audio pickups, etc.
				302322	Parts, attachments and accessories of electric audio equipment
		3031	Computer, except personal computer	303111	General computers
				303112	Midrange computers
				303113	Parts, attachments and accessories of data processing machines, digital and analog computers and auxiliary equipment
		3032	Personal computer	303211	Personal computers
				303212	Parts, attachments and accessories of Personal computers
		3033	External storages	303311	Magnetic disc equipment
				303312	Optical disc equipment
				303313	Flexible disc equipment
				303319	Miscellaneous external memories
				303321	Parts, attachments and accessories of external memories
		3034	Printer	303411	Printers
				303412	Parts, attachments and accessories of printers
		3035	Display unit	303511	Displays
				303512	Parts, attachments and accessories of displays
		3039	Miscellaneous peripheral equipment	303911	Finance terminal units
				303919	Miscellaneous terminal units
				303929	Miscellaneous input-output systems
				303939	Miscellaneous accessories equipment
				303941	Parts, attachments and accessories of miscellaneous accessories equipment

Table 2

Sector	Industries	Products	Industries/ Products	Goods Shipments (million yen)	Number of Empliyees	Shipments per Employees (million yen)
9 FOOD	41	87	2.1	23784327	1049968	22.7
10 BEVERAGES,TOBACCO AND FEED	13	31	2.4	9802268	91072	107.6
11 TEXTILE MILL PRODUCTS	64	177	2.8	3493573	257219	13.6
12 LUMBER AND WOOD PRODUCTS, EXCEPT FOURNITURE	18	43	2.4	1824205	75766	24.1
13 FURNITURE AND FIXTURES	9	22	2.4	1402558	77669	18.1
14 PULP, PAPER AND PAPER PRODUCTS	15	52	3.5	6895796	177263	38.9
15 PRINTING AND ALLIED INDUSTRIES	7	19	2.7	5724091	262370	21.8
16 CHEMICAL AND ALLIED PRODUCTS	38	160	4.2	24096231	340916	70.7
17 PETROLEUM AND COAL PRODUCTS	5	18	3.6	10241165	21956	466.4
18 PLASTIC PRODUCTS, EXCEPT OTHERWISE CLASSIFIED	25	54	2.2	9669225	383831	25.2
19 RUBBER PRODUCTS	13	40	3.1	2577212	108561	23.7
20 LEATHER TANNING, LEATHER PRODUCTS AND FUR SKINS	9	30	3.3	328166	20288	16.2
21 CERAMIC, STONE AND CLAY PRODUCTS	44	101	2.3	6186607	223326	27.7
22 IRON AND STEEL	22	65	3.0	15751510	210931	74.7
23 NON-FERROUS METALS AND PRODUCTS	17	55	3.2	6847263	136256	50.3
24 FABRICATED METAL PRODUCTS	33	127	3.8	11383456	488184	23.3
25 GENERAL-PURPOSE MACHINERY	19	97	5.1	9604354	301692	31.8
26 PRODUCTION MACHINERY	26	127	4.9	11389401	474074	24.0
27 BUSINESS ORIENTED MACHINERY	23	84	3.7	6951459	206822	33.6
28 ELECTRONIC PARTS, DEVICES AND ELECTRONIC CIRCUITS	15	68	4.5	14819858	453435	32.7
29 ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES	23	111	4.8	13485422	453686	29.7
30 INFORMATION AND COMMUNICAION ELECTRONICS EQUIPMET	15	55	3.7	11427859	214300	53.3
31 TRANSPORTATION EQUIPMENT	16	66	4.1	46946916	923495	50.8
32 MISCELLANEOUS MANUFACTURING INDUSTRIES	32	114	3.6	3521578	132655	26.5

Note) We calculate these values of report by industry of the 2009 census.

Table 3

Dependent variable:Δnumber of products

	(1)		(2)		(3)		(4)	
Relative TFP	0.011	***	0.011	***	-0.089	**	-0.091	**
	(3.49)		(3.5)		(-3.13)		(-3.18)	
ln(Industry TFP)	0.009	**	0.009	**	0.010	**	0.010	**
	(2.59)		(2.6)		(2.73)		(2.73)	
ln(Foreign Demand)	0.118	***	0.118	***	0.118	***	0.117	***
	(39.1)		(38.86)		(39.06)		(38.81)	
ln(Government Demand)			-0.002	**			-0.002	**
			(-2.79)				(-2.85)	
lnREER*Relative TFP					0.022	***	0.022	***
					(3.55)		(3.59)	
Number of Products	-1.029	***	-1.029	***	-1.029	***	-1.029	***
	(-450.03)		(-450)		(-450.02)		(-449.99)	
constant	0.347	***	0.346	***	0.343	***	0.342	***
	(23.32)		(23.27)		(23.03)		(22.97)	
sector dummy	yes		yes		yes		yes	
Observations	238335		238335		238335		238335	
R2	0.045		0.045		0.045		0.045	
rho	0.417		0.417		0.417		0.417	

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 4-1

Dependent variable:Adding dummy	(1)	(2)	(3)	(4)
Relative TFP	0.003	0.003	0.043 ***	0.043 ***
	(1.85)	(1.85)	(4.02)	(4.04)
ln(Industry TFP)	0.004 *	0.004 *	0.004 **	0.004 **
	(2.57)	(2.57)	(2.64)	(2.64)
ln(Foreign Demand)	0.005 **	0.005 **	0.005 *	0.005 **
	(2.9)	(2.95)	(2.54)	(2.59)
ln(Government Demand)		0.001		0.001
		(1.26)		(1.32)
lnREER*Relative TFP			-0.009 ***	-0.009 ***
			(-3.81)	(-3.83)
Number of Products	-0.047 ***	-0.047 ***	-0.047 ***	-0.047 ***
	(-47.7)	(-47.71)	(-47.63)	(-47.64)
constant	0.119 ***	0.119 ***	0.125 ***	0.126 ***
	(6.78)	(6.79)	(7.15)	(7.17)
sector dummy	yes	yes	yes	yes
Observations	238335	238335	238335	238335
R2	0.030	0.029	0.030	0.029
rho	0.142	0.142	0.142	0.142

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 4-2

Dependent variable:Dropping dummy	(1)	(2)	(3)	(4)
Relative TFP	-0.003 *	-0.003 *	0.244 ***	0.244 ***
	(-2.4)	(-2.39)	(22.2)	(22.19)
ln(Industry TFP)	-0.002	-0.002	-0.001	-0.001
	(-1.08)	(-1.07)	(-0.67)	(-0.67)
ln(Foreign Demand)	-0.001	-0.001	-0.004 *	-0.004 *
	(-0.33)	(-0.37)	(-2.21)	(-2.23)
ln(Government Demand)		0.000		0.000
		(-0.9)		(-0.52)
lnREER*Relative TFP			-0.053 ***	-0.053 ***
			(-22.7)	(-22.68)
Number of Products	0.100 ***	0.100 ***	0.101 ***	0.101 ***
	(100.31)	(100.31)	(100.82)	(100.82)
constant	-0.035 *	-0.035 *	0.000	0.000
	(-2.2)	(-2.21)	(0)	(-0.01)
sector dummy	yes	yes	yes	yes
Observations	245508	245508	245508	245508
R2	0.064	0.063	0.065	0.065
rho	0.155	0.155	0.156	0.156

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 4-3

Dependent variable:Adding and dropping dummy

	(1)		(2)		(3)		(4)	
Relative TFP	0.000		0.000		0.010		0.010	
	(0.29)		(0.27)		(1.59)		(1.65)	
ln(Industry TFP)	0.000		0.000		0.000		0.000	
	(0.4)		(0.39)		(0.42)		(0.41)	
ln(Foreign Demand)	-0.005	***	-0.005	***	-0.005	***	-0.005	***
	(-5.95)		(-5.76)		(-6.05)		(-5.86)	
ln(Government Demand)			0.001	***			0.001	***
			(3.83)				(3.86)	
lnREER*Relative TFP					-0.002		-0.002	
					(-1.57)		(-1.63)	
Number of Products	0.035	***	0.035	***	0.035	***	0.035	***
	(63.22)		(63.17)		(63.24)		(63.2)	
constant	-0.011		-0.010		-0.010		-0.009	
	(-1.45)		(-1.4)		(-1.29)		(-1.25)	
sector dummy	yes		yes		yes		yes	
Observations	228507		228507		228507		228507	
R2	0.047		0.047		0.047		0.047	
rho	0.191		0.191		0.191		0.191	

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 5-1

Dependent variable:Export dummy	(1)		(2)		(3)		(4)	
Relative TFP	0.002		0.002		0.021		0.020	
	(1.95)		(1.95)		(1.7)		(1.63)	
ln(Industry TFP)	0.004	***	0.004	***	0.004	***	0.004	***
	(3.42)		(3.41)		(3.49)		(3.46)	
ln(Foreign Demand)	0.003	**	0.003	***	0.003	**	0.003	**
	(3.03)		(3.34)		(2.79)		(3.11)	
ln(Government Demand)			0.001	***			0.001	***
			(3.59)				(3.56)	
lnREER*Relative TFP					-0.004		-0.004	
					(-1.53)		(-1.46)	
Number of Products	0.016	***	0.016	***	0.016	***	0.016	***
	(11.87)		(11.85)		(11.9)		(11.88)	
constant	-0.009	**	-0.009	**	-0.008	*	-0.008	*
	(-2.87)		(-2.76)		(-2.53)		(-2.43)	
sector dummy	yes		yes		yes		yes	
Observations	137670		137670		137670		137670	
R2	0.059		0.059		0.060		0.060	
rho	0.551		0.551		0.551		0.551	

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 5-2

Dependent variable:Export/output ratio

	(1)	(2)	(3)	(4)
Relative TFP	0.063 *	0.063 *	0.281	0.262
	(2.14)	(2.14)	(0.83)	(0.78)
ln(Industry TFP)	0.085 *	0.085 *	0.086 *	0.086 *
	(2.49)	(2.48)	(2.52)	(2.5)
ln(Foreign Demand)	0.043	0.049	0.040	0.047
	(1.62)	(1.86)	(1.51)	(1.76)
ln(Government Demand)		0.023 **		0.023 **
		(2.81)		(2.8)
lnREER*Relative TFP			-0.048	-0.043
			(-0.65)	(-0.59)
Number of Products	0.058	0.058	0.059	0.058
	(1.54)	(1.52)	(1.55)	(1.53)
constant	0.048	0.056	0.060	0.067
	(0.57)	(0.67)	(0.71)	(0.79)
sector dummy	yes	yes	yes	yes
Observations	137670	137670	137670	137670
R2	0.028	0.028	0.028	0.028
rho	0.562	0.562	0.562	0.562

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

Table 5-3

Dependent variable:Ln(exports)

	(1)	(2)	(3)	(4)
Relative TFP	0.060 ***	0.059 ***	0.356 **	0.347 **
	(5.74)	(5.73)	(3.00)	(2.92)
ln(Industry TFP)	0.083 ***	0.083 ***	0.084 ***	0.084 ***
	(6.88)	(6.86)	(6.97)	(6.95)
ln(Foreign Demand)	0.011	0.014	0.007	0.011
	(1.14)	(1.47)	(0.79)	(1.13)
ln(Government Demand)		0.011 ***		0.011 ***
		(3.83)		(3.78)
lnREER*Relative TFP			-0.065 *	-0.063 *
			(-2.51)	(-2.43)
Number of Products	0.167 ***	0.167 ***	0.168 ***	0.167 ***
	(12.56)	(12.54)	(12.6)	(12.58)
constant	-0.087 **	-0.083 **	-0.071 *	-0.067 *
	(-2.95)	(-2.82)	(-2.38)	(-2.27)
sector dummy	yes	yes	yes	yes
Observations	137670	137670	137670	137670
R2	0.067	0.067	0.067	0.067
rho	0.566	0.566	0.566	0.566

Note) t value is shown in parenthesis. ***, **, and * indicate that the null hypothesis of estimated coefficient is rejected at significant levels 1%, 5%, and 10%, respectively.

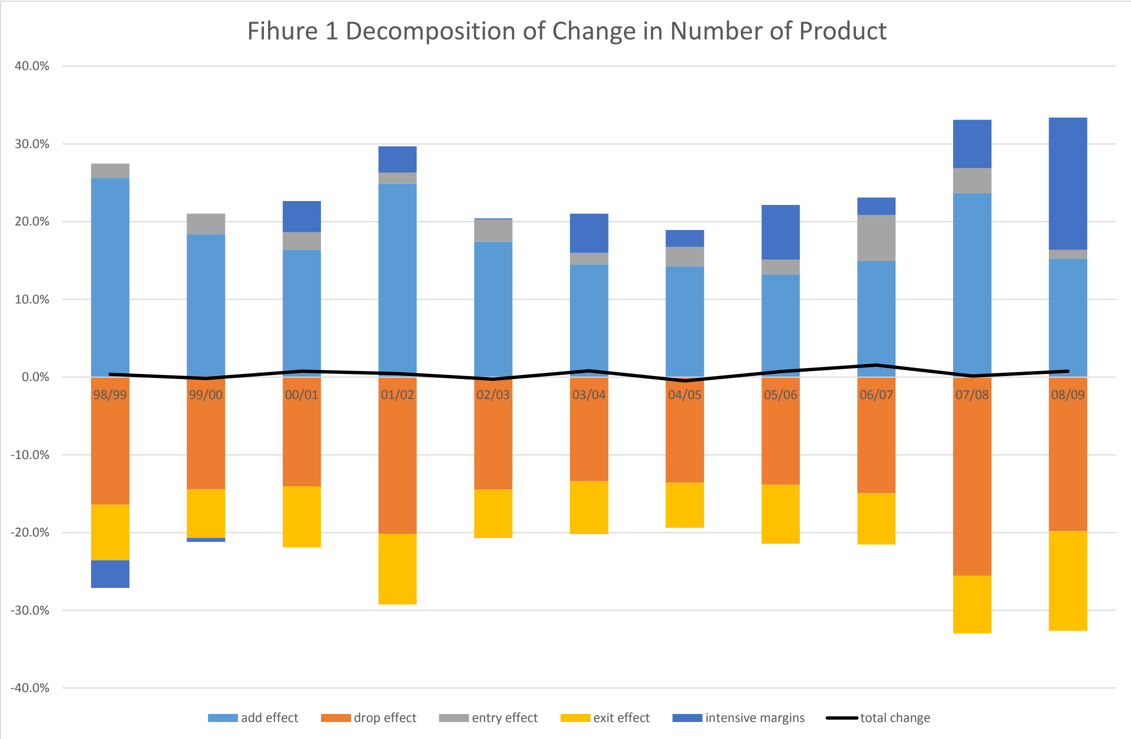
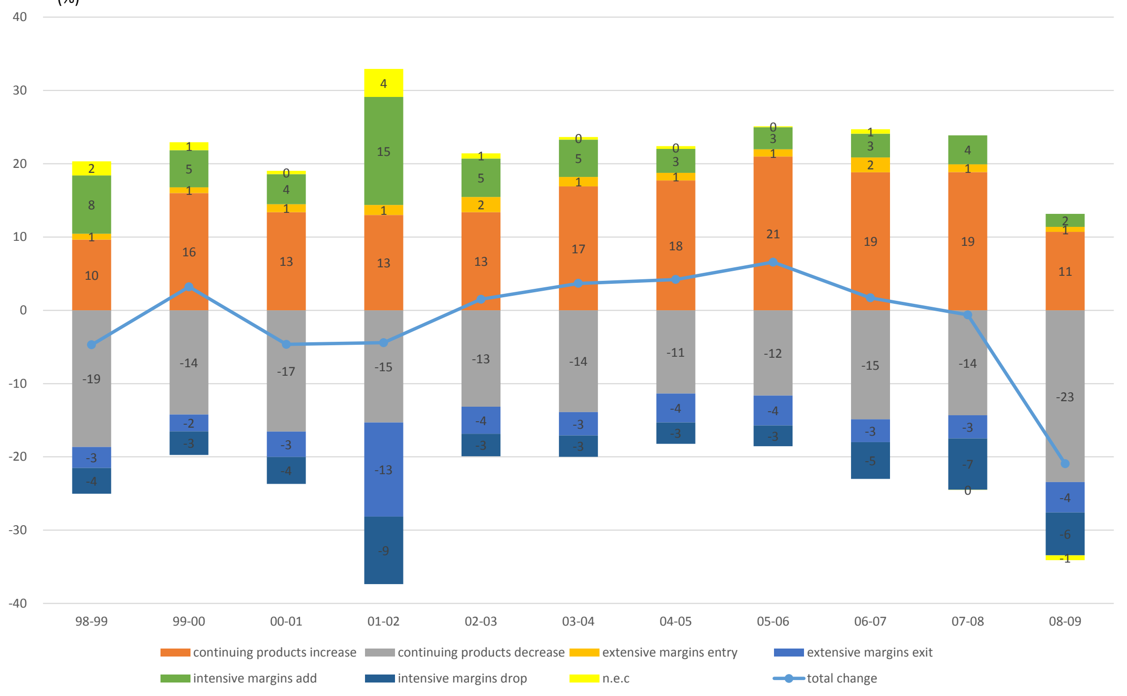

Fihure 1 Decomposition of Change in Number of Product
40.0%
30.0%
20.0%
10.0%
0.0%
-10.0%
-20.0%
-30.0%
-40.0%
98/99
99/00
00/01
01/02
02/03
03/04
04/05
05/06
06/07
07/08
08/09
add effect
drop effect
entry effect
exit effect
intensive margins
total change

Figure 2. Decomposition of shipment change



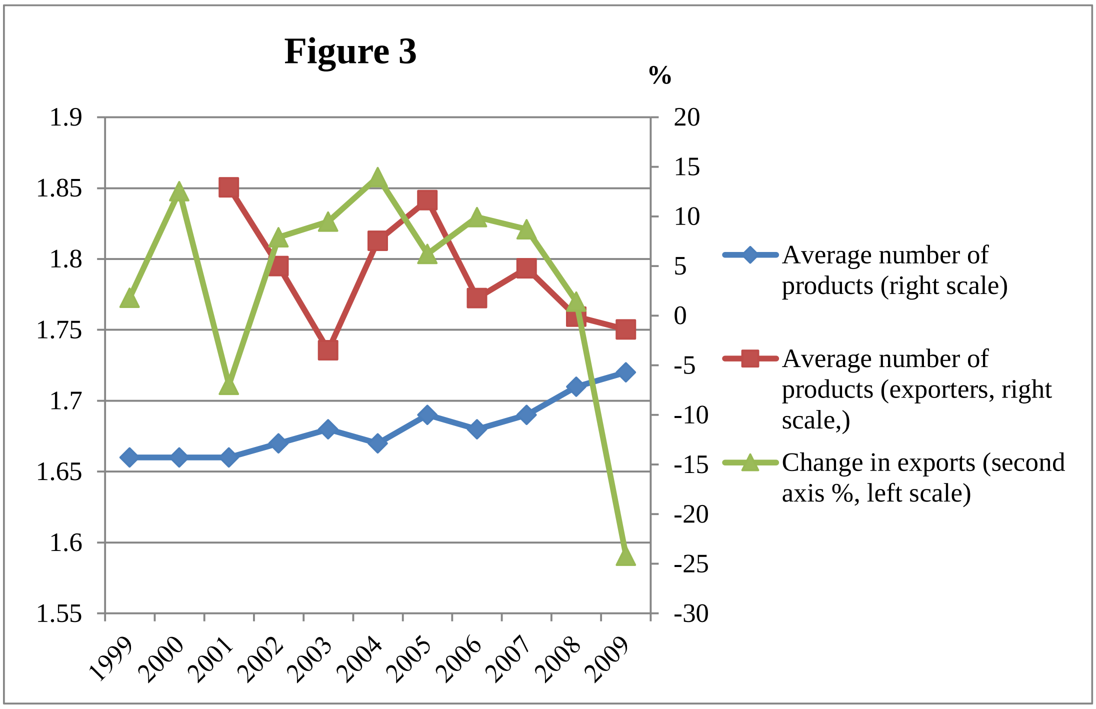
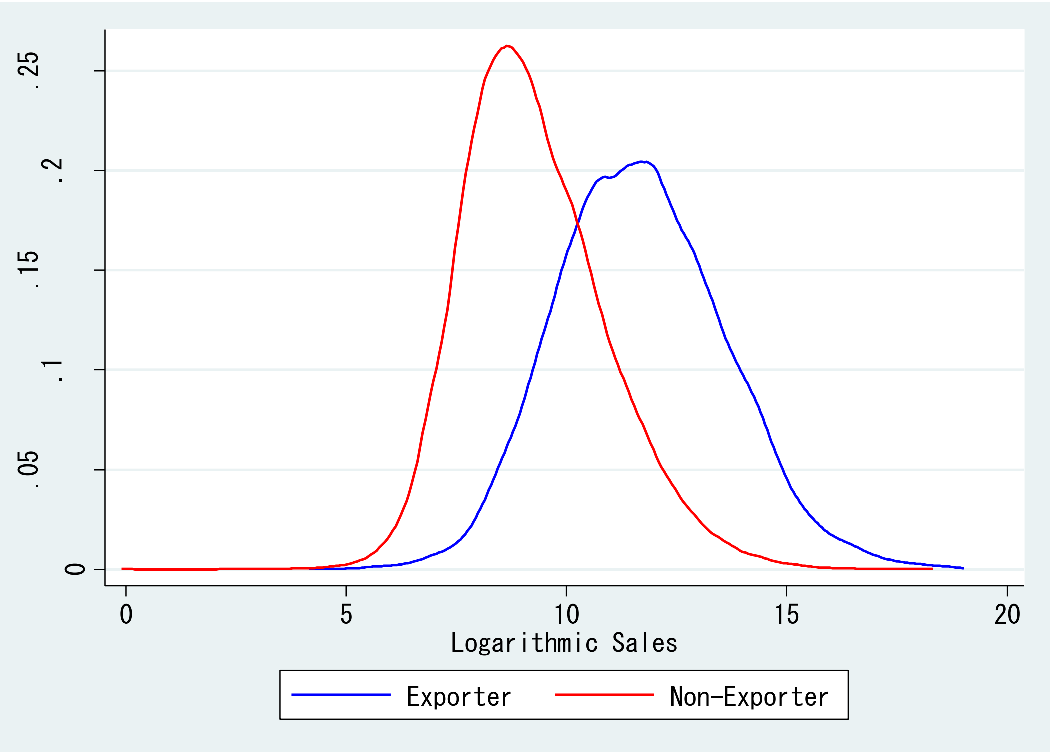


Figure 3
%
1.9
1.85
1.8
1.75
1.7
1.65
1.6
1.55
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Average number of products (right scale)
Average number of products (exporters, right scale,)
Change in exports (second axis %, left scale)

Figure 4


0
.05
.1
.15
.2
.25
0
5
10
15
20
Logarithmic Sales
Exporter
Non-Exporter

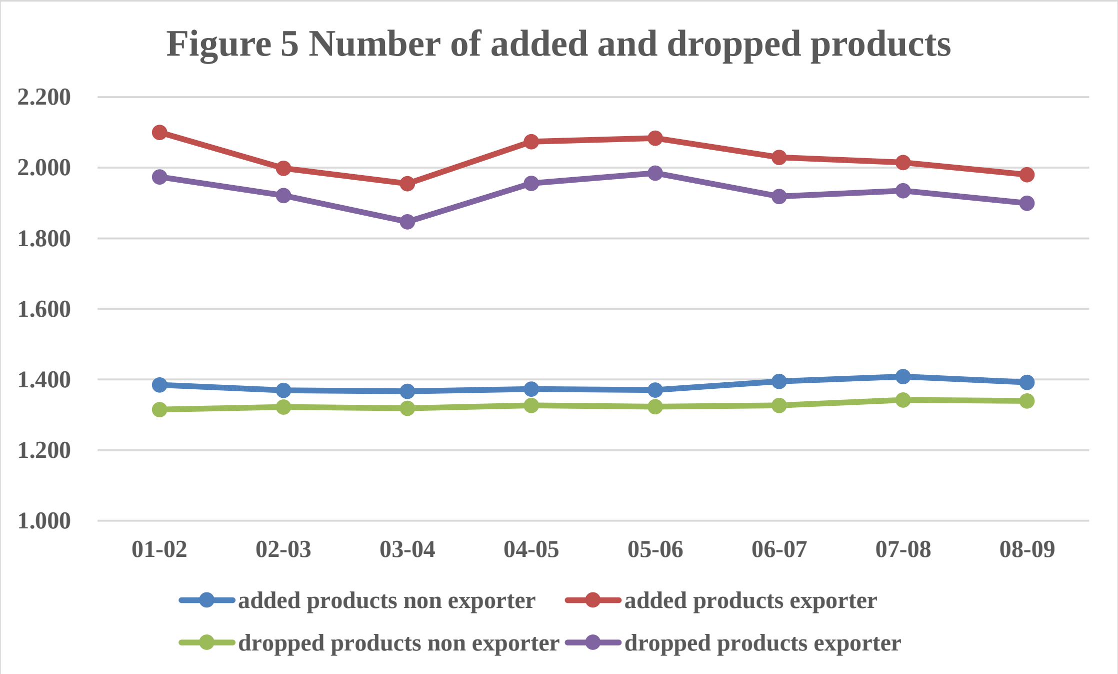


Figure 5 Number of added and dropped products
2.200
2.000
1.800
1.600
1.400
1.200
1.000
01-02
02-03
03-04
04-05
05-06
06-07
07-08
08-09
added products non exporter
added products exporter
dropped products non exporter
dropped products exporter

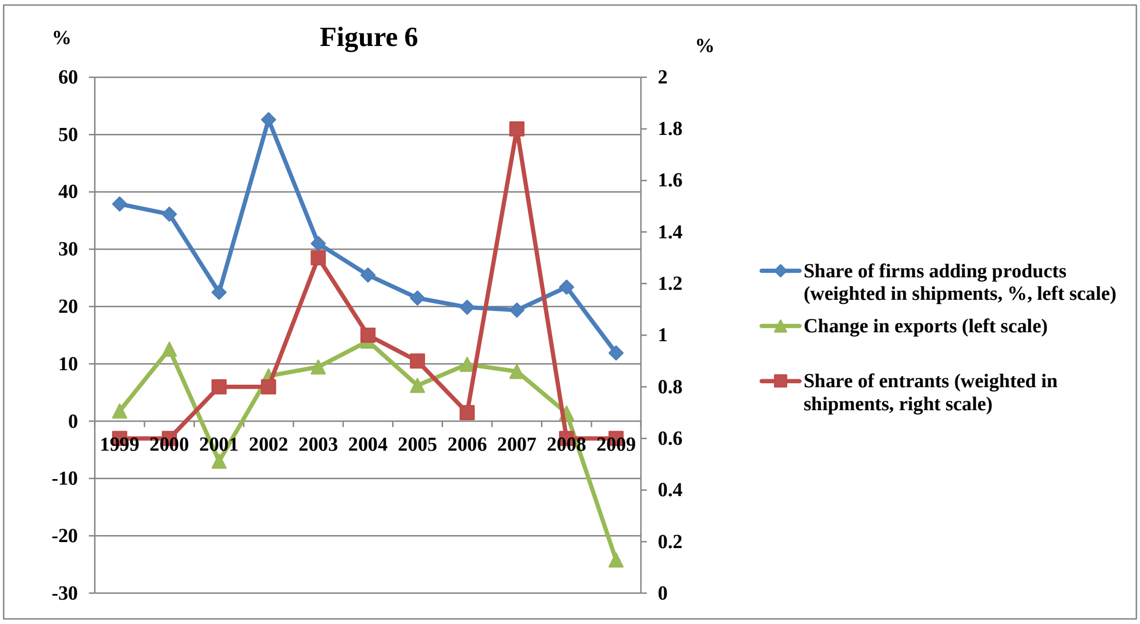


Figure 6
%
%
60
50
40
30
20
10
0
-10
-20
-30
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Share of firms adding products (weighted in shipments, %, left scale)
Change in exports (left scale)
Share of entrants (weighted in shipments, right scale)

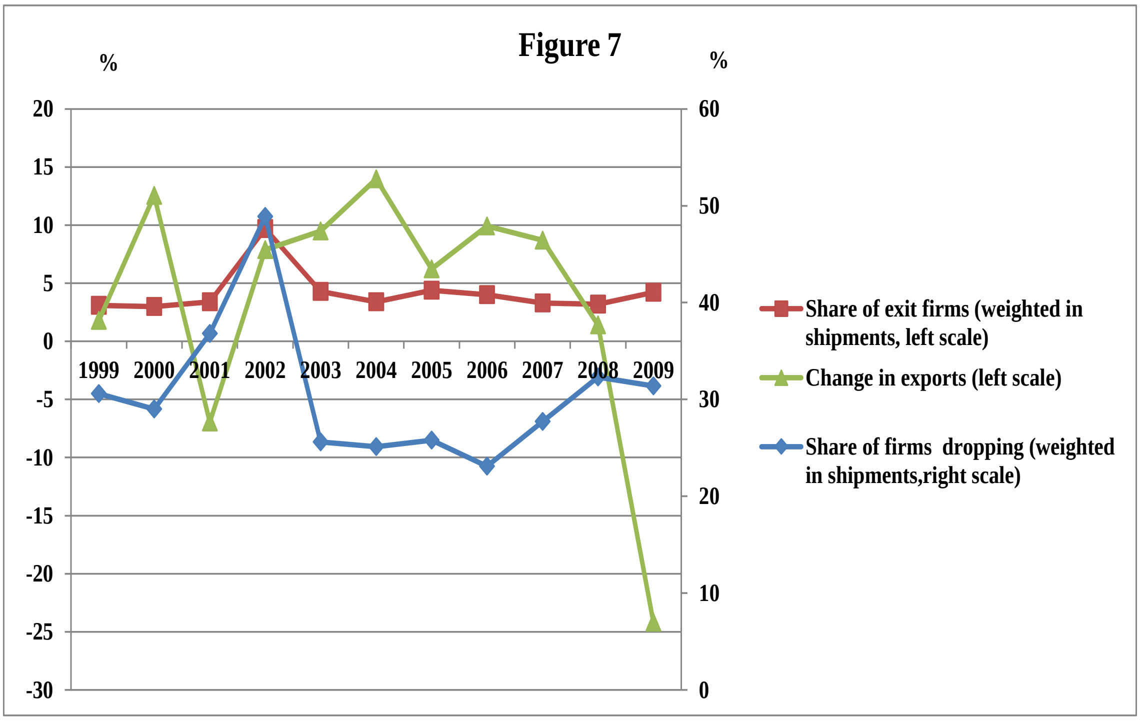


Figure 7
%
%
20
15
10
5
0
-5
-10
-15
-20
-25
-30
60
50
40
30
20
10
0
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Share of exit firms (weighted in shipments, left scale)
Change in exports (left scale)
Share of firms dropping (weighted in shipments,right scale)