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# Does Natural Selection Mechanism Still Work in Severe Recessions?
## — Examination of the Japanese Economy in the 1990s —

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**Abstract**

This paper investigates whether or not the natural selection mechanism (NSM) of economic Darwinism works in severe recessions. Although standard firm models imply the importance of NSM in an economy by showing firm's rational behavior on entry, surviving, and exit leads to macro-level TFP growth, there is almost no evidence to demonstrate NSM works even in severe recessions and depressions. Based on micro data of *the Basic Survey of Japanese Business Structure and Activities* (*BSJBSA*) by Ministry of Economy, Trade and Industry, we construct a comprehensive firm-level panel dataset for Japan from 1994 to 1998, especially designed for the analysis of a firm's entry, survival, and exit and its relationship with TFP. Empirical results show that efficient firms in terms of TFP quit while inefficient ones survived in the banking-crisis period of 1996-1997. Besides, this phenomenon is mainly observed for new entrants and contributes substantially to a fall in macro TFP after 1996. These facts strongly suggest malfunctioning of NSM in severe recessions.

Keywords: TFP, entry and exit, enterprise census
JEL Classification : D21 (Firm Behavior); D24 (Production; Capital and Total Factor Productivity; Capacity); O47 (Measurement of Economic Growth; Aggregate Productivity); L11 (Production, Pricing and Market Structure; Size Distribution of Firms)

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# 1 Introduction

Economic Darwinism explains the survival of the fittest firms in relation to the change in the business environment. According to the *laissez-faire* principle, the competitive market guarantees that the natural selection mechanism (NSM) of Darwinism leads to efficient resource allocation, because firms with low profitability are forced to quit and productive ones can survive in the market. As Galor and Moav (2002) explain, the struggle to survive can even trigger revolutions which break blockades and open the way to long term economic growth.

The microeconomic foundation of NSM has been established by the development of sophisticated firm models since Jovanovic (1982). The standard model depicts a firm's decision for entry, surviving, and exiting as a result of maximization of the expected discounted future net cash flows. Olley and Pakes (1996), demonstrated that firms' private decisions in the U.S. telecommunications industry eventually contributed to productivity progress for the industry as a whole.

Several cases of empirical evidence of a firm's entry/exit have suggested the fulfillment of NSM both in developing and advanced economies. It is, however, still not certain whether NSM really works well in severe recessions, because we have rarely experienced a serious economic downturn such as the Great Depression early in the twentieth century, where the market mechanisms might fail to function.

To answer the question of whether NSM really works well in a severe recession, the Japanese economy in the 1990s appears to be a prime example for analysis. The plight of the recent Japanese economy has stirred heated discussion on its causes and remedies. As recession showed its stubbornness despite massive fiscal and monetary stimulation, economists turned their attention toward the supply side of the Japanese economy, especially a large decline in Total Factor Productivity (TFP).[1] Since malfunction of the NSM on a firm's entry, surviving, and exit could explain the decline in macro level TFP, it might be meaningful to investigate how

[1]Carefully purging out other factors, Fukao, Inui, Kawai and Miyagawa (2002) found that the rate of Japan's macro TFP growth in 1990s was only 40% of that in 1980s. Nakajima, Kasuya, Saida and Tanemura (2002), based on a dual approach of TFP, revealed that productivity slowdown had already started before the burst of the bubble economy. Nishimura and Shirai (2003) observed serious retardation in technical progress of the Japanese service (includes wholesale & retail trade, transport, and telecommunications) sectors in 1990s. Hayashi and Prescott (2002) utilized a dynamic macro model to show the simulated business cycle caused by productivity slowdown follows the actual GDP fluctuations in Japan.

NSM has functioned in this severe recession period of the Japanese economy.[2]

A dataset at the firm-level for a panel of companies is essential to accomplish this investigation. Most countries unfortunately conduct comprehensive surveys only of establishments in manufacturing, such as the census of manufactures.[3] In contrast, the Ministry of Economy, Trade and Industry of Japan launched *The Basic Survey of Japanese Business Structure and Activities* (*BSJBSA*), which covers all commercial firms with 50 employees or more and capitalization of over 30 million yen, who are at least partly engaged in mining, manufacturing, wholesale & retail sales, and restaurant activities. Thus, this data set gives us a unique opportunity to examine whether NSM works in severe recessions in a wide range of industries in a developed economy.

The results are striking. In Japan, efficient firms in terms of TFP went out of business while inefficient ones have survived since 1996. NSM, which is supposedly inherent in a market economy, showed malfunctions. Besides, this phenomenon was mainly observed with new entrants and can explain a considerable part of the fall in macro TFP after 1996. The year 1996 is key to the interpretation of the results, because the vulnerability of the Japanese financial market started to become obvious in 1996 and 1997. Our results might be consistent with the fact that Japanese banks, suffering from non-performing loan problems after the burst of the bubble, finally fell into functional disorder early in 1997.

The remainder of the paper is organized as follows. The next section presents a brief survey of preceding entry/exit studies on both theoretical and empirical sides. Section 3 explores a firm's entry/exit behavior patterns. In Section 4 we show basic TFP calculation results and analyze the relationship between a firm's entry/exit and the industry level TFP. The final section concludes the paper. Detailed descriptions of data sources and calculation methodology of TFP

[2] Several empirical works go further than estimating macro- or industry level TFP and investigate the effects of sectoral and regional adjustment on TFP growth. Kuroda and Nomura (1999) and Fukao et al. (2002) calculated a resource reallocation effect among industries on macro TFP and showed its large slowdown in the 1990s. Higuchi, Nakajima, Nakahigashi and Hino (2003) pointed out that the rigidity of an industrial structure in prefectures prevented macro TFP progress in Japan. Bae (2002) decomposed the macro TFP growth of Japan from 1960 to 1999 into a technical progress factor and an efficiency improvement factor and derived a result showing that the latter one has rarely been found. The results of these studies suggest a problem in the adjustment process in Japan.

[3] In the U.S., for instance, because there is no survey of the "real" firm level, firm-level data is constructed by summing up inputs and outputs of establishments that belong to the same firm. This type of firm-level data can be called quasi firm-level data, because it could cause a lack of important information about firms' sales activities, R&D, and personnel management.

are provided in Appendix A and B respectively.

# 2 Theoretical background and empirical experiences

Entry and exit behavior is one of several choices a firm must make. Standard models of a firm's turnover under a competitive market situation, as depicted in Jovanovic (1982), Hopenhayn (1993), and Ericson and Pakes (1995), suggest that a firm enters (leaves) when entry (exit) is expected to contribute to the projected discounted future net cash flows. Calibration studies have played an essential role in support of this theory. Jovanovic and MacDonald (1994) applied an industry dynamics model to the U.S. automobile tire industry and showed that the model tracked actual movement of the number of firms very well. Pakes and Ericson (1998), using firm-level micro data of manufacturing and retail industries, showed the appropriateness of firm level dynamics models. Campbell (1998) focused on the relationship between business fluctuations caused by productivity shocks and a firm's entry/exit patterns, and showed calibrated numbers relative to the model "mimicking" the real U.S. economy.

Empirical analysis based on firm models is necessary for investigating whether NSM is working properly. The complexity of a rich theoretical model, however, makes it difficult to accomplish a direct statistical test of structural equations. Thus, empirical studies try to examine the feasibility of a firm model by testing the consistency between the model's implication and reality with entry/exit behavior. The model of Hopenhayn (1993), for instance, suggests that exiting firms have lower productivity than surviving firms and productivity distribution will be stochastically increasing in the age of the cohort. If a panel dataset that depicts firms' entry, surviving, and exit behavior is available, we can calculate productivity measures and test whether they really conform to the theory.

There are at least three necessary conditions that need to be met to make an empirical test on this issue truly useful. Firstly, datasets should be constructed completely at the firm level. A firm's entry and exit points are crucially important managerial decisions made by a firm itself. Besides, we must take account of increases of relative significance in non-production activities such as sales, R&D, and personnel affairs in manufacturing firms.[4] You must look at all of the

[4] According to Nakajima, Maeta and Kiyota (2000), a cost share of a non-production activities for major 54 electric machinery manufacturing firms was 35% on average in 1996. It is approximately 5 % point increase from 1985.

individual aspects of the firm when trying to reflect the firm as a whole. Only summing up the various elements of a firm does not sufficiently represent the firm for this study. Secondly, service sectors should also be included. The growing significance of non-manufacturing sectors is a general trend observed in most advanced economies. Finally, productivity should be measured in a general form. Labor productivity has the greatest popularity because of its easy calculation and interpretation, but that could be a biased indicator when a resource substitution effect exists. TFP, which is defined as the ratio of output to all input (or input index), has superiority over labor productivity because of its generality.

Viewing preceding empirical studies on a firm's entry, surviving, and exit issues, there are almost none to satisfy all of the above three conditions.[5] The critical lack of firm level surveys is inherent to all of the studies.[6] Baily, Hulten and Campbell (1992) and Haltiwanger (1997) utilized the Longitudinal Research Database and found plant-level entry/exit patterns had significant effects on the overall TFP growth of the U.S. manufacturing industry. Griliches and Regev (1995), focusing on the Israeli manufacturing industry (including mining), found the effects of firm turnover on industry-level labor productivity were quite small. Olley and Pakes (1996) utilized a firm dynamics model and confirmed that since the market liberalization in the 1980 of the telecommunications industry a plant's opening & shutdown dynamics made considerable contributions to the TFP progress in this industry. Aw, Chen and Roberts (2001), using the Taiwanese Census of Manufactures, showed that a firm's turnover made a considerable contribution to industry level TFP growth in Taiwan. Hahn (2000), based on establishment-level panel data for Korean manufacturing sector, derived the same conclusion as Aw et al. (2001).[7]

This paper is the first empirical analysis on this issue completely on a firm level, extending

[5]The only one example we are acquainted with is Bellone, Musso and Quéré (2003) targeting French manufacturing industry based on purely firm level panel data. They showed positive contribution of firm's turnover to industry level TFP growth.

[6]Dunne, Roberts and Samuelson (1988) compiled a panel dataset for the U.S. manufacturing industries by gathering the data of establishments within the same firm. For the Canadian manufacturing sector, Baldwin and Gorecki (1991) constructed a database with corresponding establishment information and identified various ways of entry and exit: plant birth, acquisition, or plant switch for entry and plant closing, divestiture, or plant switch for exit through the detailed cohort analysis. These two datasets are on a quasi-firm level, that is, aggregation of establishments.

[7]There are some empirical studies focusing on developing countries. Liu (1993) and Liu and Tybout (1996) measured plant level TFP and made a comparison between entry, surviving, and exiting plants for the Chilean and Colombian economies. The same analysis for Morocco was done by Tybout (1992). All of them concluded that a firm's turnover has a significant effect on macro level productivity growth.

the industry coverage to wholesale & retail trade and others, and based on TFP as an efficiency criterion. Furthermore, we focus only on "active firms" in *BSJBSA* to remove an upward bias of entry and exit caused by "dormant firms".[8] One common result among the preceding empirical works was that there were no negative contributions of a firm's turnover to macro TFP growth, which is strong evidence to support the effectiveness of NSM. This paper will answer the question whether the same result is obtained in the case of Japan during a serious recession.

# 3 Data

## 3.1 Data source

The main data source for the overall analysis in this paper is the micro data of *The Basic Survey of Japanese Business Structure and Activities* (*BSJBSA*) by the Ministry of Economy, Trade and Industry from 1994 to 1998. *BSJBSA* covers all the enterprises with 50 employees or more and greater than a 30 million yen capitalization and engaged in mining, manufacturing, wholesale & retail, or restaurant activities.[9] The Survey also covers firms in agriculture, construction, and various service industries, so long as they also engage at least partly in one of mining, manufacturing, wholesale and retail trade, or restaurant activities.[10] The first and second investigation years are 1991 and 1994 respectively. Only since 1994 has *BSJBSA* data been available for every year. There are four special features in *BSJBSA*.

Firstly, it is a survey of firms. Although rich micro data sources are now available in many countries like the U.S. and Canada, most of them are not based on surveys of firms but of establishments. Certainly establishment data sources are useful for the estimation of production or cost functions from the viewpoint of production technologies. A resource allocation within a firm, however, is determined as a result of managerial decisions. Information about establishments only, such as R&D, M&A, and re-organization, is hardly enough to handle the issues related to managerial strategies of a firm as a whole. In this sense *BSJBSA* provides quite

[8] Dunne et al. (1988) excluded the smallest firms from the sample for the same purpose.

[9] See Table 1 for industries that *BSJBSA* covers. The industry classification in the table is based on the System of National Accounts definition.

[10] The organization of Japanese ministries is vertically divided according to the industries of which they should take charge. METI is mainly in charge of manufacturing, electricity, and wholesale & retail trade industries and responsible for gathering their statistics.

Table 1: SNA industry classifications

| | | | |
|---|---|---|---|
| 1 | agriculture | 13 | transportation machinery |
| 2 | mining | 14 | precision machinery |
| 3 | foods | 15 | miscellaneous machinery |
| 4 | textile | 16 | construction |
| 5 | pulp & paper | 17 | electricity, gas & water |
| 6 | chemical | 18 | wholesale |
| 7 | petroleum & coal | 19 | retail |
| 8 | stone & clay | 20 | finance |
| 9 | primary metal | 21 | real estate |
| 10 | metal products | 22 | transportation & communications |
| 11 | general machinery | 23 | service |
| 12 | electric machinery | | |

valuable information to accomplish empirical studies on firm theory.

Secondly, code numbers are attached to all the samples for the identification in *BSJBSA*. Since the code is specific to each firm, we can easily trace it in time series and make a panel data set.

Thirdly, the data source covers a wide range of firm size. Although the utilization of the financial statements is another option to capture a firm's behavior, their availability is limited only to a company whose stock is listed on the stock exchange. *BSJBSA* does not have such a limitation; it is limited only in that it surveys firms with 50 employees or more and a capitalization in excess of 30 million yen.[11]

Finally, *BSJBSA* basically covers only "active firms" in the sense that they are truly engaged in regular business activities, because it imposes a lower limit on the firm size of 50 employees or more and 30 million yen in capital. Inclusion of "dormant firms," which exist just for purposes other than regular business, would lead to seriously biased results on a firm's entry and exit.

[11]However, a serious weakness exists in *BSJBSA* related to the analysis in this paper and that is a lack of information concerning a firm's duration. Suppose firms A and B were merged. There are three possibilities: (1) firm B was merged into A, (2) firm A was merged into B, and (3) they were merged to form a new firm, C. *BSJBSA* provides no information to identify which one actually occurred. It is certainly worth distinguishing the organizational expansion by self-reproduction from that by M&A. In case of (3) firm C should be obviously differentiated from a purely new firm.

## 3.2 Sample selection

*BSJBSA* has some samples with abnormally large or small values in answers to its questionnaires. However, it is difficult to identify which one is a "real" error, because it could be a true value containing worthy information. In this paper we exclude samples that have logically inconsistent values from the data set. A sample is regarded inconsistent if it fits one of the following three cases: (1) at least one of the values of regular workers, investment, capital, debt, identification code, and industry code is missing, (2) at least one of the values of firm age (the year of establishment minus the year of investigation), labor compensation, tangible fixed asset, the number of main offices, and gross value added is missing or negative, and (3) the number of regular workers (including part-time workers) is less than that of part-time workers.

## 3.3 Definitions of entry and exit

In *BSJBSA*, entry and exit are defined as appearance in and disappearance from *BSJBSA* respectively. Entry and exit under this definition do not necessarily correspond to origin and termination, respectively, because, as is mentioned above, samples in *BSJBSA* are censored. Also, we have considerable numbers of re-entry firms that disappear once and re-appear. *BSJBSA* provides no information to identify types of a firm's entry/exit and re-entry behavior. [12]

To solve the complexity, we present our own definitions of entry, exit, and surviving firms in our data set as follows.

1. Appearance in *BSJBSA* with a new identification code is defined as entry.
2. Reappearance in *BSJBSA* with the same identification code as before is also defined as entry.[13]
3. Either temporary or permanent disappearance from *BSJBSA* is defined as exit.
4. Continuing firms are defined as those which stay in *BSJBSA* for at least two consecutive years.

[12] More detailed explanations about this issue are provided in Appendix A.

[13] One might regard this procedure too extreme. We have examined robustness of our results with respect to this procedure and found qualitatively the same result was obtained when we adopted other procedures. See Appendix A.

The panel data set constructed based on the definitions above is definitely unbalanced. Hereafter, we call this data set the N2K (Nishimura-Nakajima-Kiyota) panel, which is utilized for the empirical studies in the following sections.

# 4 Entry/exit behavior of Japanese firms

Previous studies about the entry and exit of Japanese firms have pointed out that there are relatively few in the post World War II period, compared with pre-War periods and other countries. For instance, Nishimura and Kawamoto (2003), utilizing *Company Statistics* (Ministry of Commerce and Industry) and *Establishment and Enterprise Census* (Ministry of Management and Coordination), showed the exit rate of the Japanese firms was less than 1% after 1987 as compared with 6-9% at the pre-war period. (See Table 2) This evidence seems to strongly support the common conviction that firms' entries and exits are relatively rare in Japan. This subsection presents observations like Nishimura and Kawamoto based on *Company Statistics* and *Establishment and Enterprise Census* that could underestimate firms' "economically meaningful" entry and exit behavior.

In popular terminology, "exit" means a complete closure of business. However, according to this definition, "dormant" firms with no significant business but which are not closed are classified as continuing firms. It is well known in Japan that there are a sizable number of "dormant firms" existing simply for tax-shelter and/or other purposes, though it is very difficult to determine the number of such dormant firms.

In economic analysis of productivity, we are concerned not with dormant firms, but "active" firms. In this respect, entry and exit numbers presented in the previous studies, based on Company Statistics and the like, are misleading since they contain many dormant firms. In contrast, in *BSJBSA*, where firms with 50 employees or more and a capitalization in excess of 30 million yen are investigated, these firms are likely to be "active." Thus, the entry/exit behavior observed in the N2K panel illustrates the dynamics of "active firms" as properly defined.

Table 3 depicts how firms originated in a certain year have survived since then.[14] While the

[14]Since there is a two-year blank in investigation between the first investigation (in 1991) and the second investigation (in 1994), a sample identified as a closing firm in 1994 in *BSJBSA* would have already disappeared in 1992 or 1993. We calculated survival rates in 1994 for "before 1991 entry" cohort on an annual basis by dividing original hazard rates by three.

Table 2: Creation and destruction of Japanese enterprises

Source: Nishimura and Kawamoto (2003)

**Pre-World War II Era**

| year | All Indsutries | By Industry | | | | | |
|---|---|---|---|---|---|---|---|
| | | Agriculture | Fisheries | Mining | Mamufac-turing | Commerce | Transport |
| Rate of Net Increase | | | | | | | |
| *1924-28* | 5.38% | 2.70% | 2.03% | 1.17% | 3.51% | 6.49% | 9.04% |
| *1934-40* | 0.40% | -6.55% | -0.43% | 16.62% | 3.09% | -1.88% | 2.75% |
| Rate of Creation (Rate of New Enterprises) | | | | | | | |
| *1924-28* | 10.93% | 6.30% | 8.29% | 5.34% | 9.55% | 11.98% | 13.22% |
| *1936-40* | 9.25% | 5.09% | 7.79% | 19.93% | 11.32% | 7.76% | 9.88% |
| Rate of Destruction (Estimated) | | | | | | | |
| *1924-28* | 6.65% | 3.97% | 6.70% | 4.35% | 6.80% | 6.83% | 5.69% |
| *1936-40* | 8.97% | 9.43% | 8.10% | 5.77% | 9.09% | 9.07% | 7.81% |

Source: Shoko Sho (Ninistry of Commerce and Industry), *Kaisha-Tokei (Company Statistics)* , 1929 (22-25, 258-261), 1930 (22-25, 260-263), and 1945 (22-25, 364-365).

Notes: The rate of net increase is the change in the number of existing companies at the end of the fiscal year. The rate of creation is the ratio of newly-establised companies to the existing companies. The rate of destruction is estimated from the rate of creation and the rate of net increase. The rates are the average of annual rates.

**Post-World War II Era**

| year | All industries | By Industry | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Construc-tion | Manufac-turing | Wholesale Trade | Retail Trade | Eating and Drinking Places | Services | Miscella-neous |
| Rate of Net Increase | | | | | | | | |
| *1981-86* | 2.31% | 3.17% | 1.18% | 1.97% | 1.49% | 1.23% | 5.31% | 3.08% |
| *1987-91* | 3.25% | 5.26% | 2.09% | 1.66% | 1.30% | 4.53% | 6.04% | 4.72% |
| *1992-96* | 1.41% | 3.92% | -0.30% | -1.20% | 1.80% | 1.21% | 2.87% | 1.42% |
| Rate of Creation (Estimated) | | | | | | | | |
| *1981-86* | 3.52% | 5.46% | 2.25% | 3.56% | 2.25% | 1.90% | 6.10% | 4.11% |
| *1987-91* | 3.76% | 5.98% | 2.53% | 2.48% | 1.62% | 4.80% | 6.39% | 5.28% |
| *1992-96* | 2.12% | 4.90% | 0.44% | -0.08% | 2.16% | 1.55% | 3.40% | 2.19% |
| Rate of Destruction (Bunkruptcy Rate) | | | | | | | | |
| *1981-86* | 1.33% | 2.58% | 1.12% | 1.72% | 0.82% | 0.70% | 0.97% | 1.16% |
| *1987-91* | 0.57% | 0.88% | 0.48% | 0.88% | 0.33% | 0.33% | 0.44% | 0.68% |
| *1992-96* | 0.75% | 1.14% | 0.73% | 1.07% | 0.38% | 0.35% | 0.59% | 0.82% |

Source: For, net increase and creation, Somu Cho (Management and Coordination Agency), *Jigyosho Kigyo Tokei (Establishement and Enterprise Census)* , 1981 (Vol. 3, Table 3), 1986 (Vol. 3, Part 1, Table 4), 1991 (Vol. 3, Table 4), 1996 (Vol. 3-1, Table 3). For destruction, Chusho Kigyou Jigyoudan (Japan Small and Medium Enterprise Corporation), *Kigyou Tousan Chousa Nenpou (Annual Reprt of Bunkruptcy companies)* , 1990 (Table 14-1) and 1997 (Table 14-1).

Notes: The rate of net increase is change in the number of existing companies at the each survey date. The survey of existing companies was undertaken as of July 1 in 1981, 1986, and 1991 and October 1 in 1996. The number of destruction is calculated at the end of fiscal year. Destruction means disposition by suspension of bank credit, [legal] bankruptcy, an application for composition, a ruling of reorganization and rehabilitation or a ruling of liquidation. For destruction of enterprises with the total amount of the dept under ten million yen, 215 major cities are surveyed, while the whole country is surveyed for destruction with the total amount of the dept no less than ten million yen. Thus, the rate of destruction is slightly underestimated since destruction in small cities may not be properly counted. The rate of creation is estimated from the rate of destruction and the rate of net increase. The rates are the average of annual rates.

Table 3: Entry and exit patterns in the N2K panel

| | Cohorts | | | | | |
|---|---|---|---|---|---|---|
| | Entry | | | | | |
| | before 1991 | in 1994 | in 1995 | in 1996 | in 1997 | in 1998 |
| Number of firms | | | | | | |
| 1991 | 23,914 | | | | | |
| 1994 | 19,923 | 4,870 | | | | |
| 1995 | 18,227 | 3,876 | 3,844 | | | |
| 1996 | 16,970 | 3,361 | 3,054 | 2,433 | | |
| 1997 | 15,689 | 2,928 | 2,553 | 1,802 | 2,809 | |
| 1998 | 14,610 | 2,607 | 2,233 | 1,507 | 2,178 | 2,670 |
| Entry and Exit rate (%) | | | | | | |
| Entry | | 20.4 | 15.5 | 9.4 | 10.9 | 10.4 |
| Exit | | 16.7 | 10.8 | 9.9 | 11.0 | 10.3 |
| Unconditional survival rate (%) | | | | | | |
| 1991 | 100.0 | | | | | |
| 1994 | 94.1 | 100.0 | | | | |
| 1995 | 76.2 | 79.6 | 100.0 | | | |
| 1996 | 71.0 | 69.0 | 79.4 | 100.0 | | |
| 1997 | 65.6 | 60.1 | 66.4 | 74.1 | 100.0 | |
| 1998 | 61.1 | 53.5 | 58.1 | 61.9 | 77.5 | 100.0 |
| Conditional survival rate (%) | | | | | | |
| 1991 | 100.0 | | | | | |
| 1994 | 83.3 | 100.0 | | | | |
| 1995 | 91.5 | 79.6 | 100.0 | | | |
| 1996 | 93.1 | 86.7 | 79.4 | 100.0 | | |
| 1997 | 92.5 | 87.1 | 83.6 | 74.1 | 100.0 | |
| 1998 | 93.1 | 89.0 | 87.5 | 83.6 | 77.5 | 100.0 |

Notes: 1) An unconditional survival rate stands for a ratio of the number of surving firms to that in the original entry year.
2) A conditional survival rate stands for a ratio of the number of surviving firms to that in the previous year.
3) Values in 1994 are annual means. Values in 1991 show the number of firms born exactly in 1991 and before then.

Source: N2K Panel data

"unconditional" rate is a ratio of the number of surviving firms to the number of firms in their entry year, "conditional" means a comparison with the previous year.

From the table, we obtain three outstanding findings. Firstly, survival rates just after entry are quite low. More than 20% of new entrants exit from the pool of active firms within the next year, and 30% exit within two years later. Secondly, entry/exit rates are very high unlike Nishimura and Kawamoto (2003) findings. This result shows that Japanese firms of certain employment levels and capital sizes have been more frequently taking actions of entry and exit than observed in the previous studies. This result suggests that low entry/exit rates of previous studies, including dormant firms, may be misleading with respect to entry and exit of economically "active" firms.[15] Finally, survival probabilities rise as time passes. For a firm to live for a long time, it has to overcome difficulties in its infancy.

It should be emphasized here that the results in Table 3 are comparable with those for the U.S. and Canada with some reservations.[16] The entry rates of 10 to 20% in Table 3 are much higher than the Canadian case (2 to 7%), but less than the U.S. case (30 to 50%). The same relationship holds for the exit rates of the three countries, although Canada showed 10.1% exit rate in 1981 (Table 2, p.308), which is very close to that of Japan. On the contrary, surviving rates are primarily the same for the three economies. The five-year- (four-year in case of Japan) surviving rate of the entry cohort is 40 to 60% for the U.S., 40% for Canada (1970 cohort), and 47% for Japan (1994 cohort).

# 5 Entry/exit and TFP

Resemblance and difference in entry/exit patterns alone are not enough to evaluate NSM of the Japanese economy. In this section we examine whether firms with relatively higher performance survive and those with lower performance exit. Among various measures of firm performance, total factor productivity (TFP) is chosen in this paper. Although labor productivity has great

[15] A careful reader might point out that the N2K panel overestimates entry/exit frequencies because it treats re-entry firms as new entrants. To confirm whether this N2K data processing is influential or not, refer to Table A1 in Appendix based on the original *BSJBSA* data set. According to the row 52 to 58, there exist 382 firms that appear in 1994, disappear in 1995, and reappear after 1996. Even if these firms are taken into account in Table 3, more than 10% of firms originating in 1994 closed within one year.

[16] Dunne et al. (1988) covers all plants and their subsidiary firms except the smallest firms (e.g. one employee firms) in the U.S. manufacturing industry. Baldwin and Gorecki (1991) also constructed dataset on manufacturing plants and firms in Canada. Covering periods are 1963 to 1982 for the U.S., 1970 to 82 for Canada.

popularity because of its easy handling, TFP is preferable from the viewpoint of comprehensiveness. In particular, we analyze the issue in two respects. Firstly, we examine whether less productive firms quit from the market. Secondly, we investigate how firms' turnover affects the aggregate or macro TFP growth.

## 5.1 TFP measurement results

First we show the basic results of macro (industry) level TFP in Table 4.[17] The numbers are measured in terms of logarithms. The macro level TFP in the table is calculated from firm level TFP as follows.

$$\ln \widetilde{\mathrm{TFP}}_t = \sum_i v_t^i \ln \mathrm{TFP}_t^i, \tag{1}$$

where $v_t^i$ stands for value added share for firm $i$ at term $t$. According to Olley and Pakes (1996), the equation (1) can be rewritten as

$$\begin{aligned} \ln \widetilde{\mathrm{TFP}}_t = \ln \overline{\mathrm{TFP}}_t + \sum_i \Delta v_t^i \Delta \ln \mathrm{TFP}_t^i, \\ \Delta v_t^i = v_t^i - \bar{v}_t \\ \Delta \ln \mathrm{TFP}_t^i = \ln \mathrm{TFP}_t^i - \ln \mathrm{TFP}_t, \end{aligned} \tag{2}$$

where $\bar{v}_t$ is an arithmetic mean of firm's value added share at time $t$. The first term is non-weighted mean of firms' TFP and the second term is covariance of firms' TFP and value-added share. The value of the second term will be positive (negative) if there is a positive (negative) correlation between a firm size and TFP.

Table 4 shows the results of macro (industry) level TFP and its decomposition based on (2) for ten major industries.[18] The value of a covariance term is positive for all industries throughout the observation period, which implies that the firm-level economies of scale are widely observed in major industries that *BSJBSA* covers. It has been repeatedly confirmed that there exist economies of scale at establishment level in the Japanese manufacturing industry.[19]

[17] The calculation method of TFP including input/output definitions and data sources is described in Appendix B.

[18] We note that value added share $v_t^i$ used at the calculation in Table 4 is the ratio of firm $i$ 's nominal value added to total nominal value added of the "industry" that firm $i$ belongs to.

[19] See, for example, Nakajima, Nakamura and Yoshioka (1998).

Table 4: Industry level TFP and its decomposition

| | Industry level lnTFP | Non-weighted mean lnTFP | Covariance | | Industry level lnTFP | Non-weighted mean lnTFP | Covariance |
|---|---|---|---|---|---|---|---|
| **Food products and beverages** | | | | **Transportation machinery** | | | |
| 1994 | 0.639 | -0.176 | 0.815 | 1994 | 0.097 | -0.072 | 0.169 |
| 1995 | 0.721 | -0.136 | 0.857 | 1995 | 0.236 | -0.049 | 0.285 |
| 1996 | 0.724 | -0.134 | 0.858 | 1996 | 0.281 | -0.087 | 0.368 |
| 1997 | 0.753 | -0.140 | 0.892 | 1997 | 0.219 | -0.123 | 0.343 |
| 1998 | 0.756 | -0.131 | 0.887 | 1998 | 0.101 | -0.234 | 0.335 |
| **Textiles** | | | | **Precision machinery** | | | |
| 1994 | 0.037 | -0.237 | 0.275 | 1994 | -0.123 | -0.154 | 0.031 |
| 1995 | 0.167 | -0.169 | 0.336 | 1995 | -0.035 | -0.086 | 0.051 |
| 1996 | 0.079 | -0.196 | 0.275 | 1996 | 0.035 | -0.073 | 0.108 |
| 1997 | 0.120 | -0.215 | 0.335 | 1997 | 0.110 | -0.106 | 0.215 |
| 1998 | 0.049 | -0.277 | 0.326 | 1998 | 0.211 | -0.041 | 0.252 |
| **Chemicals** | | | | **Wholesale trade** | | | |
| 1994 | 0.552 | 0.207 | 0.345 | 1994 | 0.542 | 0.025 | 0.517 |
| 1995 | 0.674 | 0.229 | 0.445 | 1995 | 0.519 | 0.057 | 0.462 |
| 1996 | 0.808 | 0.306 | 0.501 | 1996 | 0.554 | 0.084 | 0.470 |
| 1997 | 0.884 | 0.351 | 0.533 | 1997 | 0.544 | 0.082 | 0.462 |
| 1998 | 0.831 | 0.330 | 0.501 | 1998 | 0.655 | 0.166 | 0.490 |
| **General machinery** | | | | **Retail trade** | | | |
| 1994 | 0.195 | -0.116 | 0.311 | 1994 | -0.152 | -0.273 | 0.121 |
| 1995 | 0.385 | -0.018 | 0.403 | 1995 | -0.086 | -0.245 | 0.160 |
| 1996 | 0.445 | -0.015 | 0.460 | 1996 | -0.066 | -0.236 | 0.170 |
| 1997 | 0.390 | 0.005 | 0.384 | 1997 | -0.091 | -0.268 | 0.177 |
| 1998 | 0.429 | -0.065 | 0.494 | 1998 | -0.073 | -0.195 | 0.122 |
| **Electrical machinery** | | | | **Construction** | | | |
| 1994 | 0.273 | -0.193 | 0.466 | 1994 | 0.179 | 0.119 | 0.060 |
| 1995 | 0.391 | -0.055 | 0.445 | 1995 | 0.303 | 0.054 | 0.250 |
| 1996 | 0.692 | 0.058 | 0.634 | 1996 | 0.219 | 0.093 | 0.126 |
| 1997 | 0.815 | 0.173 | 0.642 | 1997 | 0.240 | 0.057 | 0.183 |
| 1998 | 0.664 | 0.166 | 0.498 | 1998 | 0.347 | 0.050 | 0.296 |

Source: N2K Panel Data

Table 5: Growth rates of non-weighted means of firm TFP for industries

| | 1994-95 | 1995-96 | 1996-97 | 1997-98 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 0.370 | 0.219 | -0.102 | 0.051 |
| Mining | 0.097 | 0.076 | 0.086 | -0.043 |
| Food products and beverages | 0.040 | 0.005 | 0.006 | 0.010 |
| Textiles | 0.048 | -0.034 | -0.036 | -0.066 |
| Pulp, paper and paper products | 0.024 | 0.010 | 0.038 | -0.034 |
| Chemicals | 0.021 | 0.062 | 0.046 | -0.030 |
| Petroleum and coal products | 0.045 | 0.071 | 0.024 | -0.090 |
| Non-metallic mineral products | 0.064 | 0.010 | 0.033 | -0.095 |
| Iron, Steel and non-ferrous metals | 0.034 | 0.062 | 0.009 | -0.108 |
| Fabricated metal products | 0.056 | -0.001 | -0.020 | -0.038 |
| General machinery | 0.088 | 0.012 | 0.032 | -0.061 |
| Electrical machinery | 0.134 | 0.104 | 0.101 | -0.035 |
| Transportation machinery | 0.033 | -0.040 | -0.027 | -0.103 |
| Precision machinery | 0.072 | 0.020 | -0.024 | 0.052 |
| Other manufacturing | 0.050 | 0.041 | -0.009 | -0.044 |
| Construction | -0.074 | 0.024 | -0.021 | -0.041 |
| Electricity, gas and water supply | -0.002 | -0.047 | 0.201 | -0.042 |
| Wholesale trade | 0.030 | 0.016 | -0.006 | 0.082 |
| Retail trade | 0.025 | 0.013 | -0.026 | 0.073 |
| Finance and insurance | 0.385 | 0.264 | 0.042 | 0.049 |
| Real estate | 0.205 | 0.017 | -0.041 | -0.082 |
| Transport and communications | -0.024 | 0.008 | 0.180 | 0.114 |
| Service activities | 0.024 | 0.067 | -0.019 | 0.030 |

Source: N2K panel data

At the firm level, on the other hand, it seems ambiguous, because we have few empirical studies on this issue.[20] The result in Table 4 is the first evidence to show large firms' relative efficiency.

Table 5 summarizes annual growth rates of non-weighted means of firm TFP for industries. Until 1996 positive changes had been widely observed. TFP downturn started from 1996 to 1997 and spread over the entire industry in 1998.

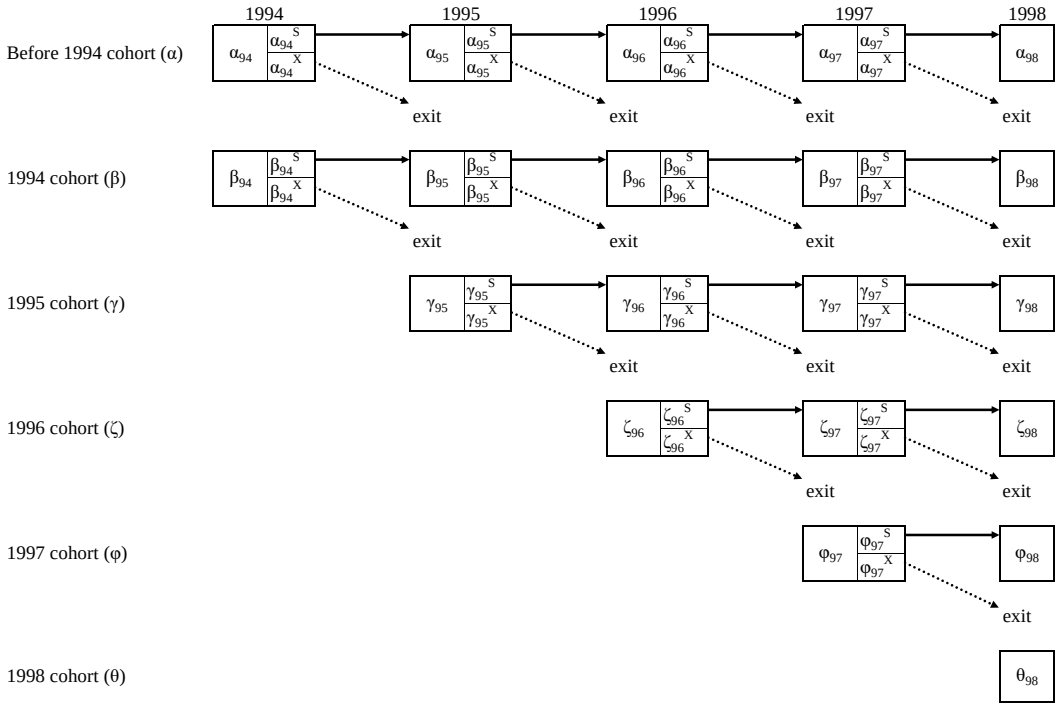
## 5.2 Cohort analysis of TFP

***How does NSM work in the market?***

If economic Darwinism is applicable to the market economy, those organizations, which are efficient in the business environment, will drive others out. In other words, firms with high productivity would survive while those with low productivity would exit. As a matter of fact,

[20] Nakajima, Nakamura, Nakamura and Nakamura (2003) shows economies of scale are not widely observed for enterprises listed on the Tokyo Stock Exchange.

Figure 1: Grouping of firms according to entry-cohort



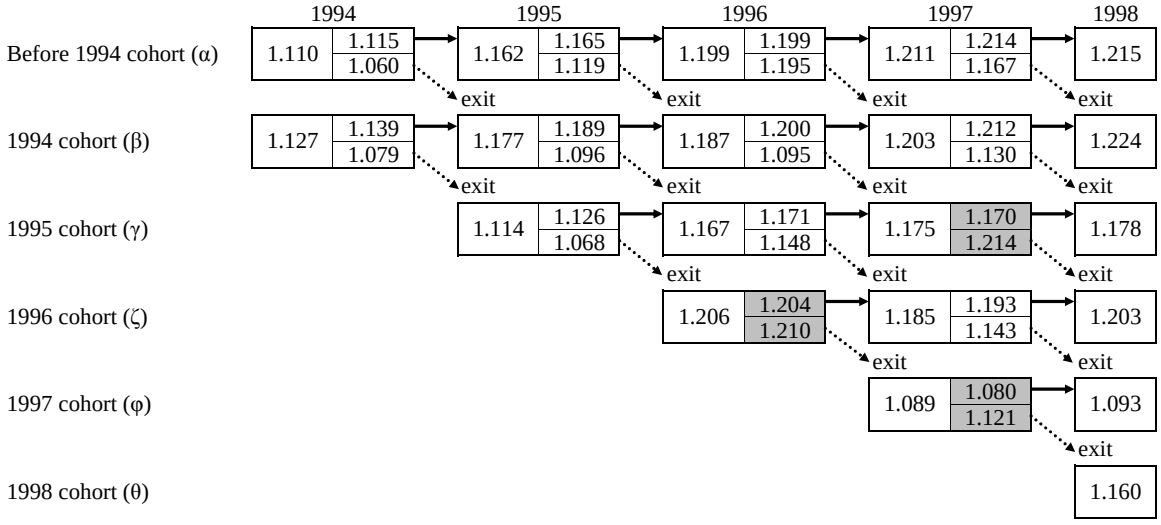

the efficiency of a competitive market economy is based on NSM. In this subsection we examine whether NSM worked in the Japanese market in the 1990s.

Figure 1 illustrates the classification of firms according to the information about when they appear in *BSJBSA* and disappear.[21] Greek letters from $\alpha$ to $\theta$ identify the entry years of firms. Subscript numbers point to the years when firms exist in *BSJBSA*. To illustrate, $\gamma_{96}$ means a group of firms that appeared in 1995 and at least existed in 1996. Superscripts, S and X, indicate "surviving" and "exit" firms in a group of firms in the year of a subscript number. Firms of group $\beta^X_{97}$, for example, entered in 1994, at least existed in 1997, and disappeared in 1998.

Table 6 displays (non-weighted) arithmetical means of TFP indices for classified firms in Figure 1. Differences between mean values of surviving and exiting firms are *not* significant at least at the 5% level except $\alpha_{94}$. Shaded areas just show that the TFP of exiting firms is

[21] We have referred to Aw et al. (2001) to draw the figure.

Table 6: TFP for entry, surviving, and exit firms




Note: Shaded areas indicate a non-weighted mean of TFP of exiting firms is greater than that of surviving firms.

greater than that of surviving firms. Although significant differences are not observed, we can collect some noteworthy messages from the table. For the cohort of before-1994, 1994, and 1995 entrants, TFP levels of "active firms" have been increasing yearly while less productive firms exit. This is consistent with the implication derived from the model in Olley and Pakes (1996) and the empirical results from Tybout (1992), which show the market mechanism was appropriately working at that time. On the other hand, the TFP cohort of 1996 entrants shows the opposite direction of change to 1997, because more productive infant firms had exited before 1997. For 1997 entrant's cohort the same tendency is observed. These results may suggest a malfunction of NSM in Japan since 1996.

***Observation on industry level***

To assess the effectiveness of NSM at industry levels, we should consider an additional channel of entry and exit. It is a switchover from one industry to another. Suppose firm A converts its main product from X to Y. It will be re-classified and treated as an exit firm in X industry and an entry firm in Y. Because firm A is obviously different from a "real" or greenfield entry firm in the Y industry, it is desirable to distinguish firms such as A from others.

We selected three industries: manufacturing, wholesale & retail, and construction and made calculations of non-weighted mean TFP indices for entry, surviving, switching, and exiting firms as shown in Table 7. Shaded areas indicate TFP indices of switching out and exiting firms are higher than those of surviving firms at a 5% significance level. Results in manufacturing industries are in sharp contrast with those in wholesale & retail industries. In manufacturing industries, less productive firms have exited from the pool of active firms, while more productive firms have shifted to other industries (and thus become entry firms with higher productivity). In wholesale and retail trade industries surviving firms have shown lower TFP than exiting firms and more productive firms have shifted from these industries. These findings suggest NSM is effectively working in manufacturing industries, but it is not in wholesale and retail industries. In contrast, few significant differences between surviving, switching, and exiting firms are found in the construction sector.[22]

## 5.3 Effect of entry/exit on industry level TFP

If there is neither entry/exit nor switch-in/out, industry level TFP growth rate in the equation (1) shows a consistent decomposition into the contribution of each firm's TFP growth and that of a change in its value-added share.

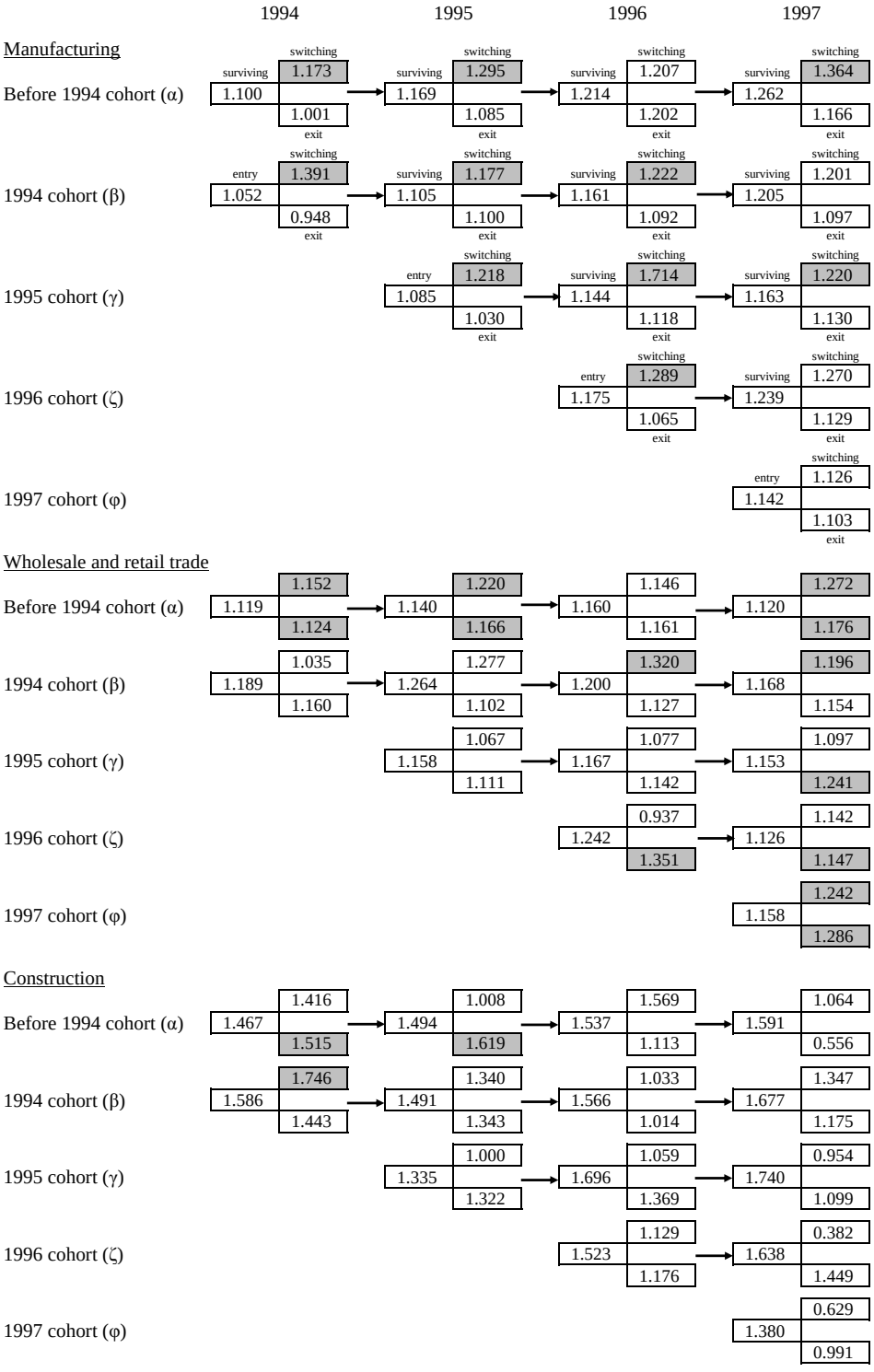
$$\begin{aligned}
\ln \widetilde{\mathrm{TFP}}_{t+1} - \ln \widetilde{\mathrm{TFP}}_t &= \sum_i v^i_{t+1} \ln \mathrm{TFP}^i_{t+1} - \sum_i v^i_t \ln \mathrm{TFP}^i_t \\
&= \sum_i \left( \frac{v^i_t + v^i_{t+1}}{2} \right) \left( \ln \mathrm{TFP}^i_{t+1} - \ln \mathrm{TFP}^i_t \right) \qquad (3) \\
&\quad + \sum_i \left( \frac{\ln \mathrm{TFP}^i_t + \ln \mathrm{TFP}^i_{t+1}}{2} \right) \left( v^i_{t+1} - v^i_t \right) \qquad (4)
\end{aligned}$$

The second term of the above expression is called "re-allocation effect" because a gain in market share by a productive firm makes a positive contribution to macro level TFP.

The decomposition of (4), however, is not applicable to unbalanced panel data containing firms of entry/exit and switch-in/out. A more general decomposition formula, including the

[22] We should be careful to interpret the result of the construction sector, however. As shown before, construction firms in *BSJBSA* are mostly small and medium size enterprises that also engage in manufacturing as their minor activities.

Table 7: Non-weighted mean TFP for entry, switching, and exit firms




Note: Shaded areas indicate TFP indices of switchinging and exiting firms are higher than those of surviving firms at 5% significant level.

effect of entry and exit firms, is given by Griliches and Regev (1995) as follows.

$$\begin{aligned}
\ln \widetilde{\mathrm{TFP}}_{t+1} - \ln \widetilde{\mathrm{TFP}}_t = & \left( \frac{v_t^X + v_{t+1}^E}{2} \right) \left( \ln \mathrm{TFP}_{t+1}^E - \ln \mathrm{TFP}_t^X \right) \\
& + \left( \frac{v_t^I + v_{t+1}^O}{2} \right) \left( \ln \mathrm{TFP}_{t+1}^I - \ln \mathrm{TFP}_t^O \right) \\
& + \sum_{i \in C} \left[ \left( \frac{v_t^i + v_{t+1}^i}{2} \right) \left( \ln \mathrm{TFP}_{t+1}^i - \ln \mathrm{TFP}_t^i \right) \right] \\
& + \left( \frac{\ln \mathrm{TFP}_{t+1}^E + \ln \mathrm{TFP}_t^X}{2} \right) \left( v_{t+1}^E - v_t^X \right) \\
& + \left( \frac{\ln \mathrm{TFP}_{t+1}^I + \ln \mathrm{TFP}_t^O}{2} \right) \left( v_{t+1}^I - v_t^O \right) \\
& + \sum_{i \in C} \left[ \left( \frac{\ln \mathrm{TFP}_{t+1}^i + \ln \mathrm{TFP}_t^i}{2} \right) \left( v_{t+1}^i - v_t^i \right) \right], \qquad (5)
\end{aligned}$$

where the superscripts $E$, $X$, $I$, and $O$ symbolize entry, exit, switch-in, and switch-out firms respectively.[23] The first term stands for the effect of the TFP difference between entry and exit firms that becomes positive (negative) when TFP for entry firms is higher (lower) than exit firms. The same effect in the case of switch-in and out firms is shown in the second term. The third term is the contribution of surviving firms' TFP growth. The forth, fifth, and sixth terms mean "re-allocation effects" through entry/exit and switch-in/out channels and changes in market shares for surviving firms respectively.

The decomposition results for major industries are shown in Table 8. For most industries especially major manufacturing sectors, continuing firms' performances are quite influential to industry level TFP growth. At this point our results are consistent with the results of preceding studies like Griliches and Regev (1995) and Haltiwanger (1997). The effect of switch-in/out is an indicator to investigate whether relatively productive firms come from or go out to other sectors. Looking at the numbers in the third column, there is no industry with constantly positive or negative effects. The effect of market share reallocation in the forth column is positive when resources are shifted from less productive to more productive firms. The numbers, however, are mostly negative, especially for chemicals, transportation machinery, precision machinery, and

[23] Productivity levels $\ln \mathrm{TFP}_{t+1}^E$, $\ln \mathrm{TFP}_t^X$, $\ln \mathrm{TFP}_{t+1}^I$, and $\ln \mathrm{TFP}_t^O$ are value added share weighted means of TFP for entry, exit, switch-in, and switch-out firms between $t$ and $t+1$ respectively.

Table 8: Decomposition of macro level TFP growth rate

| | TFP growth | Continuing firms | Switch-in vs. switch-out | Market share reallocation | Entry vs. exit |
|---|---|---|---|---|---|
| **Food products and beverages** | | | | | |
| 1994-95 | -0.036 | 0.084 | 0.028 | -0.196 | 0.048 |
| 1995-96 | -0.067 | 0.008 | 0.018 | -0.126 | 0.033 |
| 1996-97 | 0.117 | 0.050 | -0.038 | 0.138 | -0.033 |
| 1997-98 | 0.041 | -0.008 | -0.026 | 0.071 | 0.004 |
| **Textiles** | | | | | |
| 1994-95 | 0.125 | 0.102 | 0.040 | -0.016 | -0.001 |
| 1995-96 | -0.085 | -0.062 | -0.007 | 0.008 | -0.025 |
| 1996-97 | 0.094 | -0.003 | 0.040 | 0.096 | -0.039 |
| 1997-98 | 0.014 | -0.020 | -0.153 | 0.197 | -0.010 |
| **Chemicals** | | | | | |
| 1994-95 | -0.008 | 0.121 | 0.019 | -0.186 | 0.037 |
| 1995-96 | 0.209 | 0.128 | -0.007 | 0.095 | -0.007 |
| 1996-97 | 0.056 | 0.050 | 0.091 | -0.026 | -0.058 |
| 1997-98 | -0.073 | -0.069 | -0.006 | -0.012 | 0.014 |
| **General machinery** | | | | | |
| 1994-95 | 0.194 | 0.197 | -0.057 | 0.022 | 0.032 |
| 1995-96 | 0.044 | 0.053 | 0.008 | -0.032 | 0.015 |
| 1996-97 | 0.057 | -0.058 | -0.017 | 0.167 | -0.035 |
| 1997-98 | -0.045 | -0.037 | 0.118 | -0.111 | -0.015 |
| **Electrical machinery** | | | | | |
| 1994-95 | 0.072 | 0.108 | 0.013 | -0.075 | 0.026 |
| 1995-96 | 0.280 | 0.295 | 0.009 | -0.013 | -0.011 |
| 1996-97 | 0.219 | 0.094 | -0.015 | 0.157 | -0.017 |
| 1997-98 | -0.148 | -0.115 | -0.058 | 0.012 | 0.013 |
| **Transportation machinery** | | | | | |
| 1994-95 | 0.118 | 0.142 | -0.002 | -0.027 | 0.004 |
| 1995-96 | 0.079 | 0.026 | -0.001 | 0.059 | -0.005 |
| 1996-97 | -0.066 | -0.053 | 0.004 | -0.011 | -0.006 |
| 1997-98 | -0.133 | -0.133 | 0.003 | -0.011 | 0.008 |
| **Precision machinery** | | | | | |
| 1994-95 | 0.151 | 0.021 | -0.038 | 0.120 | 0.048 |
| 1995-96 | 0.070 | 0.013 | 0.051 | -0.002 | 0.008 |
| 1996-97 | 0.043 | 0.025 | 0.126 | -0.060 | -0.048 |
| 1997-98 | 0.039 | 0.041 | -0.042 | -0.098 | 0.138 |
| **Wholesale trade** | | | | | |
| 1994-95 | -0.042 | -0.026 | -0.006 | -0.042 | 0.031 |
| 1995-96 | 0.036 | 0.028 | -0.001 | -0.025 | 0.035 |
| 1996-97 | -0.012 | -0.012 | 0.015 | -0.003 | -0.011 |
| 1997-98 | 0.102 | 0.124 | -0.004 | -0.014 | -0.003 |
| **Retail trade** | | | | | |
| 1994-95 | 0.003 | 0.061 | 0.020 | -0.124 | 0.046 |
| 1995-96 | 0.038 | 0.019 | 0.001 | 0.028 | -0.010 |
| 1996-97 | 0.010 | -0.007 | -0.027 | 0.080 | -0.035 |
| 1997-98 | 0.028 | 0.024 | -0.003 | 0.014 | -0.007 |
| **Construction** | | | | | |
| 1994-95 | -0.004 | -0.105 | 0.307 | -0.203 | -0.002 |
| 1995-96 | -0.028 | -0.133 | 0.048 | 0.098 | -0.041 |
| 1996-97 | 0.183 | -0.060 | -0.015 | 0.346 | -0.088 |
| 1997-98 | 0.030 | -0.026 | 0.207 | -0.133 | -0.019 |

Source: N2K Panel Data

wholesale trade sectors, which illustrates that resource misallocation among existing firms has been occurring in the Japanese market. Finally, the entry/exit effect has negative values for many cases. Textile and construction industries especially show constantly negative contributions to industry level TFP growth. For other industries, values from 1996 to 97 are negative. This finding, consistent with the results in Table 6 and 7, indicates there were wide occurrences of market malfunction at that time.

As was discussed in Section 2, preceding studies have shown diversified results on entry/exit contribution according to the target economies. In the case of Japan, continuing firms' TFP has been influential to industry level TFP and this is similar to the U.S. manufacturing industry. What should be emphasized here, however, is that a firm's turnover effect was negative and an efficient resource allocation system through a firm's entry/exit channels seems to have been functioning poorly in terms of TFP growth.

## 5.4 Discussion

Well-functioning financial markets are important in easing firms' entry, survival, and exit behavior. While banks and venture capital help entrepreneurs to get started, declining stock prices and withdrawal of bank loans force firms to leave their competitive market. Among the several avenues for a firm to raise funds, loans from banks still have nearly a 40% share of total funds for commercial firms in Japan, although its relative dominance has been decreasing steadily.[24] Thus, some evidences of market malfunctioning as shown in the previous section can be interpreted in connection with serious non-performing loan problems within the Japanese banking system.

As in Stiglitz and Weiss (1981), credit rationing itself could occur because of asymmetric information between lenders and borrowers even if financial markets are functioning properly. The real problem is whether funds go to productive firms. Cabinet Office (2001) pointed out that serious credit shrinking occurred in 1996 as a result of the unwillingness of banks to loan the available decreasing capital which had been badly damaged by decreasing stock prices since the burst of bubble. Even with low interest rates, investment in small and medium sized firms fell in 1997 and 1998. There is additional suggestive evidence provided in Figure 2-2-6 of

[24] See Hoshi and Kashyap (1999) for more details about the structural change in the Japanese financial markets since 1980s.

Cabinet Office (2001) which shows that TFP of sectors with the larger share of banking loans has been lower than the national level of TFP since 1985, and the gap between the two expanded in 1996.[25] This observation coincides exactly with our results.

These findings also have theoretical backgrounds. Kobayashi, Saita and Sekine (2002) presents a model to explain that "forbearance of lending" to unproductive firms would occur as a result of a bank's rational profit maximization behavior when additional lending leads to fewer losses than withdrawal of loans. They estimated a non-linear loan supply function and showed that increases in a firm's debt over a certain level induced more loan supply from banks in the last half of 1990s. Fukao, Nishimura, Sui and Tomiyama (2003) model two alternatives that banks face at their profit maximization. One is screening of lending opportunities, and another is improving borrower firms' performances. They show that screening activity has been more dominant in the Japanese banking system than previously and point out that the economic downturn in the 1990s badly damaged banks. Many banks lost good lending opportunities after the burst of bubble and, in many cases, they have also been unable to raise borrower firms' profitability. These models indicate the possibility that banks' "rational" behavior, under certain situations, could make productive firms leave and unproductive firms stay.

# 6 Conclusion

It has been widely accepted that the natural selection mechanism (NSM) of economic Darwinism in competitive markets plays a key role in efficient resource allocation and evolution for long-term economic growth. Recent development of firm models provides theoretical background to the NSM in terms of productivity growth, showing that firms' rational decisions on entry, surviving, and exit leads to macroeconomic TFP growth.

We have attempted to examine whether NSM works properly in the most stressful circumstances, e.g., severe recessions. Preceding empirical studies on this issue have examined the working of NSM only in normal times and have shown evidence to support proper functioning of NSM with positive contribution of a firm's turnover to macro level TFP growth. However, the real "test" of NSM is admittedly not normal times but rather times of crisis. We have focused on the 1990s in the Japanese economy as our period of investigation, with special focus on the

[25] Refer to http://www5.cao.go.jp/j-j/wp/wp-je01/wp-je01-2-2-06z.html.

1996-1997 period of banking crisis.

In contrast with preceding works, we have found that efficient firms in terms of TFP quit while inefficient ones survived, which suggests a malfunctioning of NSM between 1996 and 1997. Besides, this phenomenon is mainly observed for new entrants and contributes substantially to a fall in macro TFP growth after 1996. The result clearly shows that NSM is not working properly.

One feasible explanation for these results might be the poor functioning of the Japanese banking system. In Japan, where an indirect financial system through banking is still dominant, banks are widely involved in the resource allocation process such as establishment, liquidation, and reconstruction of enterprises. The banking system, suffering from non-performing loan problems after the burst of the bubble economy, might be unable to allocate funds to productive enterprises and eventually these firms leave their competitive market. This suggests that models of firm dynamics should involve financial aspects, at least in recession times, in order to reasonably explain the movement of the real economy.

Although this paper has presented new fact-findings on the working of NSM, there still remain several issues that are beyond the scope of this paper. More thorough analysis of the relationship between NSM and financial sectors is needed to examine the role of financial sectors in firm dynamics. In addition, we have not discussed time-series fluctuations of TFP and its implications on NSM. We have neither examined how inter-firm differentiation of TFP occurs nor how TFP affects a firm's organizational dynamics. These issues will be explored in the next stage of our research.

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# Appendix

# A Supplementary explanation to N2K Panel

As is described in the text, samples in *BSJBSA* are censored at certain points of employment size (50 employees) and capitalization size (30 million yen). Therefore, if a firm decreases the number of employees or capital and goes out of the range of investigation, it disappears from *BSJBSA*, but actually still exists in the market. It reappears when its employment and capital size criteria are satisfied.

Table A1 summarizes entry/exit patterns of *BSJBSA* firms that satisfy the consistency criteria in the previous subsection. The shadowed area (from group 22 to 63) corresponds to a firm's re-entry behavior patterns. More than 10 % of the all firms take re-entry action every year. The following three reasons might be considered to explain these considerably large numbers. Firstly, a firm might give wrong answers or no response to questionnaires. Secondly, a firm's employment or capital size would fluctuate around the censoring points of *BSJBSA*. The table, however, might not support this possibility, because the mean values of employment and capital sizes for re-entry firms are far more than censoring points. Thirdly, a firm might repeatedly experience a merger or a separation. Because *BSJBSA* provides no information to identify specific cases for each firm, we have to simply treat re-entry firms as new entrants.

Table A2 and A3 show the basic statistics for the original *BSJBSA* and for the N2K panel respectively. There are no big differences between the two values before and after for value

# Table A1: Entry/exit patterns

| | | The number of firms | | | | | | Employment size (the mean value) | | | | | | Capital size (the mean value, million yen) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| group | year | 1991 | 1994 | 1995 | 1996 | 1997 | 1998 | 1991 | 1994 | 1995 | 1996 | 1997 | 1998 | 1991 | 1994 | 1995 | 1996 | 1997 | 1998 |
| 1 | 1991 | 2,423 | | | | | | 210 | | | | | | 381 | | | | | |
| 2 | 1991-1994 | 946 | 946 | | | | | 205 | 193 | | | | | 406 | 403 | | | | |
| 3 | 1991-1994-1995 | 723 | 723 | 723 | | | | 230 | 237 | 226 | | | | 513 | 528 | 541 | | | |
| 4 | 1991-1994-1995-1996 | 873 | 873 | 873 | 873 | | | 289 | 276 | 269 | 263 | | | 650 | 705 | 727 | 737 | | |
| 5 | 1991-1994-1995-1996-1997 | 1,079 | 1,079 | 1,079 | 1,079 | 1,079 | | 265 | 258 | 248 | 245 | 251 | | 521 | 615 | 619 | 644 | 705 | |
| 6 | 1991-1994-1995-1996-1997-1998 | 14,610 | 14,610 | 14,610 | 14,610 | 14,610 | 14,610 | 494 | 493 | 487 | 483 | 483 | 477 | 1,581 | 1,638 | 1,679 | 1,727 | 1,756 | 1,795 |
| 7 | 1994 | | 610 | | | | | | 190 | | | | | | 211 | | | | |
| 8 | 1994-1995 | | 318 | 318 | | | | | 194 | 201 | | | | | 632 | 640 | | | |
| 9 | 1994-1995-1996 | | 318 | 318 | 318 | | | | 167 | 169 | 166 | | | | 318 | 311 | 351 | | |
| 10 | 1994-1995-1996-1997 | | 321 | 321 | 321 | 321 | | | 193 | 192 | 196 | 189 | | | 511 | 518 | 548 | 579 | |
| 11 | 1994-1995-1996-1997-1998 | | 2,607 | 2,607 | 2,607 | 2,607 | 2,607 | | 277 | 277 | 280 | 284 | 280 | | 687 | 698 | 729 | 750 | 765 |
| 12 | 1995 | | | 395 | | | | | | 140 | | | | | | 238 | | | |
| 13 | 1995-1996 | | | 257 | 257 | | | | | 177 | 176 | | | | | 280 | 284 | | |
| 14 | 1995-1996-1997 | | | 242 | 242 | 242 | | | | 156 | 157 | 163 | | | | 319 | 325 | 352 | |
| 15 | 1995-1996-1997-1998 | | | 1,702 | 1,702 | 1,702 | 1,702 | | | 204 | 208 | 213 | 213 | | | 407 | 425 | 434 | 441 |
| 16 | 1996 | | | | 259 | | | | | | 178 | | | | | | 226 | | |
| 17 | 1996-1997 | | | | 172 | 172 | | | | | 306 | 303 | | | | | 239 | 259 | |
| 18 | 1996-1997-1998 | | | | 856 | 856 | 856 | | | | 185 | 194 | 192 | | | | 356 | 343 | 342 |
| 19 | 1997 | | | | | 326 | | | | | | 320 | | | | | | 304 | |
| 20 | 1997-1998 | | | | | 1,294 | 1,294 | | | | | 355 | 348 | | | | | 332 | 355 |
| 21 | 1998 | | | | | | 1,245 | | | | | | 194 | | | | | | 254 |
| 22 | 1991-1994-1995-1996-1998 | 405 | 405 | 405 | 405 | | 405 | 346 | 349 | 346 | 348 | | 344 | 745 | 798 | 805 | 819 | | 872 |
| 23 | 1991-1994-1995-1997 | 102 | 102 | 102 | | 102 | | 245 | 226 | 222 | | 216 | | 343 | 300 | 313 | | 385 | |
| 24 | 1991-1994-1995-1997-1998 | 295 | 295 | 295 | | 295 | 295 | 267 | 296 | 301 | | 295 | 302 | 464 | 493 | 506 | | 538 | 595 |
| 25 | 1991-1994-1995-1998 | 131 | 131 | 131 | | | 131 | 391 | 384 | 377 | | | 368 | 1,360 | 1,363 | 1,367 | | | 1,397 |
| 26 | 1991-1994-1996 | 82 | 82 | | 82 | | | 226 | 222 | | 214 | | | 240 | 259 | | 253 | | |
| 27 | 1991-1994-1996-1997 | 53 | 53 | | 53 | 53 | | 178 | 175 | | 183 | 187 | | 661 | 715 | | 712 | 710 | |
| 28 | 1991-1994-1996-1997-1998 | 341 | 341 | | 341 | 341 | 341 | 286 | 280 | | 296 | 292 | 302 | 737 | 786 | | 833 | 861 | 887 |
| 29 | 1991-1994-1996-1998 | 38 | 38 | | 38 | | 38 | 273 | 250 | | 247 | | 240 | 277 | 320 | | 362 | | 409 |
| 30 | 1991-1994-1997 | 31 | 31 | | | 31 | | 230 | 213 | | | 212 | | 101 | 102 | | | 109 | |
| 31 | 1991-1994-1997-1998 | 114 | 114 | | | 114 | 114 | 226 | 220 | | | 243 | 235 | 247 | 259 | | | 283 | 286 |
| 32 | 1991-1994-1998 | 80 | 80 | | | | 80 | 285 | 312 | | | | 300 | 460 | 453 | | | | 518 |
| 33 | 1991-1995 | 106 | | 106 | | | | 200 | | 178 | | | | 151 | | 164 | | | |
| 34 | 1991-1995-1996 | 82 | | 82 | 82 | | | 383 | | 399 | 400 | | | 470 | | 611 | 650 | | |
| 35 | 1991-1995-1996-1997 | 77 | | 77 | 77 | 77 | | 238 | | 265 | 268 | 259 | | 227 | | 259 | 259 | 301 | |
| 36 | 1991-1995-1996-1997-1998 | 530 | | 530 | 530 | 530 | 530 | 356 | | 386 | 390 | 379 | 382 | 1,333 | | 1,933 | 1,503 | 1,540 | 1,630 |
| 37 | 1991-1995-1996-1998 | 36 | | 36 | 36 | | 36 | 203 | | 254 | 231 | | 227 | 692 | | 924 | 1,206 | | 1,392 |
| 38 | 1991-1995-1997 | 21 | | 21 | | 21 | | 318 | | 317 | | 312 | | 731 | | 776 | | 786 | |
| 39 | 1991-1995-1997-1998 | 33 | | 33 | | 33 | 33 | 233 | | 207 | | 230 | 229 | 420 | | 429 | | 439 | 440 |
| 40 | 1991-1995-1998 | 30 | | 30 | | | 30 | 163 | | 181 | | | 225 | 89 | | 116 | | | 135 |
| 41 | 1991-1996 | 68 | | | 68 | | | 173 | | | 184 | | | 184 | | | 261 | | |
| 42 | 1991-1996-1997 | 39 | | | 39 | 39 | | 159 | | | 165 | 161 | | 198 | | | 219 | 221 | |
| 43 | 1991-1996-1997-1998 | 162 | | | 162 | 162 | 162 | 323 | | | 320 | 323 | 321 | 647 | | | 760 | 774 | 798 |
| 44 | 1991-1996-1998 | 25 | | | 25 | | 25 | 292 | | | 386 | | 483 | 598 | | | 946 | | 959 |
| 45 | 1991-1997 | 47 | | | | 47 | | 202 | | | | 200 | | 162 | | | | 173 | |
| 46 | 1991-1997-1998 | 161 | | | | 161 | 161 | 169 | | | | 169 | 166 | 193 | | | | 233 | 243 |
| 47 | 1991-1998 | 127 | | | | | 127 | 240 | | | | | 219 | 248 | | | | | 284 |
| 48 | 1994-1995-1996-1998 | | 115 | 115 | 115 | | 115 | | 304 | 319 | 341 | | 328 | | 518 | 552 | 554 | | 584 |
| 49 | 1994-1995-1997 | | 40 | 40 | | 40 | | | 189 | 201 | | 192 | | | 275 | 280 | | 295 | |
| 50 | 1994-1995-1997-1998 | | 109 | 109 | | 109 | 109 | | 342 | 339 | | 315 | 411 | | 178 | 193 | | 200 | 210 |
| 51 | 1994-1995-1998 | | 48 | 48 | | | 48 | | 215 | 220 | | | 205 | | 147 | 146 | | | 168 |
| 52 | 1994-1996 | | 35 | | 35 | | | | 166 | | 141 | | | | 438 | | 124 | | |
| 53 | 1994-1996-1997 | | 31 | | 31 | 31 | | | 153 | | 144 | 141 | | | 2,253 | | 2,277 | 2,277 | |
| 54 | 1994-1996-1997-1998 | | 143 | | 143 | 143 | 143 | | 209 | | 225 | 224 | 218 | | 315 | | 332 | 335 | 343 |
| 55 | 1994-1996-1998 | | 24 | | 24 | | 24 | | 242 | | 219 | | 235 | | 148 | | 159 | | 182 |
| 56 | 1994-1997 | | 25 | | | 25 | | | 117 | | | 158 | | | 113 | | | 120 | |
| 57 | 1994-1997-1998 | | 66 | | | 66 | 66 | | 213 | | | 199 | 201 | | 137 | | | 154 | 158 |
| 58 | 1994-1998 | | 58 | | | | 58 | | 175 | | | | 176 | | 353 | | | | 377 |
| 59 | 1995-1996-1998 | | | 125 | 125 | | 125 | | | 167 | 172 | | 174 | | | 253 | 258 | | 262 |
| 60 | 1995-1997 | | | 33 | | 33 | | | | 180 | | 167 | | | | 118 | | 120 | |
| 61 | 1995-1997-1998 | | | 100 | | 100 | 100 | | | 173 | | 212 | 224 | | | 198 | | 224 | 232 |
| 62 | 1995-1998 | | | 68 | | | 68 | | | 173 | | | 168 | | | 353 | | | 513 |
| 63 | 1996-1998 | | | | 95 | | 95 | | | | 186 | | 198 | | | | 328 | | 353 |

| | 1991 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| The number of non re-entry firms | 20,654 | 22,405 | 23,445 | 23,296 | 23,209 | 22,314 |
| The number of re-entry firms | 3,216 | 2,366 | 2,486 | 2,506 | 2,553 | 3,459 |
| The number of total firms | 23,870 | 24,771 | 25,931 | 25,802 | 25,762 | 25,773 |

added, tangible fixed asset, investment, labor compensation, the number of regular workers, working hours, and depreciation rate.[26]

# B Calculation method of TFP

In this appendix we present a methodology for TFP measurement and variables definitions for the calculation.

## B.1 Methodology

For the both cross-section and time-series comparability of TFP, we applied the methodology utilized in Caves, Christensen and Diewert (1982), Caves, Christensen and Tretheway (1983), and Good, Nadiri, Roeller and Sickles (1983). To avoid complex arithmetical expressions we simply describe the calculation procedure.

1. Define a hypothetical (representative) firm for each year. Its input and output are calculated as geometric means of those of all firms, and its input cost shares as arithmetic means.

2. Calculate TFP index based on the Theil=Törnqvist specification for each firm, for each year, relative to a hypothetical firm calculated in the first step.

3. Make time series of TFP index for a hypothetical firm for each year.

4. Adjust TFP index for each form of the second step according to a hypothetical firm's TFP index calculated in the previous step.

In the second step, time series (absolute) comparison is impossible because a firm's TFP index has a relative value to a hypothetical firm for each year. A time series linkage of a TFP index for a hypothetical firm in the third step makes it possible to compare a firm's TFP both cross-sectionally and in time series.[27]

[26] Careful readers may find the difference in the number of firms between Table A1 and A3. The difference reflects whether the new definition of entry/exit in the previous subsection is applied or not. In Table A4 a re-entry firm is treated as a new entrant. Firms that do not satisfy the consistency conditions, at least for a single year, are entirely excluded from the data set in Table A1 but would be included in Table A3 as a new (re-entry) firm satisfying the consistency conditions.

[27] To illustrate, suppose the TFP index of a hypothetical firm is 1.0 for a benchmark year ($T$) and 1.2 for the next year ($T+1$). The TFP index numbers at $T+1$ for all samples calculated in the second step are adjusted to be

Table A2: Basic statistics for the original *BSJBSA*

| | variables | The number of firms | mean | S.D. | min. | 10 percentile | median | 90 percentile | max. |
|---|---|---|---|---|---|---|---|---|---|
| 1991 | value added | 24,345 | 12,904 | 102,933 | -36,187 | 672 | 2,454 | 16,093 | 8,940,898 |
| | tangible asset | 24,345 | 4,311 | 27,489 | 0 | 137 | 846 | 5,854 | 1,481,413 |
| | investment | 24,345 | 1,091 | 7,805 | 0 | 0 | 82 | 1,446 | 419,300 |
| | labor compensation | 24,345 | 1,911 | 10,264 | 0 | 238 | 580 | 2,913 | 578,086 |
| | regular worker | 24,345 | 398 | 1,649 | 50 | 65 | 146 | 659 | 82,221 |
| | working hours | 24,351 | 2,001 | 108 | 1,796 | 1,890 | 2,000 | 2,155 | 2,208 |
| | depreciation rate | 24,280 | 0.16 | 4.43 | 0.00 | 0.02 | 0.09 | 0.23 | 649.00 |
| 1994 | value added | 25,237 | 7,037 | 46,094 | -18,974 | 542 | 1,642 | 9,636 | 2,615,367 |
| | tangible asset | 25,237 | 4,593 | 29,855 | 0 | 130 | 885 | 6,300 | 1,327,445 |
| | investment | 25,237 | 583 | 4,644 | -9,332 | 0 | 45 | 770 | 230,000 |
| | labor compensation | 25,237 | 1,966 | 10,358 | 0 | 238 | 596 | 3,085 | 560,300 |
| | regular worker | 25,237 | 392 | 1,605 | 50 | 64 | 143 | 662 | 77,185 |
| | working hours | 25,242 | 2,005 | 45 | 1,822 | 1,962 | 1,996 | 2,066 | 2,208 |
| | depreciation rate | 25,207 | 0.27 | 5.84 | 0.00 | 0.01 | 0.06 | 0.21 | 589.00 |
| 1995 | value added | 26,424 | 7,123 | 44,703 | -1,068 | 555 | 1,621 | 9,575 | 2,331,719 |
| | tangible asset | 26,424 | 4,537 | 29,229 | 0 | 130 | 873 | 6,221 | 1,304,089 |
| | investment | 26,424 | 744 | 7,317 | 0 | 0 | 46 | 866 | 603,384 |
| | labor compensation | 26,424 | 2,064 | 10,655 | 2 | 262 | 631 | 3,278 | 574,947 |
| | regular worker | 26,424 | 381 | 1,535 | 50 | 63 | 139 | 653 | 76,106 |
| | working hours | 26,429 | 2,005 | 46 | 1,825 | 1,967 | 1,985 | 2,066 | 2,173 |
| | depreciation rate | 26,388 | 0.14 | 2.13 | 0.00 | 0.02 | 0.08 | 0.21 | 323.75 |
| 1996 | value added | 26,310 | 7,712 | 53,397 | -55,958 | 575 | 1,674 | 9,791 | 3,114,603 |
| | tangible asset | 26,310 | 4,609 | 28,758 | 0 | 129 | 893 | 6,377 | 1,326,891 |
| | investment | 26,310 | 775 | 6,060 | 0 | 0 | 52 | 943 | 439,573 |
| | labor compensation | 26,310 | 2,130 | 11,097 | 5 | 273 | 652 | 3,382 | 654,735 |
| | regular worker | 26,310 | 380 | 1,520 | 50 | 64 | 141 | 648 | 72,837 |
| | working hours | 26,315 | 2,030 | 49 | 1,825 | 1,984 | 2,015 | 2,092 | 2,192 |
| | depreciation rate | 26,263 | 0.12 | 0.26 | 0.00 | 0.02 | 0.08 | 0.21 | 22.05 |
| 1997 | value added | 26,277 | 7,524 | 50,046 | -25,551 | 570 | 1,663 | 9,598 | 2,285,374 |
| | tangible asset | 26,277 | 4,706 | 30,033 | 0 | 130 | 918 | 6,458 | 1,366,758 |
| | investment | 26,277 | 798 | 6,330 | 0 | 0 | 52 | 965 | 397,028 |
| | labor compensation | 26,277 | 2,071 | 11,106 | 11 | 265 | 632 | 3,224 | 653,401 |
| | regular worker | 26,277 | 388 | 1,613 | 50 | 63 | 140 | 649 | 75,510 |
| | working hours | 26,282 | 2,015 | 54 | 1,818 | 1,985 | 1,987 | 2,093 | 2,152 |
| | depreciation rate | 26,210 | 0.12 | 0.85 | 0.00 | 0.02 | 0.08 | 0.21 | 83.60 |
| 1998 | value added | 26,270 | 6,934 | 44,422 | -17,831 | 543 | 1,571 | 9,131 | 2,417,829 |
| | tangible asset | 26,270 | 4,745 | 30,034 | 0 | 131 | 930 | 6,577 | 1,424,669 |
| | investment | 26,270 | 743 | 6,228 | 0 | 0 | 41 | 861 | 329,523 |
| | labor compensation | 26,270 | 2,024 | 10,788 | 9 | 262 | 621 | 3,175 | 674,022 |
| | regular worker | 26,270 | 385 | 1,585 | 50 | 62 | 138 | 645 | 71,237 |
| | working hours | 26,276 | 1,866 | 112 | 1,745 | 1,745 | 1,902 | 2,011 | 2,096 |
| | depreciation rate | 26,219 | 0.13 | 1.05 | 0.00 | 0.02 | 0.08 | 0.22 | 128.18 |

Table A3: Basic statistics for the N2K panel

| | variables | The number of firms | mean | S.D. | min. | 10 percentile | median | 90 percentile | max. |
|---|---|---|---|---|---|---|---|---|---|
| 1991 | value added | 23,914 | 13,074 | 103,816 | 1 | 696 | 2,489 | 16,220 | 8,940,898 |
| | tangible asset | 23,914 | 4,351 | 27,716 | 1 | 142 | 852 | 5,886 | 1,481,413 |
| | investment | 23,914 | 1,102 | 7,871 | 0 | 0 | 84 | 1,458 | 419,300 |
| | labor compensation | 23,914 | 1,924 | 10,351 | 0 | 238 | 580 | 2,927 | 578,086 |
| | regular worker | 23,914 | 400 | 1,662 | 50 | 65 | 146 | 662 | 82,221 |
| | working hours | 23,914 | 2,001 | 108 | 1,796 | 1,890 | 2,000 | 2,155 | 2,208 |
| | depreciation rate | 23,914 | 0.17 | 4.46 | 0.00 | 0.02 | 0.09 | 0.23 | 649.00 |
| 1994 | value added | 24,793 | 7,085 | 46,454 | 4 | 544 | 1,648 | 9,685 | 2,615,367 |
| | tangible asset | 24,793 | 4,627 | 30,091 | 1 | 135 | 892 | 6,330 | 1,327,445 |
| | investment | 24,793 | 582 | 4,653 | -9,332 | 0 | 45 | 775 | 230,000 |
| | labor compensation | 24,793 | 1,976 | 10,441 | 2 | 238 | 597 | 3,099 | 560,300 |
| | regular worker | 24,793 | 393 | 1,615 | 50 | 64 | 143 | 663 | 77,185 |
| | working hours | 24,793 | 2,005 | 45 | 1,822 | 1,962 | 1,996 | 2,066 | 2,208 |
| | depreciation rate | 24,793 | 0.27 | 5.89 | 0.00 | 0.01 | 0.06 | 0.20 | 589.00 |
| 1995 | value added | 25,947 | 7,169 | 45,049 | 2 | 558 | 1,628 | 9,601 | 2,331,719 |
| | tangible asset | 25,947 | 4,570 | 29,465 | 1 | 134 | 877 | 6,264 | 1,304,089 |
| | investment | 25,947 | 748 | 7,370 | 0 | 0 | 46 | 867 | 603,384 |
| | labor compensation | 25,947 | 2,073 | 10,743 | 2 | 261 | 631 | 3,276 | 574,947 |
| | regular worker | 25,947 | 382 | 1,546 | 50 | 63 | 139 | 653 | 76,106 |
| | working hours | 25,947 | 2,005 | 46 | 1,825 | 1,967 | 1,985 | 2,066 | 2,173 |
| | depreciation rate | 25,947 | 0.14 | 2.15 | 0.00 | 0.02 | 0.08 | 0.21 | 323.75 |
| 1996 | value added | 25,818 | 7,773 | 53,842 | 8 | 578 | 1,680 | 9,860 | 3,114,603 |
| | tangible asset | 25,818 | 4,644 | 28,998 | 1 | 135 | 898 | 6,404 | 1,326,891 |
| | investment | 25,818 | 781 | 6,108 | 0 | 0 | 52 | 945 | 439,573 |
| | labor compensation | 25,818 | 2,137 | 11,181 | 5 | 273 | 652 | 3,384 | 654,735 |
| | regular worker | 25,818 | 381 | 1,531 | 50 | 64 | 141 | 648 | 72,837 |
| | working hours | 25,818 | 2,030 | 49 | 1,825 | 1,984 | 2,015 | 2,092 | 2,192 |
| | depreciation rate | 25,818 | 0.12 | 0.26 | 0.00 | 0.02 | 0.08 | 0.21 | 22.05 |
| 1997 | value added | 25,781 | 7,599 | 50,509 | 2 | 575 | 1,667 | 9,653 | 2,285,374 |
| | tangible asset | 25,781 | 4,747 | 30,296 | 1 | 137 | 923 | 6,490 | 1,366,758 |
| | investment | 25,781 | 801 | 6,370 | 0 | 0 | 52 | 966 | 397,028 |
| | labor compensation | 25,781 | 2,082 | 11,203 | 11 | 265 | 633 | 3,232 | 653,401 |
| | regular worker | 25,781 | 389 | 1,625 | 50 | 63 | 141 | 650 | 75,510 |
| | working hours | 25,781 | 2,015 | 54 | 1,818 | 1,985 | 1,987 | 2,093 | 2,152 |
| | depreciation rate | 25,781 | 0.12 | 0.86 | 0.00 | 0.02 | 0.08 | 0.21 | 83.60 |
| 1998 | value added | 25,805 | 6,992 | 44,801 | 3 | 545 | 1,574 | 9,142 | 2,417,829 |
| | tangible asset | 25,805 | 4,781 | 30,279 | 1 | 136 | 934 | 6,584 | 1,424,669 |
| | investment | 25,805 | 748 | 6,277 | 0 | 0 | 42 | 860 | 329,523 |
| | labor compensation | 25,805 | 2,033 | 10,876 | 9 | 262 | 621 | 3,183 | 674,022 |
| | regular worker | 25,805 | 385 | 1,596 | 50 | 62 | 138 | 645 | 71,237 |
| | working hours | 25,805 | 1,867 | 112 | 1,745 | 1,745 | 1,902 | 2,011 | 2,096 |
| | depreciation rate | 25,805 | 0.13 | 1.05 | 0.00 | 0.02 | 0.08 | 0.22 | 128.18 |

## B.2 Variable definitions for TFP calculation

***Output***

To describe production technology in general, output is defined in terms of gross value while materials are included in input factors. On the other hand, value added, subtracting the latter from the former, is less preferable because it may cause a systematic bias in TFP indicators.[28] In this paper, however, we use value added instead of gross value for output because of the restriction in data availability of *BSJBSA*. In *BSJBSA*, the only available information concerning material input is "amount of goods purchased," where no breakdown is given. This limitation is very crucial to the calculation of material input price index. Value added deflators are available in *System of National Accounts* by Cabinet Office of Japan.

***Input***

We define input factors as labor and capital to keep consistency with our output definition. Labor input is simply calculated by multiplying the number of regular workers by annual per capita working hours.[29] Making time-series of capital stock from *BSJBSA*, on the other hand, is really a tricky job. Because *BSJBSA* has considerable numbers of samples with null investment, a well-known perpetual inventory method is not applicable. Instead the following steps are taken to make capital stock series. First we define the book value of a tangible fixed asset in 1994 (a bench mark year) as a real capital stock of 1994.[30] Capital stock for the next term is then calculated according to the following formula.

$$\tilde{K}_{t+1} = \begin{cases} \tilde{K}_t + (K_{t+1} - K_t)/q_{t+1} & \text{if} \quad K_{t+1} - K_t > 0 \\ \tilde{K}_t + (K_{t+1} - K_t) & \text{if} \quad K_{t+1} - K_t \leq 0 \end{cases} \qquad t = 1, ..., T \qquad \text{(A2)}$$

where $\tilde{K}_t$ stands for real capital stock at $t$, $K_t$ for book values of tangible fixed assets, and $q_t$ for a investment goods deflator.[31] This formula means that positive increments of book values are assumed as net investments and added to real capital stock of the previous term through

multiplied by 1.2.

[28] See McGuckin and Nguyen (1993) for more details about this issue.

[29] The statistics of working hours are available in *Monthly Labor Survey* by Ministry of Health, Labor, and Welfare.

[30] This may cause an underestimate of capital stock for older firms.

[31] The statistics of investment goods deflators is available in *System of National Accounts* by Cabinet Office of Japan.

the deflation process. If book values are decreasing, on the other hand, we simply subtract the amount of reduction from real capital stock of the previous term.[32] Interest rates (10-year-bond yield) and depreciation rates for user cost of capital are from Bank of Japan and KEO Data Base respectively.[33] User cost of capital is defined as follows.

$$P_{Kt} = q_t \left( \frac{1 - \tau_t z}{1 - \tau_t} \right) \left( r_t + \delta - \frac{\dot{q}_t}{q_t} \right), \tag{A3}$$

where $\tau$ is the corporate tax rate on business income[34] and $z$ denotes the present value of the depreciation deduction on unit nominal investment.[35]

Table A5: Labor and capital cost shares

| Summary statistics | | | | | |
|---|---|---|---|---|---|
| Labor share | | | | | |
| | *N* | Mean | S.D. | Minimum | Maximum |
| 1994 | 24793 | 0.744837 | 0.164026 | 0.006031 | 0.999935 |
| 1995 | 25947 | 0.779443 | 0.147063 | 0.008931 | 0.999944 |
| 1996 | 25818 | 0.785927 | 0.143513 | 0.004469 | 0.999952 |
| 1997 | 25781 | 0.808969 | 0.133764 | 0.017319 | 0.999946 |
| 1998 | 25805 | 0.796084 | 0.139587 | 0.014316 | 0.999939 |
| Capital share | | | | | |
| | *N* | Mean | S.D. | Minimum | Maximum |
| 1994 | 24793 | 0.255163 | 0.164026 | 0.000065 | 0.993970 |
| 1995 | 25947 | 0.220558 | 0.147063 | 0.000056 | 0.991069 |
| 1996 | 25818 | 0.214073 | 0.143513 | 0.000048 | 0.995531 |
| 1997 | 25781 | 0.191031 | 0.133764 | 0.000055 | 0.982681 |
| 1998 | 25805 | 0.203916 | 0.139587 | 0.000061 | 0.985684 |

Source: N2K Panel Data

Table A5 shows labor and capital cost shares based on the definitions above. Relatively high

[32] A decrease in book values appears in the case of greater depreciation and/or disposal of stock than gross investment. Because of the lack of information on capital stock vintage it is quite difficult to apply other procedures than the one described in the text.

[33] Although capital cost and depreciation rates are certainly different, company by company, according to its managerial condition and production technology, the limitation of data availability forces us to assume that capital cost is common to all firms and a depreciation rate is differentiated only between industries. Financial data, materials, and papers published in the Bank of Japan are now available at Tokiwa Sogo Service Ltd. KEO Data Base (KDB) has been developed at Keio Economic Observatory. We thank Koji Nomura for the provision of information about KDB.

[34] The tax rate are quoted from Cabinet Office (2001).

[35] The variables $z$ is differentiated only by industry and derived so that the following equations are satisfied: $z = \sum_{t=1}^{T} \frac{(1-\delta)^{t-1}\delta}{(1+r)^{t-1}}$ and $(1-\delta)^T \approx 0.05$. The second equation means that the end point of depreciation period is defined the time when the accumulated depreciation cost approximately equals to 90% of initial investment.

labor cost shares may reflect *BSJBSA*'s wide coverage of small and medium enterprises.[36]

[36]To test this possibility, we have estimated Tobit model that has a capital cost share as a dependent variable and sales, firm age, industry dummy variable, and year as independent variables. As a result the coefficient of sales was positive and statistically significant.