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Entry, Exit, and Aggregate Productivity Growth: Micro Evidence on Korean Manufacturing

Chin Hee Hahn

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ABSTRACT/RÉSUMÉ

Using plant level panel data on Korean manufacturing during the 1990-98 period, this study tries to assess the role of entry and exit in enhancing aggregate productivity, both qualitatively and quantitatively. The main findings of this study are summarised as follows. First, plant entry and exit rates in Korean manufacturing seem quite high: they are higher than in both the United States and several developing countries for which comparable studies exist. Second, in line with existing studies on other countries, plant turnover reflects underlying productivity differentials in Korean manufacturing, with the "shadow of death" effect as well as selection and learning effects all present. Third, plant entry and exit account for as much as 45 and 65 per cent in manufacturing productivity growth during cyclical upturn and downturn, respectively. This study also shows that plant birth and death are mainly a process of resource reallocation from plants with relatively low and declining productivity to a group of heterogeneous plants, some of which have the potential to become highly efficient in future. The most obvious lesson from this study is that it is important to establish a policy or institutional environment where efficient businesses can succeed and inefficient businesses fail.

JEL classification: D21; D24; E32; G38; L60; O40
Keywords: productivity growth, Korean manufacturing, entry and exit

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Cette étude essaie de déterminer le rôle des entrées et sorties des firmes dans l'amélioration de la productivité globale, à la fois qualitativement et quantitativement, en utilisant des données de panel dans le secteur manufacturier coréen au niveau des installations industrielles durant la période 1990-98. Les conclusions de l'étude se résument comme suit : premièrement, les taux des entrées et sorties des firmes au niveau des installations dans le secteur manufacturier coréen semblent assez élevés. Ils sont plus élevés qu'aux États-Unis et dans plusieurs pays en voie de développement pour lesquels des études comparables existent. Deuxièmement, en accord avec des études existantes sur d'autres pays, la dynamique industrielle est le produit des différentiels de productivité sous-jacents dans le secteur manufacturier coréen ; l'effet "ombre de la mort" ainsi que les effets de sélection et d'apprentissage sont également présents. Troisièmement, les entrées et sorties représentent jusqu'à 45 et 65 pour cent de la croissance de la productivité manufacturière, respectivement, au cours des périodes de haut de cycle et de bas de cycle. L'étude montre également que la création et la disparition des installations industrielles sont liées à l'allocation des ressources entre des installations industrielles ayant une productivité relativement basse et en déclin, et d'installations hétérogènes, parmi lesquelles certaines ont le potentiel d'être très productives à l'avenir. La leçon la plus évidente à tirer de cette étude est qu'il est important de formuler une politique ou de créer un environnement institutionnel où les entreprises performantes puissent réussir et les entreprises non performantes soient liquidées.

Classification JEL: D21; D24; E32; G38; L60; O40
Mots-clés: Croissance de la productivité ; secteur manufacturier coréen; entrées et sorties des firmes

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ENTRY, EXIT, AND AGGREGATE PRODUCTIVITY GROWTH: MICRO EVIDENCE ON KOREAN MANUFACTURING

by
Chin-Hee Hahn[1]

1. Introduction

The process of economic growth involves the continual process of resource reallocation among heterogeneous producers. Even in the same narrowly defined industry, it is common to observe new or expanding producers as well as exiting or contracting ones at business cycle or longer-run frequencies. Motivated by this observation, a growing number of studies try to assess the role played by resource reallocation in enhancing industry or aggregate productivity.[2]

In the existing literature that tries to understand the sources of growth of Korea and other East Asian countries, the resource reallocation among heterogeneous producers as an inevitable part of growth process has received little attention. For example, Kim and Lau (1994), Young (1995), and Collins and Bosworth (1996), that provided the basis for the so-called TFP controversy, mainly focus on the respective roles of productivity growth and input accumulation using country or industry level data. Even though it is well acknowledged that productivity growth is the ultimate driving force for raising our standard of living, the studies based on aggregate data has a limitation for understanding how the productivity growth occurs. This will be particularly true if aggregate productivity improvement takes place through a gradual process of resource reallocation among heterogeneous producers.

This study attempts to broaden our understanding of the micro dynamics of entry, exit, and productivity growth using the plant level data on Korean manufacturing. Specifically, this study has three objectives. The first one is to document actual patterns of plant entry and exit. The next one is to answer whether the plant turnover patterns reflect underlying productivity differential among plants. In order to do this, this study examines the relative productivities of entering and exiting plants, both at a point in time and over time. Also, this study analyses whether the plant productivity is persistent over time. The final objective of this study is to make a quantitative assessment of the contribution from resource reallocation to aggregate productivity growth. To do so, this study decomposes the total factor productivity growth in manufacturing into contributions from three components: productivity growth of continuing plants, entry and exit effect, and market share reallocation among continuing plants.

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1. Korean Development Institute, P.O. Box 113, Cheongryang, Seoul, 130-012, Korea. Email: Chhahn@kdiux.kdi.re.kr. The author would like to thank the Korea Statistical Office for allowing the access to the data. The research grant from World Bank's Global Development Network is greatly acknowledged. Jeong-sam Yang in KDI provided an invaluable contribution to data processing. Also, the research assistance by Hwa-Jung Choi was of great help. The author also thanks the participants of the OECD workshop on economic growth held in Paris in July 2000 for helpful comments on the early draft.

2. For a recent survey of empirical literature in this vein, see Roberts and Tybout (1996), Caves (1997), and Foster, Haltiwanger, and Krizan (1998).

The theoretical framework of this paper is provided by the studies on industry dynamics with firm heterogeneity.[3] Motivated by the empirical evidence that smaller firms grow faster and are more likely to fail than large firms, Jovanovic (1982) provides the first industry equilibrium model where firm specific stochastic elements generate observed firm dynamics. In his model, firms are faced with uncertainty about their "true cost" and learn about their relative efficiency as they operate. The equilibrium leads to selection through exit and entry; the efficient grow and survive and the inefficient decline and fail. Hopenhayn (1992) provides a variant of Jovanovic's model where firms are faced with exogenous productivity shock and make decision when to exit the industry. He shows that there are simultaneous entry and exit in the long run stationary equilibrium with sufficiently small fixed cost. He also performs steady state comparative static analysis to examine how the structural characteristics of an industry, such as sunk entry costs, demand, the productivity shock process, affect turnover and distribution of firms. He shows that the high sunk entry cost leads to a lower turnover rate and a larger divergence between surviving and exiting firms, since the cost of entry acts to protect the incumbent firms and exiting firms will endure low productivity for longer period of time before exiting. He also provides conditions where the recent entrants have higher hazard rates and lower productivity than incumbent firms.

The existing empirical findings on the importance of exit and entry or market share reallocation among plants or firms are diverse. In the case of the United States, Baily, Hulten, and Campbell (1992) finds that, while entry and exit plays a minor role, market share reallocation among existing plants are important in aggregate productivity growth. However, Olley and Pakes (1992) report that not only the share reallocation but also entry and exit are important in the US telecommunications equipment industry. Foster, Haltiwanger, and Krizan (1998) conclude that entry and exit plays a large role especially in the medium to long run.

The evidence on developing countries is also mixed. Griliches and Regev (1995) analyse Israeli data and finds that the effect of entry, exit, and share reallocation explains very small part of labour productivity growth. One interesting finding, however, is that there is a "shadow of death" effect; firms which will exit in the future have lower productivity performance several years earlier. Using Chilean panel data, Liu (1993) reports similar effect even though she does not attempt to quantify the contribution of entry and exit. Meanwhile, Aw, Chen, and Roberts (1997) finds a significant role of entry and exit in total factor productivity growth in Taiwanese manufacturing industries. They claim that Taiwan's institutional environment, such as the manufacturing sector's dense network of subcontracting relationships and trading firms, combined with low capital intensity of much of the production, makes entry and exit of firms relatively easy and inexpensive, allowing the economy to rapidly exploit micro-level differences in productivity.

Even though it is hard to draw out a general conclusion on the importance of entry and exit as a process of enhancing aggregate productive efficiency, it is also true that these studies differ in various details that might affect the conclusion, as Foster, Haltiwanger, and Krizan (1998) point out. They emphasise that the measured contribution of such reallocation effects varies over time and across sectors and is quite sensitive to measurement methodology. However, after performing sensitivity analysis on methodological details, they report that a large contribution from efficient entering plants displacing inefficient ones is a clear conclusion, especially when productivity changes are measured over five or ten year horizons. They also show that the large role of entry and exit is not just an artifact of longer run analysis but also reflect entering plants displacing less productive exiting plants (selection) and entering plants becoming relatively productive over time (learning).

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3. The theoretical framework of this type of study is also related to recent endogeneous growth models of learning by doing or creative destruction, such as Stokey (1991), Grossman and Helpman, (1991), Aghion and Howitt (1992), Young (1991). For a detailed survey of the theoretical underpinnings, see Tybout (1996) and Foster, Haltiwanger, and Krizan (1998).

While a detailed summary of the results of this study will be presented at the end of the paper, it might be useful to give a brief overview of the findings of this study here. To begin with, most qualitative findings of this study are in line with those frequently reported for other countries. That is, this study documents that plant turnovers reflect underlying productivity differential in Korean manufacturing, with the "shadow of death" effect as well as selection and learning effects all present. Also, there is a persistency in plant productivity. Thus, plant exit and entry, particularly birth and death, are mainly a process of resource reallocation from plants with relatively low and declining productivity to a group of heterogeneous plants, some of which have the potential to become highly efficient in future.

However, this study provides several findings that differ quantitatively from existing studies on other countries. Among others, plant entry and exit rates in Korean manufacturing seem quite high. Plants born during the past five-year period account for between 21.5 and 26.2 per cent of manufacturing output. A roughly similar portion is attributable to the plants that will die within five years. These figures are higher than those found in the United States or several developing countries for which comparable studies exist. However, the importance of entry by birth in Korea is not as much pronounced as in Taiwan.

Another finding of interest in Korea comes from the comparison of aggregate productivity decomposition between Korea and the United States. The entry and exit plays an important role in aggregate productivity growth in Korea while, in the United States, its role is more modest. In Korean manufacturing, the entry and exit effect accounts for about 45 and 65 per cent in cyclical upturn and downturn, respectively. In the reasonably comparable study for the United States, the entry and exit effects are at best below 40 per cent even in the cyclical downturn when the effect tends to get stronger. This seems to reflect not only fast overall productivity shift and high rate of plant turnover but also strong learning effect in Korea as will documented in this paper. By contrast, market share reallocation plays relatively minor role in Korea than in the United States, which, however, is not unique to Korean manufacturing but in line with other studies on several developing countries.

The remaining part of this paper will be organised as follows. The following section describes briefly the patterns of entry and exit. The next section will examine the relation between plant turnover and plant productivity. Section four will assess the contributions from resource reallocation to aggregate productivity growth. As the paper proceeds, the results will be discussed and compared with existing studies on other countries. The final section provides a summary of the empirical results of this paper and discusses the implications of this study. Finally, data and measurement of plant productivity will be described in the appendix.

2. Patterns of entry and exit in Korean manufacturing

Utilising the longitudinal aspect of our data set, we can define continuing plant, birth, death, switch-in, and switch-out. For each year, birth is defined as the plant that first appears in the data set and death is defined as the plant that disappears next year. Continuing plant is the one that stays within the five-digit industry and is not either birth or death. Switch-out plant is the one that moves out to another five-digit industry next year and is not either birth or death. Similarly, switch-in plant is the one that moved into the industry from another five-digit industry.[4]

Table 1 summarises the importance of plant births. Specifically, it shows what fraction of output or number of plants for each year is attributable to the plants that are grouped by plant age. In 1995, plants between zero and two years of age account for about 17.1 per cent of manufacturing output and three to four-year-

4. However, the plant classification depends on the time interval of the analysis. For example, in the five-year transition matrix that will be discussed below, births could be many years old.

old plants explains about 9.1 per cent. So, the fraction of manufacturing output in 1995 produced by plants less than five years-old is as much as 26.2 per cent. In 1998, the contribution from those plants drops visibly to 21.5 per cent. This is due not only to the fall in birth rate but also to the increase in closing of young plants, reflecting severe economic recession. In terms of number of plants, the importance of births becomes more dramatic. Plants less than five years old account for between 58.1 and 67.5 per cent of manufacturing plants depending on the year. The larger contribution of younger aged plants in terms of number of plants indicates that those plants are usually small ones.

The importance of births in Korea could be assessed by comparison across countries. Aw, Chen, and Roberts (1997) report, after examining nine manufacturing industries in Taiwan, that one to five year-old firms accounts for approximately two-thirds of the number of firms in operation and between one-third and one-half of each industry's production in 1991.[5] They also summarise similar statistics for other countries. Using data for Colombian manufacturing plants, Roberts (1996) finds that the combined market share of one to five year-old plants varies between 18.3 and 20.8 per cent depending on the year. With similar data for Chile, Tybout (1996) finds one to five year-old plants account for 15.0 to 15.7 per cent of manufacturing output. Using data for US manufacturing firms, Dunne, Roberts, and Samuelson (1988) find the market share of one to five-year old firms varies from 13.6 to 18.5 depending on the year. Thus, the importance of entry by birth in Korean manufacturing seems to be less pronounced than in Taiwan. However, entry by birth in Korea seems to be more active than in the United States or several developing countries in Latin America.

The plant death rate is also high in Korean manufacturing as shown in Table 2. In terms of output, between 13.4 per cent and 15.8 per cent of plants dies within three years depending on the year. Between 19.9 per cent and 24.1 per cent of a given year's output is produced by plants that will die within five years. The figures for deaths within five years in number of plants are again much larger than in output, indicating that the deaths are concentrated in small plants. In terms of number of plants, the fraction of plants that will survive more than five years is surprisingly as low as 36.1 to 47.4 per cent, depending on the year. Again, the fraction of plants that will survive more than five years in 1993 drops dramatically due to high rate of plant closing in 1998.

The plant death rate among births is even higher than the death rate among all plants. Table 3 shows the distribution of a given year's output or number of plants according to the length of plant life, conditional on birth. The death rate of birth is much higher than the unconditional death rate especially during the first three years of operation, which is in line with the theories of firm dynamics. In terms of number of plants between 46.4 and 55.9 per cent of births die within three years depending on the year, which is much higher than the corresponding numbers in Table 2. In terms of output the difference is even more striking, which seems to be natural since births are usually small ones. However, the death rate of births between three to four years of operation is not much different from the unconditional death rate. Thus, new plants seem easy to fail especially during the first three years. This might be due, among others, to the low productivity of births at the beginning of operation as will be discussed later. After five years, only between 24.0 and 35.8 per cent of a given year's birth plants will still be operating. Even among birth plants, smaller ones die more frequently, which can be seen by comparing the shares of deaths in output and in number of plants.

Switch-ins, which is another type of entry, are also frequently observed in Korean manufacturing. In terms of output, they are almost as important as births. Table 4 shows that plants that switched into a five-digit industry for the past three years account for between 11.6 and 15.6 per cent of manufacturing output depending on the year. In terms of number of plants, however, they are between 13.1 and 15.3 per

5. This paragraph heavily borrows from Aw, Chen, and Roberts. Explicit quotation will be omitted.

cent. Plants that switched in during the past five years and survived produce between 18.3 and 22.9 per cent of manufacturing output. Compared with births, switch-in plants are generally bigger in size.

Finally, switch-outs are also almost as important as deaths. Again, switch-out plants are larger than deaths in size. Plants that will switch out to another industry within three years account for between 8.8 and 12.4 per cent of manufacturing output and between 13.1 and 14.8 per cent of the number of plants, as shown in Table 5. Plants that will be operating at another five-digit industry within five years produce between 14.5 and 16.3 per cent of a given year's manufacturing output.

3. Plant productivity and turnovers

Summary measures of productivity

The distribution of plant productivity and its changes over time are summarised in Figure 1. Figure 1 shows the cross-sectional relative frequencies of plants along equal-length productivity intervals for three years. For both total manufacturing and all disaggregated industries presented here, there exists a large degree of heterogeneity in plant productivity, which provides the background of micro-level analysis of this sort. The distribution of plant productivity moved rightward over time, suggesting that productivity growth is widespread among plants.

Table 6 provides an alternative summary of plant productivity distribution and its changes over time. It reports the quartiles of cross-sectional productivity distribution for total manufacturing and twelve disaggregated industries in 1990, 1994, and 1998. The table shows that there is a clear rightward shift in the productivity distribution over time. In the case of total manufacturing, the median plant experienced a productivity improvement of about 26 per cent over the 1990-98 period, which corresponds to an annual growth rate of about 3.2 per cent. All twelve industries have positive productivity growth by the median plant during the 1990-98 period, although the growth rate varies substantially across industries. Communication equipment and transport equipment show the largest median plant productivity improvement of 68 per cent and 47 per cent, respectively, while wood and pulp (2 per cent) and food and beverages (10 per cent) show the lowest growth rates. Productivity growth rates by the median plant of the other industries range from 22 per cent to 33 per cent. The productivity growth of the median plant is accompanied by the roughly similar growth rates of the 25th and 75th percentiles in each of the industries, indicating that the shape of the productivity distribution did not change much during the eight-year period.[6]

The discussion above suggests that plants are heterogeneous in terms of productivity levels. It also suggests that aggregate productivity growth involve the productivity improvement of most plants that are observed. However, this discussion does not shed light on the patterns of micro plant dynamics underlying the aggregate productivity change. In the previous section, it was shown that there is a substantial amount of entry and exit of plants even at annual frequencies. In addition, plants that stay in the market over a certain time interval could move across productivity distribution. This suggests that the micro plant dynamics underlying Figure 1 might be very complex.

We do not attempt to characterise fully the complex plant dynamics in this paper. Instead, we focus below on a subset of questions, using the data for Korean manufacturing, which have been often raised in the literature. A short list of those questions is as follows. Do plants exit because they are inefficient? Are

6. In fact, the interquartile range increases slightly during the 1994-98 period for most industries. However, this phenomenon is largely due to the rapid rightward shift of the 75th percentile relative to 25th percentile in 1998.

entrants more or less productive, at the time of entry, relative to continuing plants or exits? How about switch-ins and switch-outs? How do surviving entrants perform in terms of productivity after entry? What is the pre-exit productivity performance of exiting plants like? How persistent is the productivity differential among plants? As we move along these issues, we hope to determine whether the observed plant turnovers or, more broadly, resource reallocation among plants reflect underlying differences in productivity and whether those differences are not an outcome of a transitory or random event.[7]

Productivity differential among entering, exiting and continuing plants

As the first step toward identifying the relationship between plant productivity and plant turnover patterns, we compare productivity levels of continuing plants, entrants, and exiting plants at the time of entry and exit. We also examine the productivity levels of switch-in and switch-out plants that might be different from birth and death. Table 7 shows the unweighted mean productivity levels of plants in total manufacturing that are observed at a given year for each of the five plant groups.

The main features of Table 7 could be summarised as follows. First, deaths in a given year are, on average, less productive than continuing plants in that year. Depending on the year, they are about 3 to 6 per cent less productive than continuing plants. This result is consistent with the prediction by models of plant or firm heterogeneity that market selection forces sort out low-productivity plants from high-productivity plants. Also, this result is not unique to the Korean manufacturing data but reported by many studies for other countries.

Second, births are on average less productive than continuing plants in the first year they are observed. They are even less productive than deaths. In fact, the productivity of a typical birth plant is the lowest among all groups of plants in every year. Initial low productivity of birth plants relative to continuing plants or deaths is not consistent with the presence of the simple vintage effect that new plants are more productive than older plants. However, it is not necessarily contradictory to the prediction of several recent models of plant dynamics, such as Jovanovic (1982) and Hopenhayn (1992). Potential entrants who are uncertain about their productivity but hold a positive outlook on their post-entry productivity performance - *i.e.* who expect they could catch up with the incumbents in terms of productivity sooner or later - might enter despite their initially low productivity. Of course, birth plants themselves are also heterogeneous in terms of productivity, as will be discussed later.

Initial low productivity of births relative to incumbents is also documented by other studies, although these studies differ from ours in data and methodologies. For example, Aw, Chen, and Roberts (1997), using firm level data on Taiwanese manufacturing industries, reports that entrants in 1986 are, depending on industry, between 0.6 per cent and 6.9 per cent less productive than incumbent firms in the same year. Meanwhile, Foster, Haltiwanger, and Krizan (1998), using plant level data on US manufacturing and based on ten-year interval analysis, reports that there is no statistical difference between continuing plants and entering plants in terms of multifactor productivity in 1987 (Table 10). However, the same table shows that the cohort of plants that entered during the past five-year period, rather than ten-year period, shows lower productivity than continuing plants in 1987.[8]

7. The question of persistency in productivity is related to the question of what is the source of the productivity differential among plants. In this paper, however, we do not pursue this question in detail. For a brief review of the theoretical literature on reasons for heterogeneity in plant-level and firm-level outcomes, see Baily, Hulten and Campbell (1992), Davis and Haltiwanger (1998) and Foster, Haltiwanger and Krizan (1998). Baily, Hulten and Campbell also examine this issue empirically in detail.

8. They report, however, that in terms of labour productivity entering plants have lower productivity than continuing plants even at ten year intervals.

Third, switch-in or switch-out plants have higher productivity than birth or death, respectively. The productivity of those plants is roughly comparable to the continuing plants on average. Recalling our definition of plant groups, switch-ins are distinguished from birth in that they have a previous experience in another market defined at five-digit level. Thus, higher productivity of switch-ins relative to births is consistent with the idea that previous experience at related market helps. It would not be surprising to find higher productivity of switch-outs relative to deaths, since switch-outs are distinguished from deaths in that they continue their operation for the next year at another market. The finding that switch-outs have productivity level comparable to continuing plants seems to suggest that high productivity plants have mobility. However, it could also be consistent with the story that multi-product plants have both high productivity and mobility. High productivity could come from the possible spillovers generated by producing multiple related products, and mobility could come from, given the presence of sunk costs, the ease of changing product mix relative to restarting a business at an entirely new product market.

Fourth, each new cohort of birth is more productive than its previous cohorts. This fact conforms well with the presumption of recent R&D-based endogenous growth models, such as Grossman and Helpman (1991), that potential entrants receives externality from previous innovation.

The above discussion suggests that observed patterns of plant turnovers reflect the underlying productivity differential. In order to examine the statistical significance of the productivity differential among plant groups, we also present the results from dummy variable regressions which are similar to the regressions in Aw, Chen, and Roberts (1997). Table 8 reports the regression results using the pooled 1990-98 data. The measured plant level productivity is regressed on a set of dummy variables indicating whether the plant is a birth, switch-in, death, or switch-out, and year dummies (not reported). Thus, the estimated coefficients can be interpreted as the average productivity differential between each group of plants and continuing plants which is assumed to be common across years.

The regression for total manufacturing shows that the difference in productivity between continuing plants and each of the other groups of plants is statistically significant. Births and deaths are less productive than continuing plants by 6.3 per cent and 4.2 per cent, respectively. Switch-ins and switch-outs are statistically more productive than continuing plants, although the differences are small. The fifth column of Table 8 tests the hypothesis that there is no productivity differential between birth and death. The reported F-statistic shows that the hypothesis is rejected at usual significance level. We also tested the hypothesis that there is no productivity differential between births and switch-ins and it was rejected. The hypothesis of there being no productivity differential between deaths and switch-outs was also rejected.

We then ran the same regression separately for each of the twelve industries. The estimated coefficients show that in every industry births and deaths are significantly less productive than continuing plants. The productivity differential between births and continuing plants ranges from 3 per cent (medical and precision instrument) to 13 per cent (food and beverages). In the case of deaths, the differential is also the smallest at 2 per cent in medical and precision instrument and the largest at 10 per cent in food and beverages. The hypothesis of there being no productivity differential between births and deaths is rejected at 1 per cent significance level in nine of the twelve industries.

The column two and four in Table 8 reveal that the high productivity of switch-ins and switch-outs relative to continuing plants estimated for total manufacturing masks the industry differences. It turns out that, depending on the industry, the productivity of switch-ins and switch-outs can be either higher or lower than continuing plants. However, in all of the twelve industries, switch-ins and switch-outs are significantly more productive than births and death, respectively.

The analysis so far reveals that plant turnovers, especially entry by birth and exit by death, are not random events. In other words, the productivity of birth and death plants are more likely to be located at lower part of the cross-sectional productivity distribution shown in Figure 1. In particular lower productivity of deaths relative to continuing plants indicates that market selection forces are at work as predicted by theoretical models of plant or firm dynamics. Market selection of low productivity plants from surviving high productivity ones is a process that enhances the aggregate level productive efficiency.

Even though lower productivity of births relative to continuing plants or even death is not inconsistent with the prediction of theoretical models and often found for other countries, however, it could cast doubts on the positive role of exit and entry on aggregate efficiency gain. That is, it suggests that the *instantaneous* effect of resource reallocation by plant deaths and births on aggregate productivity growth might be very small or even negative, which might be true especially if the resources released by deaths are entirely used up by births. If this is the end of the story, then any positive role of plant turnovers on improvement of aggregate productivity measured at certain time interval will be an accounting result arising from current births having higher productivity than past deaths.

However, this is not the end of the story. The literature points out that the benefits of the resource reallocation by exit and entry are realised *over time.* First, examination of post-entry performance of entrants reveals that entrants are a heterogeneous group going through the process of market selection themselves. More importantly, it is frequently documented that the surviving members of entrants experience fast productivity improvement or rapid learning and catch up to the incumbents after a certain period of the entry. In other words, plant exit and entry is a process of resource reallocation from inefficient plants to a group of heterogeneous plants, some of which have the potential to become highly efficient in future. Second, it has also been noted that exiting plants are less productive than continuing plants not just at the time of exit but also for a certain period before exit. That is, there is a "shadow of death" effect. The productivity gap between exiting plants and continuing ones often widen over time before exit.[9] In other words, the process of plant productivity is not purely random but highly persistent over time, indicating the presence of plant-specific effects. Then, plant death or survival might reflect not just temporary misfortune but also plant-specific factors that will be fixed over time, such as managerial ability. Thus, we examine below post-entry and pre-exit performance of plants, focusing on market selection, learning, and persistency of plant productivity using the data on Korean manufacturing.

Post-entry performance: market selection and learning

We examine whether the market selection forces sort out low productivity plants among births. In our sample, there are eight cohorts of birth according to birth year, 1991 to 1998. Focusing on a particular birth-year cohort has the advantage that possible age effect on survival are controlled for. Specifically, we examine whether plants that belong to 1991 birth cohort but die in 1993 have lower productivity at the time of death than the other surviving members of the birth cohort. In order to do this, plant productivity is regressed on a set of year dummies (not reported) and a dummy variable denoting whether the plant died after birth within the sample period interacted with year dummies. Thus, the estimated coefficients denote the productivity differential between deaths and survivors at the time of death. The regression results for three birth cohorts are reported in Table 9.

The table shows clearly that, for each birth-year cohort reported here, exiting plants has lower productivity than surviving ones at the time of exit, even after controlling for the birth year. Also, the differences are highly significant. Depending on cohort year or death year, the deaths are less productive than surviving plants by about 3 to 6 per cent. Thus, the results strengthen the conclusion we draw earlier that markets sort out plants on the basis of productivity.

9. See Liu (1993) for evidence on Chilean manufacturing.

Next, we examine the productivity performance of the surviving members of the entrants relative to continuing plants. Figure 2 and Table 10 shows the average productivity of birth cohorts that survived until 1998 by birth year, in comparison with continuing plants in 1991 that also survived until 1998. Continuing plants have increased their productivity steadily and experienced their average productivity by about 23 per cent during the 1991-98 period. Each birth-year cohort starts with productivity disadvantage relative to continuing plants at entry year.

However, each birth cohort shows very rapid productivity improvement following entry, and catches up with continuing plants in productivity level after several years. The productivity differential between births and continuing plants at the time of entry ranges from 6 to 10 per cent depending on the birth year. In the second year after entry, the productivity differential narrows to only about 0 to 3 per cent. The productivity growth between the first and the second year by births is very large. It is between 6 per cent (1995 birth cohort) and 13 per cent (1994 birth cohort). In the third year after entry, the productivity level of births is roughly the same as, or even slightly higher than, continuing plants. The 1991 birth cohort in particular, which has the longest time series, maintains higher average productivity than continuing plants three years after entry. For some years these differences are statistically significant. Similar conclusion also holds for 1992 birth cohort, which is shown in Table 10. Thus, the results are clearly supportive of the presence of rapid learning by surviving members of births, especially during the first several years after entry.

Table 11 examines the convergence in productivity of surviving births to continuing plants for each of the twelve disaggregated industries. Specifically, it compares the average productivity levels of continuing plants and births as of 1991 that did not exit the five digit level industry either by death or switch-out until 1998. The reported coefficients are the average productivity differential between the two groups. Overall, the results indicate that the experiences of the twelve industries are consistent with the initial productivity disadvantage and subsequent learning of surviving births. The coefficients on the dummy variable for 1991 are negative and significant in most industries. However, the coefficients tend to become insignificant or turn positive as years go by.

Of course, the experiences of the twelve industries are diverse. In some industries, surviving births either catch up or overtake the continuing plants in productivity levels. In non-metallic mineral product and machinery and equipment industries, the productivity advantage of surviving births over continuing plants is statistically significant. There are also industries, however, where the surviving births never catch up with continuing plants, such as food and beverages and communication equipment industries. Even in these industries the productivity disadvantage of surviving births in later years is smaller than in earlier years.

The examination of post-entry performance of births using the plant-level Korean manufacturing data reveals the presence of both market selection and learning process. Births are a heterogeneous group themselves among which low productivity plants die over time. Surviving members of births experience fast productivity improvement or rapid learning after entry and catch up with continuing plants in productivity level within approximately three years. Examination of early year birth cohorts with longer time series reveals that those plants overtake continuing plants in productive efficiency in relatively short period of time. These results are broadly consistent with those reported by studies on other countries. Thus, it is strongly supported by the present study that plant exit and entry is a process of resource reallocation from inefficient plants to a group of heterogeneous plants some of which have the potential to become highly efficient in future.

Productivity performance by exiting plants

So far it has been found that there are certain patterns in the post-entry performance of births: market selection and learning. Here, we examine another dynamic aspect of our data set in order to understand the role of plant exit and entry on aggregate productivity growth: pre-exit performance of deaths.

Figure 3 and Table 12 show the time series of average productivity of plants that existed in 1990 grouped by the death year cohort, in comparison with plants that survived throughout the sample period. As could be expected from the previous discussion, with the exception of 1993 death cohort, the average productivity of each death cohort in the last year it is observed is the lowest among all cohorts. For example, the productivity of 1997 death cohort is the lowest in 1997, and the productivity of 1996 death cohort is the lowest in 1996, and so on. There are two additional points to be noted.

First, there is a significant productivity gap not only at the time of death but also for years before death between each death cohort and the group that survived until 1998, even though each death cohort experienced productivity gain over time. This phenomenon suggests that plant deaths reflect underlying productivity differences that have existed for quite a period of time. In other words, those differences are not just an outcome of a random or transitory bad luck. To take an example of 1997 death cohort, the productivity disadvantage relative to the surviving group is about 6.5 per cent in 1997. However, the productivity differential goes as early as 1990, when it is as large as 3.7 per cent already. Similar results hold for other death cohorts. Thus, plant deaths seem to reflect not only point-in-time productivity disadvantage around death but also persistently bad productivity performance.

Second, the productivity differential between deaths and surviving plants tends to widen, especially during the period close to death year. To take an example of 1997 death cohort again, the productivity differential fluctuates between 3.5 and 4.7 per cent during 1990-96 period, but in 1997 it rises to 6.5 per cent. Similar patterns are found for other death-year cohorts.

In order to examine whether the persistent and widening productivity gap before death reflects industry differences, we also compared, for each of the twelve industries, the average productivity level of 1997 death cohort with the surviving group among the plants observed in 1990. Here, switching-out plants after 1990 were removed from both groups. Table 13 shows the regressions of productivity on a set of year dummies (not reported) and a dummy variable denoting 1997 death cohort interacted with year dummies. Thus, the reported coefficient indicates the average productivity differential between the 1997 death cohort and the group of plants that survived until 1998.

Most coefficients reported in Table 13 is negative and frequently significant, consistent with our previous results. The productivity of deaths is lower than survivors in 1997 and the differences are statistically significant at 5 per cent level in eight of the twelve industries. In basic metals and machinery and equipment industries, it is significant at 10 per cent level. Seven industries show productivity difference significant at 5 per cent level in 1995 out of those eight industries. In addition, seven industries show significant productivity differential as early as 1990. Finally, ten industries show larger productivity differential in absolute terms in 1997 compared with 1995.

So far we examined pre-death productivity performance of death cohorts relative to surviving groups of plants and observed large and persistent productivity differences. They often widen over time during the period close to death year. Such large and persistent productivity differences observed in Figure 3, however, might reflect not only whether or not plants survive but also other factors that differ between survivors and deaths, such as plant age. That is, younger plants are less productive and die more frequently than older plants. In order to control for this possible age effect on productivity and survival, we also looked at pre-death performance of plants that are born in the same year.

Figure 4 shows pre-death productivity performance of 1991 birth cohort that is further divided by the death year, in comparison with the 1991 births that survived until 1998. For comparison, the productivity performance of 1991 continuing plants that survived until 1998 is also shown. As expected, the persistence of productivity differential among 1991 births is somewhat weaker than suggested by Figure 3. That is, the 1991 births that dies before 1998 do not show noticeable productivity disadvantage in the early years of their beginning of operation compared with the surviving group. Especially in the first year of operation, 1991, there is virtually no productivity differential among them, except 1996 deaths. Moreover, for the several years after entry, the productivity differential between 1991 births and 1991 continuing (and surviving until 1998) plants narrows over time.

However, as surviving members of 1991 births improve their productivity at fast speed, the productivity gap begins to develop and persists over time. In addition, for each death-year cohort among 1991 births, the productivity disadvantage relative to the continuing group becomes the largest in the last year they are observed. Thus, even if the possible age effect on productivity and survival is controlled for, it still holds that plant deaths reflect somewhat persistent productivity disadvantage that often widens during the period close to death.

If productivity differential between deaths and survivors are persistent, then it is expected that the initial productivity of a plant at a point in time is correlated with whether that plant dies within certain period or not. To examine this, we first chose plants in 1993 which belong to the group of continuing plants, births, or deaths. Then we further divided these groups according to whether the plants survived until 1998. Table 14 shows the average productivity of each group, expressed as the difference from the productivity of continuing plants that died within five years, and statistical test results on equal productivity between survivors and deaths. We report the results for 1993 only, since the results for other years are qualitatively similar. Thus, the table shows any productivity differential between plants that survived more than five years and those that did not, conditional on 1993 status.

Within continuing plants, plants that survived until 1998 had clearly higher productivity in 1993 than those that died before 1998. The average productivity differential for total manufacturing is about 4 per cent and it is statistically significant. Out of twelve disaggregated industries, ten industries show productivity differences that are statistically significant at 1 per cent level.

Within births, however, there is not a clear initial productivity differential between survivors and deaths, even though the average productivity of the former is higher than the latter in many industries. The F-test statistics show that the difference is significant in only two of the twelve industries. This result is consistent with the previous result from Figure 4 that the first year productivity of births does not differ much across death-year cohorts. Similar results hold for switch-ins, which would not be surprising since both births and switch-ins are newcomers in a market defined at five digit industries.

At first sight, the observation that there is no clear initial productivity differential among births between survivors and deaths over five-year period seems to run counter to the results by Aw, Chen, and Roberts (1997). For seven out of nine Taiwanese manufacturing industries, they found that there exists a significant productivity differential in 1986 among 1981-86 entrants between survivors and deaths over the subsequent five-year period. However, the two studies differ, among others, in that the average age of births in our study is only 0.5 year while average age of entrants in their study is about 2.5 years.

Motivated by this observation, we decided to examine whether there is a productivity differential among births after several years after entry depending on whether those plants survive or not over the subsequent period. Specifically, we examined the productivity differential as of 1994 among 1990-94 births between plants that survived until 1998 and those that did not. Table 15 shows that the productivity differential is significant for total manufacturing. In addition, five out of 12 industries show clear productivity differential among birth between survivors and deaths. Thus, comparison of the results in Table 14 and Table 15 indicates that even though there may not be a clear productivity differential within a birth-year cohort in the first year of their entry, the productivity differential arises over the years. This is also consistent with Figure 4 where the surviving members of the 1991 birth cohort differentiates themselves from others in terms of productivity after several years after entry. Thus, the results found in this study for Korean manufacturing are not at odds with those for Taiwan.

In short, the patterns of plant survival or exit reflect productivity differential at an earlier year in Korean manufacturing. In other words, plant death or survival might not be an outcome of random productivity shock but reflect persistent productivity differential.

Transition matrix analysis

We have presented above quite a few pieces of evidence consistent with market selection, learning, and persistence of plant productivity, by focusing on the *average* productivity differentials among various plant groups. However, there could be high productivity entrants as well as low productivity ones. The same can be said about exiting plants. Even among continuing plants, there might be movement of plants across productivity distribution over time. One useful way of summarising the above features of our data and complement our previous analysis is to rely on transition matrix analysis.

We set up transition matrices for various time intervals following Baily, Hulten, and Campbell (1992) (BHC henceforth), but focus primarily on five-year transition during 1990-95 period. The primary reason for our interest in five-year transition is to make our results comparable to theirs, so that any similarities or differences between Korean manufacturing and the US might be found.

In order to do this, the plants within each five-digit industry are ranked according to their relative productivity in each year and divided into quintiles. Then, for each quintile in 1990, we calculate what fractions of those plants are in each quintile in 1995 in their own industry and what fractions have either died or switched out to another industry. Among the plants that are observed in 1995, there are also births and switch-ins during the 1990-95 period. We can also examine where in the productivity distribution the births and switch-ins started, by calculating the fractions of those plants that are in each quintile in 1995. Table 16 shows the transition matrix which has been weighted by employment size measured by number of workers. For entrants in 1995 and exits in 1990, the weights denote number of workers in the year they are observed. For continuing plants that are observed in both years, the weights are the average number of workers in the two years.

Starting from the first row of the table, of the plants that were in the top quintile in 1990, about weighted 28.5 percent of them are again in the top quintile in 1995. However, the fractions of those plants that experience downward movement in relative productivity ranking decrease monotonically. The drop in the percentage as we move rightward along the first row is so huge that only about 3 per cent of those plants were in the bottom two quintiles in 1995. Among the plants that were in the second quintile in 1990, 16.6 per cent of them stayed in the second quintile and roughly equal fraction of them moved up to the first quintile in 1995. However, the percentage decreases rapidly and monotonically as we move off the diagonal to the right.

When there is a persistency in productivity it is expected that the relative productivity rankings does not change much over time and the diagonal numbers of the transition matrix tend to be bigger than off-diagonal ones. The discussion above suggests that plant productivity in Korean manufacturing is very persistent, especially in the top of the productivity distribution. Similar results are also reported for the US manufacturing by BHC.

However, the persistency is less visible in the middle and bottom of the productivity distribution. Of the plants that were in the third quintile in 1990, only about 7.7 per cent stayed in the same quintile. In this case, about 28.7 per cent move up to top tow quintiles, while only about 10.1 per cent moved down to bottom two quintiles in 1995. There is somewhat lower persistency also in the bottom two quintiles in 1990. Most of those plants either move up in the productivity distribution or exit the industry by switch-out or death. Especially in the case of bottom quintile in 1990, a weighted 12.7 per cent moved into the third quintile while only 6 percent stayed in their own quintile in 1995. Of course, a huge fraction of them (68.7 per cent) either exited the industry either by switch-out or death.

We also calculated the unweighted transition matrix during 1990-95 period, which is reported in Table 17, where the numbers denote percentages in terms of number of plants. In the unweighted matrix, all of the diagonal numbers are bigger than off-diagonal numbers. In this case again, however, the persistency is marked in the top of the productivity distribution.

Based on the US manufacturing data, BHC reports that there is not much evidence of a systematic plant vintage effect. In our data, the systematic evidence in favour of plant vintage effect is hard to find, either. If plant vintage effect is present, then it is expected that older plants move down the productivity distribution over time. Among the plants in the second quintile in 1990, more of them moved up to the first quintile than down to the third quintile. In the third quintile again, there were by far more plants that moved up than those that moved down over time.

The transition matrix also shows the percentage of plants for each quintile in 1990 that exited their own industry. As expected, the percentage of death conditional on the 1990 productivity quintile gets higher as we go down the productivity quintiles. In the top quintile about 22.6 per cent of the plants, weighted by employment, died within five years, while as much as 43.5 per cent died in the bottom quintile during the same period. If we look at unweighted matrix, the same pattern exists but the numbers gets higher. Even in the top quintile about 46.0 per cent did not exist after five years, while in the bottom quintile the corresponding number is as large as 57.0 per cent. Larger percentage of deaths in the unweighted matrix indicates that plants that dies during the period are usually small ones. One interesting observation here is that there are many high productivity deaths that are small in size. A similar result is reported by BHC for the United States.

The percentages of switch-outs are roughly even across 1990 productivity quintiles. In fact, the weighted matrix shows that the switch-outs are more frequent in the top and bottom of the productivity distribution. Not only high productivity plants but also low productivity one are more likely to move to another industry. The unweighted matrix shows, however, that in terms of number of plants high productivity plants are more likely to switch out than low productivity one. As discussed before, it is not clear whether this phenomenon reflects the general mobility of high productivity plants or the advantage of multi-product plants coming from the technological spillovers and the ease of entry by changing product mix.

The transition matrix also shows the relative productivity of entrants during 1990-95 period. Here, births and switch-ins that died during the period are not in the sample. Thus, the entrants in the sample are relatively successful ones that partly went through the process of market selection and learning, with average experience in the industry of 2.5 years. The table shows that both switch-ins and births are moderately concentrated in the high productivity quintiles. Relatively high productivity of birth does not contradict our previous result that births have lower productivity than continuing plants in the first year they are observed. In fact, we already showed in Figure 2 that in Korean manufacturing it does not take many years for the surviving births to catch up with continuing plants in terms of productivity. Thus, it would not be surprising to find higher productivity of birth relative to continuing ones, which has gone through market selection and experienced learning for 2.5 years on average. Meanwhile, in terms of number of plants, the births are slightly concentrated on the lower quintiles. This implies that birth plants in the top productivity quintiles are bigger in size by 1995 than those in the bottom quintiles.

We also examined transition matrices for various time periods. Since the results are not much different from the five-year transition matrix discussed here, we do not present all of them. However, even in the eight-year transition matrix (1990-98 period) reported in the Appendix B, we could observe moderate degree of persistency in productivity. Of course, shorter period transition matrix tended to show stronger persistency. Also, longer period transition matrix showed larger selection and learning effect of successful births.

So far we have examined the transition matrices of plant relative productivity and discussed mainly around results similar to those for the US manufacturing. However, it might be useful to summarise this section by pointing out several aspects of the Korean data that apparently differ from Baily, Hulten, and Campbell (1992). First, even though the data are consistent with persistency of productivity, the degree of persistency seems to be weaker in Korea than in the United States. To take one example, weighted 60.8 per cent of the plants in top quintile in 1972 were again in top quintile in 1977 while only 14.9 per cent of them moved down to the second quintile, in the US manufacturing (Table 3 of BHC). However, the corresponding numbers are 28.5 and 13.4, respectively, in the Korean manufacturing.

Second, the fractions of entrants and exits are much larger in Korea than in the United States, during the five-year interval. In BHC, only 11.2 per cent of the bottom quintile in 1972 either switched out (5.5 per cent) or died (5.7 per cent), while the corresponding number is as large as 68.7 per cent (25.3 per cent for switch-outs and 43.5 per cent for deaths) in Korea. Plant turnovers are much more frequent in Korean manufacturing than in the United States.

Finally, the time it takes for surviving entrants as a group to become as productive as continuing plants seems to be somewhat shorter in Korean manufacturing than in United States. For example, in the case of Korea, weighted 25.6 per cent of births during 1990-95 period were in the top quintile and only 16.5 per cent of them were in the bottom quintile in 1995. However, the corresponding numbers for the United States. are 20.8 per cent and 29.3 per cent, respectively: low productivity entrants were the largest even at five-year interval. This might be related to both high frequency of death by unproductive plants and fast learning in Korea.

4. Exit, entry and aggregate productivity growth

In this section, we examine what effect the entry and exit of plants, or more broadly, the resource reallocation among plants has on aggregate productivity growth. In order to do this, we begin by defining the level of industry total factor productivity in year t as follows.

$$\ln TFP_t = \sum_i \theta_{it} \ln TFP_{it} ,$$

where θ_{it} is the market share of the ith plant in five-digit level industry and $\ln TFP_{it}$ is plant total factor productivity calculated as described in Appendix A. Then, the industry TFP growth rate between year t and t-τ is

$$\Delta TFP_t = \sum_i \theta_{it} \ln TFP_{it} - \sum_i \theta_{it-\tau} \ln TFP_{it-\tau} .$$

Following Baily, Hulten, and Campbell (1992), we can decompose the industry TFP growth as follows.

$$\Delta TFP_t = \sum_{i \in S} \theta_{it-\tau} \Delta \ln TFP_{it} + \sum_{i \in S} (\theta_{it} - \theta_{it-\tau}) \ln TFP_{it}$$

$$+ \sum_{i \in N} \theta_{it} \ln TFP_{it} + \sum_{i \in X} \theta_{it-\tau} \ln TFP_{it-\tau} , \qquad (1)$$

where S, N, and X denote the set of continuing plants that operated in both year t and t-τ, entrants, and exits during the period, respectively. Among the entrants, there are births and switch-ins. Similarly, there are deaths and switch-outs among the exits. Thus, the first term in equation (1) represents the "within" component that comes from the improvements in each plant separately, weighted by initial shares in the industry. The second term represents the share effect, *i.e.* the contribution from changes in the output shares.[10] The last two terms represent the contribution of entrants and exits, respectively. The net effect of the entrants and exits will reflect any differences in the levels of productivity between the groups and any differences in the output shares.

Table 18 shows the results of the decomposition for Korean manufacturing for 1990-95 and 1995-98 periods. The manufacturing-average figure weights each five-digit industry result by its share of nominal gross output, averaged over the beginning and ending years of the period. The results for twelve disaggregated industries are presented in Appendix B. The sample period is divided into the two distinct sub-periods as above for the following reasons. First, the literature suggests that the relative contribution of each of the component varies systematically over the business cycle (*e.g.* Baily, Hulten, and Campbell 1992 and Foster, Haltiwanger, Krizan 1998). The first five-year period is intended to capture the patterns observed in the cyclical upturns, even though it does not exactly coincide with the officially reported one.[11] The second reason for dividing the sample period as above is to focus on five-year changes, which will make our results more comparable to other results in the literature.

To begin with, the TFP growth in Korean manufacturing is as high as 23.0 per cent during the 1990-95 period, or roughly 4.6 per cent per annum, but is only 4.7 per cent during the 1995-98 period (about 1.5 per cent per annum). Thus, the measured TFP growth shows well-known procyclicality.

Overall, the decomposition yields strikingly different results between the two sub-periods of cyclical upturn and downturn. The contribution from the within effect is 13.2 per cent during the 1990-95 period, accounting for as much as about 60 percent of manufacturing TFP growth. However, the within

10. The second term can be further decomposed into between-plant component and cross term, as shown in Foster, Haltiwanger, and Krizan (1998). They point out that when there are random measurement errors in output it will generate an upward bias in the correlation between productivity growth and output growth, making the cross term spuriously high in the output-weighted industry productivity growth decomposition. In this paper, we combine the between-plant and cross term into share effect term as in Baily, Hulten, and Campbell (1992) in order to make our results comparable to theirs.

11. The Statistical Office defines 1989 and 1993 as cyclical troughs and 1992 and 1996 as cyclical peaks. Nevertheless, the business conditions improved significantly over the 1990-95 period as a whole so that the decomposition results during this period are expected to show overall patterns observed in upturns, which seems be supported by our results.

effect falls to slightly below zero during the 1995-98 period. Larger role of within effect in aggregate TFP growth during the period of cyclical upturns is consistent with the results for the US manufacturing reported by BHC and Foster, Haltiwanger, and Krizan (1998) (FHK hereafter).

The effect of entry and exit on aggregate TFP growth in Korea is very large. It is as large as 10.5 per cent (2.1 per cent per annum) during the 1990-95 period, accounting for more than 40 per cent of manufacturing average TFP growth during the same period. The effect of entry and exit also falls in 1995-98 cyclical downturn to about 3.1 per cent(1.0 per cent per annum). The diminished effect of entry and exit during this period suggests that the productivity improvements of the entrants also slowed down together with the overall productivity slowdown. However, in percentage terms, the effect of entry and exit rises during the downturn of 1995-98 period: it accounts for more than 65 per cent of the manufacturing aggregate TFP growth. Thus, entry and exit plays a greater role in aggregate productivity growth in cyclical downturns.

Again, this cyclical pattern is consistent with the results for the US manufacturing by FHK. After performing various sensitivity analyses, they report that while the contribution of net entry is sensitive to time period, the pattern is regular in the sense that the contribution of net entry is greater in cyclical downturns. In addition, they also report that the contribution of net entry is robust to the alternative measurement method. This suggests that the large role of entry and exit and its greater role in downturns found in this paper are not likely to result from the use of a particular decomposition methodology.

The contribution of market share reallocation among the continuing plants also varies over the periods. During 1990-95 period, this share effect is negative even though it is small in magnitude. However, during the downturn of 1995-98 period, the share effect turns positive at 1.8 per cent. In terms of percentage contribution, it accounts for about 38 per cent of manufacturing TFP growth during that period. It helps offset the productivity decline of the continuing plants between 1995 and 98. The greater contribution of reallocation among continuing plants during the period of cyclical downturn accords well again with the results for the US manufacturing reported by BHC and FHK.

Taken together, the above discussions suggest that the role of resource reallocation in aggregate productivity growth, by entry and exit or by market share reallocation among continuing plants, tends to be greater during cyclical downturns. During the 1995-98 period, the entry and exit and share effect together explains virtually all of the aggregate TFP growth. In the case of Korean manufacturing, the role of entry and exit seems to be particularly large. Even though the entry and exit effect is smaller and the share effect is bigger during the 1995-98 period compared with the previous five-year period, the former effect is still larger than the latter.

While the cyclical pattern of each component of aggregate TFP growth in Korean manufacturing is quite similar to the United States, the relative importance of each component seems very different between the two countries, controlling for the cyclical factors. Table 19 compares the decomposition results of this study with two of the studies for the United States, Baily, Hulten, and Campbell (1992) and Foster, Haltiwanger, and Krizan (1998), which are reasonably comparable to this study in terms of methodology and data. The second column of Table 19 shows that the relative contribution of within effect for Korea is quite similar to that of the United States by FHK in both business upturn and downturn. The within effect by BHC seems to be bigger than this study in absolute terms, indicating that it is cyclically more volatile than ours.

However, the relative contribution of the entry and exit effect in Korean manufacturing is larger than the United States, regardless of the business condition. In Korean manufacturing, the entry and exit effect accounts for about 45 and 65 per cent in cyclical upturn and downturn, respectively. In the case of the United States, the entry and exit effects from both studies are at best below 40 per cent even in the cyclical downturn when the effect tends to get stronger.[12] Larger role of entry and exit in Korean manufacturing seem to reflect not only fast overall productivity shift and high rate of plant turnover but also strong learning effect documented in this paper.

By contrast, the relative contribution of the share effect in Korea is smaller than in the United States, although there is also a cyclical pattern. Even in the downturn of 1995-98 period when the share effect tends to get larger, the share effect, 0.38, is much smaller than corresponding figures for the United States where the share effect accounts for most of the manufacturing productivity growth. However, the relative minor role of the share effect is frequently reported by studies on developing countries, such as Taiwan, Israel, Chile and Colombia.[13]

To summarise, the cyclical patterns of the contributions from within, entry and exit, and share effects in Korean manufacturing mirrors those found for the US manufacturing. However, in terms of relative importance of each component, the results on Korea differ from the United States Among others, the entry and exit plays an important role in aggregate productivity growth in Korea while, in the United States, its role is more modest. To the contrary, the aggregate productivity growth attributable to market share reallocation is smaller in Korea than in the United States. where much of the productivity growth came from efficient plants getting bigger. However, relatively minor role of the share effect is not unique to Korean manufacturing but frequently reported for developing countries.

5. Summary and concluding remarks

In this study, we examined the micro dynamics of entry, exit, and productivity growth using the plant level data on Korean manufacturing. In order to do this, we documented the patterns of plant entry and exit, examined the relation between plant productivity and turnovers, and assessed the contribution from plant turnovers or resource reallocation among producers to the aggregate productivity change. The following summarises the main findings of this study.

First, there is a large amount of resource reallocation going on in Korean manufacturing through plant births, deaths, switch-ins and switch-outs. Plants born during the past five year period plants account for between 21.5 and 26.2 percent of manufacturing output. A roughly similar portion is attributable to the plants that will die within five years. They account for much larger fraction of the total number of manufacturing plants, indicating that those plants are usually small ones. Switch-ins and switch-outs are almost as important as births and deaths, respectively, in terms of output contribution. Those plants are on average bigger in size than births and deaths. Cross-country comparison of plant birth rate indicates that the turnover rate in Korean manufacturing is higher than in the United States or several developing countries for which comparable studies exist. However, the importance of entry and by birth in Korea is not as much pronounced as in Taiwan.

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12. The two studies differ in their assessment of the importance of entry and exit effect. Baily, Hulten, and Campbell concludes that, even though there is an apparent cyclical pattern, the net effect of entry and exit is not great because the relative productivities of the entrants are not much different from the relative productivities of the exits. By contrast, Foster, Haltiwanger, and Krizan concludes that the contribution from the replacement of less productive exiting plants with more productive entering plants over five or ten year horizon is large, not only due to the overall productivity change but also due to selection and learning effect.

13. See Aw, Chen, and Roberts (1997), Griliches and Regev (1995), Liu and Tybout (1996) for results on Taiwan, Israel, and Chile and Colombia, respectively.

Second, examination of the data on Korean manufacturing reveals that plant turnovers reflect systematic differences in underlying productivity as found in many other countries. Death are on average less productive than continuing plants, consistent with the prediction by models of plant or firm dynamics that market selection forces sort out low-productivity plants from high-productivity plants. Births are less productive than not only continuing plants but also deaths in the first year they are observed. However, the productivity levels of switch-ins and switch-outs are higher than births or deaths and comparable to continuing plants.

The post-entry performance of births shows the presence of both market selection and learning process. Births are a heterogeneous group themselves among which low productivity plants die over time. Surviving members of births experience rapid productivity improvement or learning, especially during the first several years after entry, and catch up with continuing plants in productivity level in approximately three years.

Meanwhile, deaths are less productive than continuing plants not just at the time of death but also for a certain period before death. In other words, plant deaths on average reflect not just temporary misfortune but persistent productivity disadvantage, which seems to indicate the existence of plant-specific effects on plant productivity.

In order to examine whether the persistent productivity differential between deaths and survivors arises from the age differential, i.e., younger plants are less productive and die more frequently than older plants, we also examined the pre-death performance of plants in the same birth-year cohort. As expected, the persistence of productivity differential between survivors and deaths within the same birth-year cohort was somewhat weaker. Especially in the early years of the beginning of operation, there was not a noticeable productivity differential between survivors and deaths within births. However, as surviving members of births improve their productivity at fast speed, the productivity gap begins to develop and persists over time.

Recognising the possibility that the analysis based on the average productivity differential might mask the diversity that exists within the same plant categories, we also utilised the transition matrices. Similar to the results reported by Baily, Hulten, and Campbell (1992) for the United States, the persistence of productivity was noticeable especially in the top of the productivity distribution. In addition, while the plants in low productivity quintiles were more likely to die within five years, there were many high productivity deaths that are small in size. Likewise, the diversity in productivity was present for other plant groups.

Comparison of transition matrices between Korea and the United States, however, revealed not only similarities but also differences. First, the degree of persistency was somewhat weaker in Korea than in the United States. This might be partly due to the fact that there is a higher percentage of young plants that show weaker persistency in productivity in Korea, as has already been documented. Second, the fractions of entries and exits are much larger in Korea than in the United States. Even though the sources of cross-country variation of the turnover rate are not well understood yet, this might be related to factors such as differences in the growth rate and the pace of structural change of the economy and the development of financial market, for example. Third, the time it takes for surviving entrants as a group to become as productive as continuing plants seems to be somewhat shorter in Korea. This might be related to both high frequency of death by unproductive plants and fast learning in Korea.

Finally, we decomposed the productivity growth in manufacturing into the within effect, the entry and exit effect, and the share effect for the periods of 1990-95 and 1995-98. It was found that the cyclical patterns of the contribution from each component in Korea are very similar to those found for the United States. That is, the resource reallocation effect, *i.e.* the entry and exit effect and the share effect, plays a larger role during cyclical downturns. During the 1995-98 period, for example, the combined effect of entry and exit and market share reallocation more than explains away the aggregate productivity growth in manufacturing.

However, in terms of relative importance of each component, the results on Korea differ from the United States. Among others, the entry and exit plays an important role in aggregate productivity growth in Korea while, in the United States, its role is more modest. This seems to reflect not only fast overall productivity shift and high rate of plant turnover but also strong learning effect in Korea as documented in this paper. By contrast, market share reallocation plays relatively minor role in Korea. This finding, however, is not unique to Korean manufacturing but in line with other studies on several developing countries.

Taken together, the evidence presented in this study confirms that the entry and exit of plants has been an important source of productivity growth in Korean manufacturing. Plant birth and death are mainly a process of resource reallocation from plants with relatively low and declining productivity to a group of heterogeneous plants, some of which have the potential to become highly efficient in future. Thus, much of the benefit from the resource reallocation by entry and exit on aggregate productivity growth will be realised over time even though the instantaneous gain might be small.

The most obvious lesson from this study is that it is important to establish policy or institutional environment where efficient businesses can succeed and inefficient businesses fail. In other words, policies that hinder the processes of entry and exit of businesses are likely to be inefficient. Considering the persistently low and declining productivity of deaths and the rapid learning opportunities of births as documented in this paper, the cost of such policies is likely to be very large.

This point would be particularly relevant for Korea these days which is going thorough a process of large-scale corporate sector restructuring. Maintaining exit barriers for firms simply because they are large is highly likely to make matters worse. The evidence of this study suggests that, even though the cost of such policies might not be evident momentarily, it will show up and grow over time in the form of foregone aggregate efficiency gain. Of course, removing all entry and exit barriers *per se* is not likely to guarantee that the outcome is efficient when there are market imperfections for variety of reasons.[14] However, the existence of market failures or poor institutions would not justify the barriers to entry and exit especially if the creative destruction process is an inescapable and essential element of improving the aggregate productive efficiency.

14. Market imperfections can arise for the following reasons, as discussed in Haltiwanger (2000). First, there might be externalities involved in innovation activity. In creative destruction models such as Aghion and Howitt (1992) and Grossman and Helpman (1991), agents do not internalize the impact of their decisions on others so that the resulting pace of creative destruction and, hence, the rate of aggregate growth may not be optimal. Second, Caballero and Hammour (1996) emphasise that the specific investments that firms and workers make combined with contracting difficulties in the formation of production units can disrupt the timing and volatility of creative destruction and hamper the pace of renovation in the economy. Third, and related to the second, markets may be incomplete due to missing insurance and contingent claim market, as Haltiwanger (2000) points out. He argues further that the inability of losers in reallocation process to insure against idiosyncratic risks can be a source of distortion. That is, barriers to the reallocation process can emerge through a variety of interventions in product, labour, trade, and credit markets that are rationalised in terms of protecting against the potential losses to those that would be adversely affected in the reallocation process.

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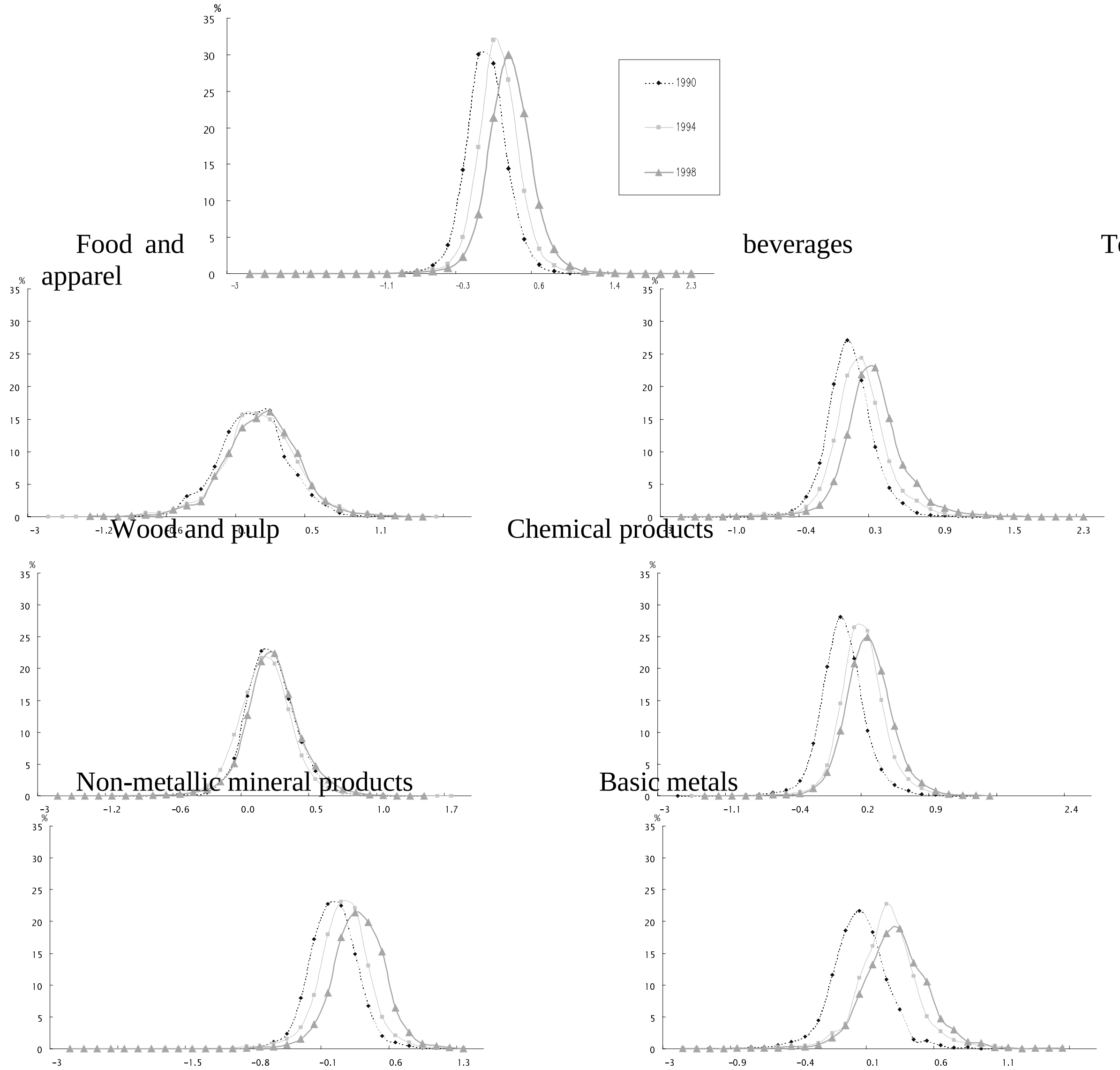
Figure 1. Plant productivity distribution and its changes over time

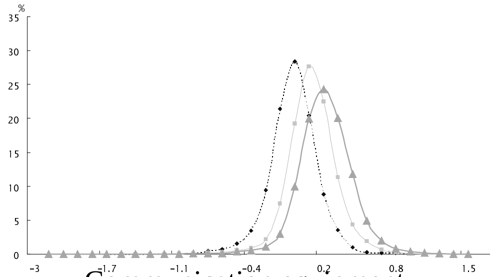
All



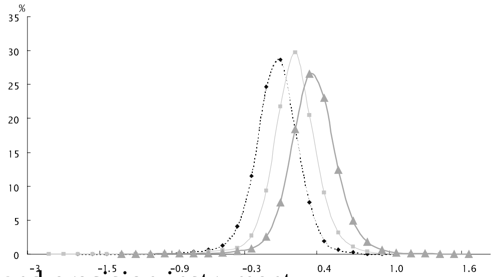
Fabricated metal products

Machinery and equipment

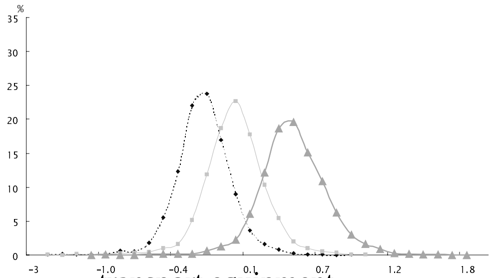
Figure 1. Plant productivity distribution and its changes over time (cont.)



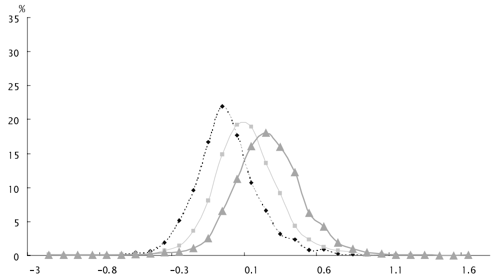
Communication equipment



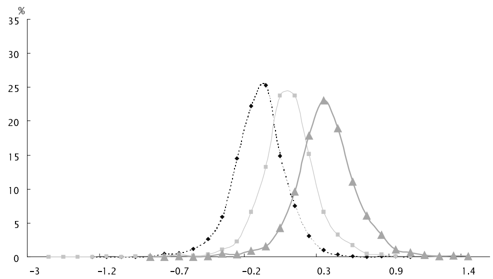
Medical and precision instrument



transport equipment



Others



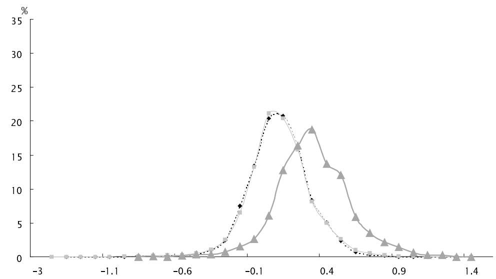


Figure 2. Post-entry productivity performance of surviving births

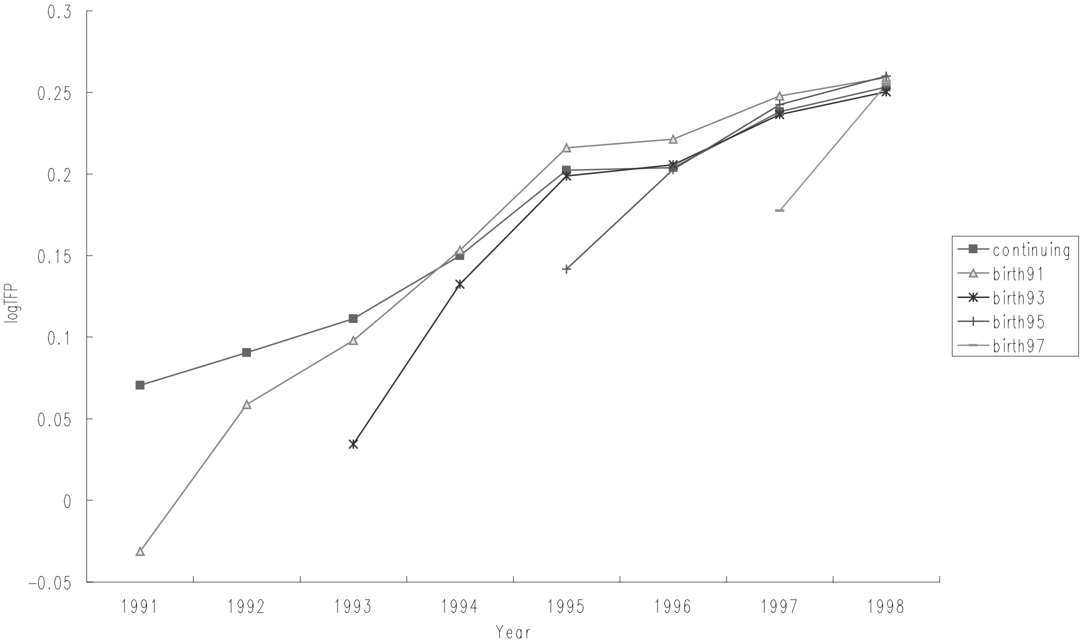


Figure 3. Pre-exit productivity performance of deaths

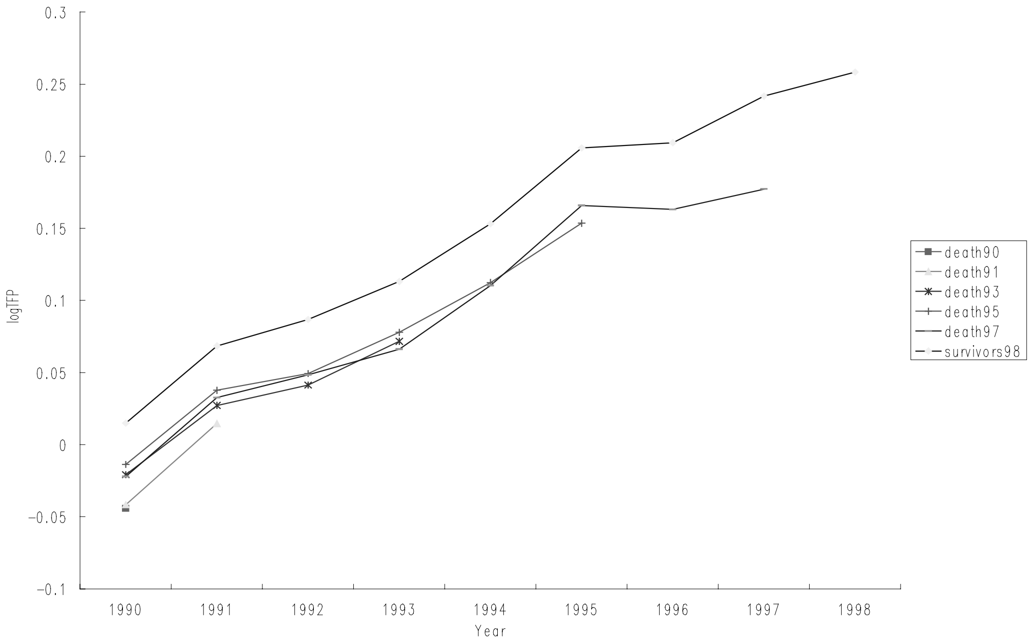


Figure 4. Pre-exit productivity performance of deaths among 1991 births

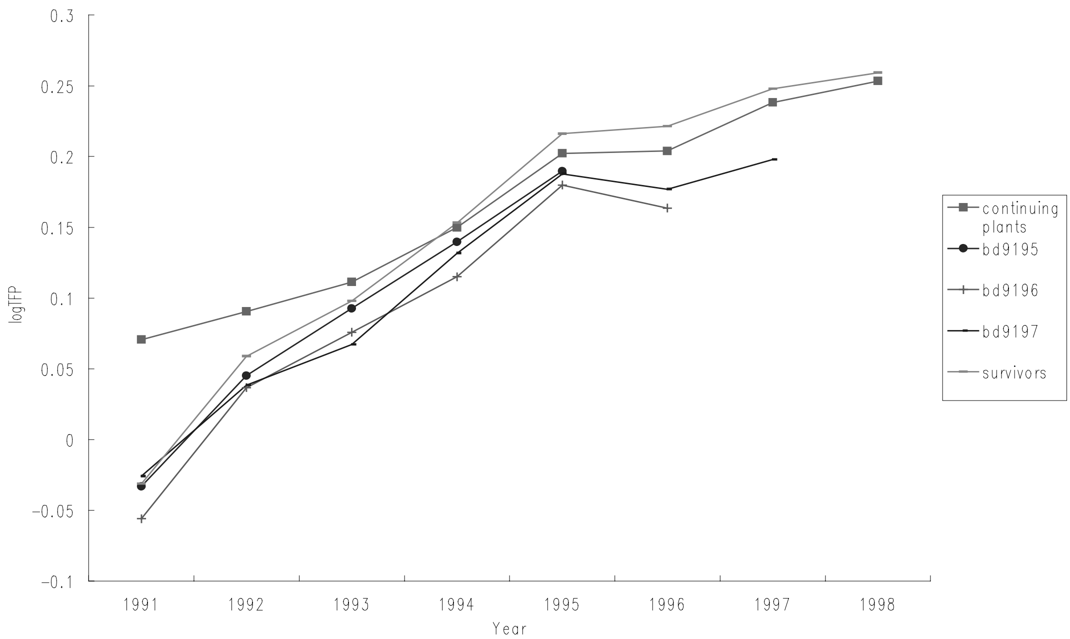


Table 1. Contribution of plant births

(Unit : %)

Year	Under 5 years						Over 5 years	
	1-3		4-5		Total			
	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output
1995	53.32	17.13	14.22	9.09	67.54	26.22	32.46	73.78
1996	47.60	15.36	18.68	11.11	66.29	26.46	33.71	73.54
1997	45.40	14.77	18.67	10.63	64.08	25.40	35.92	74.60
1998	39.45	12.77	18.63	8.68	58.08	21.45	41.92	78.55

Table 2. Contribution of plant deaths

(Unit : %)

Year	Within 5 years						Survive more than 5 years	
	1-3		4-5		Total			
	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output
1990	36.85	13.36	15.71	6.48	52.57	19.85	47.43	80.15
1991	37.41	14.52	17.11	7.62	54.52	22.14	45.48	77.86
1992	39.28	15.08	16.72	7.77	56.00	22.85	44.00	77.15
1993	43.71	14.92	20.23	9.13	63.93	24.05	36.07	75.95

Table 3. Contribution of exits within births

(Unit : %)

Year	Within 5 years						Survive more than 5 years	
	1-3		4-5		Total			
	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output
1991	47.41	40.15	16.84	13.51	64.25	53.65	35.75	46.35
1992	46.38	36.03	17.10	12.20	63.49	48.23	36.51	51.77
1993	55.90	38.58	20.06	12.75	75.96	51.33	24.04	48.67

Table 4. Contribution of switch-ins

(Unit : %)

Year	Within 5 years						Before 5 years	
	1-3		4-5		Total			
	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output
1995	13.09	12.61	5.16	5.72	18.25	18.33	-	-
1996	13.92	11.57	4.47	7.30	18.39	18.88	2.44	3.28
1997	15.32	15.60	4.47	7.29	19.78	22.89	3.44	4.62

Table 5. Contribution of switch-outs

(Unit : %)

Year	Within 5 years						After 5 years	
	1-3		4-5		Total			
	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output	Number of plant	Current Output
1991	14.29	12.36	3.80	3.92	18.09	16.28	2.61	4.60
1992	14.82	10.90	3.46	5.24	18.29	16.14	2.20	1.60
1993	13.08	8.79	4.47	5.68	17.55	14.47	-	-

Table 6. Distribution of plant productivity by industry

	1990	1994	1998
Total	43,259	72,286	62,462
25th percentile	-0.153	-0.017	0.099
Median	-0.018	0.117	0.245
75th percentile	0.122	0.254	0.399
Food and beverages	1,929	3,359	3,303
25th percentile	-0.170	-0.111	-0.103
Median	0.012	0.065	0.085
75th percentile	0.190	0.258	0.274
Textiles and apparel	4,470	8,548	6,840
25th percentile	-0.112	-0.029	0.083
Median	0.012	0.108	0.226
75th percentile	0.143	0.252	0.384
Wood and pulp	5,622	8,857	7,147
25th percentile	0.005	0.069	0.022
Median	0.126	0.203	0.146
75th percentile	0.258	0.335	0.286
Chemical products	6,090	7,958	7,835
25th percentile	-0.150	0.049	0.097
Median	-0.019	0.175	0.236
75th percentile	0.109	0.308	0.390
Non-metallic mineral products	2,066	3,965	3,036
25th percentile	-0.170	-0.057	0.077
Median	-0.022	0.090	0.233
75th percentile	0.131	0.237	0.406
Basic metals	1,761	1,868	1,878
25th percentile	-0.120	0.094	0.137
Median	0.003	0.217	0.270
75th percentile	0.132	0.341	0.420
Fabricated metal products	4,234	8,490	7,604
25th percentile	-0.188	-0.026	0.073
Median	-0.065	0.096	0.211
75th percentile	0.058	0.221	0.357
Machinery and equipment	10,078	15,623	14,520
25th percentile	-0.167	-0.001	0.157
Median	-0.046	0.117	0.284
75th percentile	0.075	0.233	0.416
Communication equipment	1,555	3,243	2,742
25th percentile	-0.347	-0.116	0.309
Median	-0.228	0.015	0.452
75th percentile	-0.097	0.149	0.618
Medical and precision	634	1,375	1,710
25th percentile	-0.142	-0.035	0.098
Median	-0.042	0.091	0.233
75th percentile	0.090	0.227	0.380
Transport equipment	2,593	3,450	3,319
25th percentile	-0.246	-0.034	-0.223
Median	-0.128	0.076	0.343
75th percentile	-0.023	0.190	0.472
Others	2,227	5,523	2,528
25th percentile	-0.083	-0.078	0.125
Median	0.043	0.040	0.265
75th percentile	0.173	0.171	0.437

Note: The figures in the first rows for each industry denote the number of plants.

Table 7. Average productivity of plant groups, 1990-1998

	Continuing	Entry		Exit		Total
		Birth	Switch in	Death	Switch out	
1990	-0.005			-0.044	-0.026	-0.016
1991	0.046	-0.031	0.041	-0.003	0.050	0.026
1992	0.061	-0.005	0.061	0.018	0.068	0.046
1993	0.087	0.030	0.096	0.051	0.101	0.072
1994	0.132	0.056	0.141	0.101	0.144	0.118
1995	0.190	0.132	0.199	0.150	0.202	0.174
1996	0.197	0.143	0.208	0.160	0.214	0.185
1997	0.239	0.177	0.252	0.182	0.245	0.218
1998	0.256	0.200	0.267			0.249

Note: Unweighted averages.

Table 8. Relative productivity of plant groups by industry

	Birth (α)	Switch-in(β)	Death (γ)	Switch-out(δ)	F-Statistics		
					$\alpha = \gamma$	$\alpha = \beta$	$\gamma = \delta$
All	-0.063 (0.001)	0.007 (0.001)	-0.042 (0.001)	0.006 (0.001)	325.1	2598.1	1599.2
Food and beverages	-0.127 (0.007)	-0.009 (0.008)	-0.098 (0.007)	-0.019 (0.007)	10.8	140.7	75.5
Textile and apparel	-0.075 (0.003)	0.019 (0.004)	-0.026 (0.003)	0.015 (0.004)	154.3	404.3	100.2
Wood and pulp	-0.052 (0.003)	-0.001 (0.003)	-0.040 (0.002)	-0.006 (0.003)	15.8	183.5	114.0
Chemical Products	-0.086 (0.003)	-0.016 (0.003)	-0.067 (0.003)	-0.021 (0.003)	28.4	349.9	202.9
Non-metallic mineral Products	-0.088 (0.005)	0.055 (0.007)	-0.083 (0.004)	0.035 (0.007)	0.8	321.5	258.5
Basic metals	-0.084 (0.006)	-0.003 (0.006)	-0.052 (0.005)	-0.014 (0.005)	21.8	129.0	39.7
Fabricated metal Products	-0.056 (0.003)	0.008 (0.003)	-0.034 (0.002)	0.015 (0.003)	55.4	338.8	249.6
Machinery and Equipment	-0.050 (0.002)	-0.003 (0.002)	-0.031 (0.002)	-0.001 (0.002)	87.5	387.0	211.3
Communication equipment	-0.088 (0.005)	-0.018 (0.006)	-0.060 (0.005)	-0.010 (0.005)	22.5	105.8	74.5
Medical and precision Instruments	-0.029 (0.006)	0.019 (0.007)	-0.024 (0.006)	0.023 (0.007)	0.5	32.1	34.7
Transport equipment	-0.071 (0.004)	-0.008 (0.005)	-0.044 (0.004)	0.006 (0.004)	37.2	144.1	123.7
Others	-0.042 (0.004)	0.005 (0.006)	-0.035 (0.003)	0.010 (0.005)	2.4	54.1	69.0

Note: Numbers in the parenthesis are standard errors.

Table 9. Market selection among birth cohorts

	Births 1991	Births 1993	Births 1995
Deaths 1992	-0.065 (0.005)		
Deaths 1993	-0.044 (0.004)		
Deaths 1994	-0.036 (0.004)	-0.042 (0.003)	
Deaths 1995	-0.032 (0.004)	-0.032 (0.003)	
Deaths 1996	-0.048 (0.004)	-0.030 (0.003)	-0.053 (0.003)
Deaths 1997	-0.038 (0.003)	-0.044 (0.002)	-0.039 (0.002)

Note: Numbers in the parenthesis are standard errors.

Table 10. Productivity performance of surviving births relative to continuing plants

	1991	1992	1993	1994	1995	1996	1997	1998
Continuing Plants	0.071	0.091	0.111	0.150	0.202	0.204	0.238	0.253
Births 1991	-0.031	0.059	0.098	0.153	0.216	0.221	0.248	0.259
Births 1992		0.006	0.090	0.150	0.219	0.219	0.246	0.263
Births 1993			0.034	0.132	0.199	0.206	0.236	0.250
Births 1994				0.057	0.190	0.209	0.247	0.261
Births 1995					0.142	0.203	0.242	0.260
Births 1996						0.149	0.241	0.270
Births 1997							0.177	0.255
Births 1998								0.200

Table 11. Productivity performance of surviving births by industry

	Births 1991							
	1991	1992	1993	1994	1995	1996	1997	1998
Food and beverages	-0.238 (0.037)	-0.122 (0.036)	-0.138 (0.038)	-0.088 (0.038)	-0.116 (0.042)	-0.036 (0.040)	-0.103 (0.036)	-0.119 (0.035)
Textile and apparel	-0.136 (0.023)	0.009 (0.023)	0.019 (0.023)	0.005 (0.022)	0.037 (0.022)	0.038 (0.022)	0.021 (0.023)	0.013 (0.022)
Wood and pulp	-0.091 (0.019)	-0.045 (0.019)	-0.016 (0.019)	0.015 (0.019)	0.002 (0.019)	-0.003 (0.019)	-0.004 (0.019)	-0.014 (0.019)
Chemical Products	-0.168 (0.024)	-0.097 (0.024)	-0.051 (0.024)	-0.030 (0.024)	-0.005 (0.024)	-0.039 (0.024)	-0.025 (0.024)	-0.026 (0.023)
Non-metallic mineral Products	-0.095 (0.020)	0.036 (0.020)	0.041 (0.020)	0.063 (0.020)	0.065 (0.020)	0.048 (0.020)	0062 (0.020)	0.08 (0.02)
Basic metals	-0.161 (0.041)	0.014 (0.044)	0.018 (0.044)	0.040 (0.043)	0.059 (0.044)	0.037 (0.044)	0.053 (0.043)	0.071 (0.043)
Fabricated metal Products	-0.034 (0.022)	0.011 (0.022)	0.013 (0.022)	0.009 (0.023)	0.034 (0.023)	0.054 (0.023)	0.021 (0.023)	0.018 (0.022)
Machinery and Equipment	-0.062 (0.015)	-0.016 (0.015)	-0.007 (0.015)	0.010 (0.015)	0.023 (0.015)	0.037 (0.015)	0.032 (0.015)	0.021 (0.014)
Communication equipment	-0.105 (0.041)	-0.083 (0.037)	-0.065 (0.040)	-0.085 (0.031)	-0.024 (0.036)	-0.037 (0.029)	-0.045 (0.029)	-0.060 (0.029)
Medical and precision Instruments	-0.034 (0.042)	-0.043 (0.043)	-0.021 (0.042)	0.038 (0.048)	-0.012 (0.040)	0.013 (0.050)	0.010 (0.039)	0.011 (0.038)
Transport equipment	-0.016 (0.027)	-0.053 (0.029)	-0.014 (0.032)	-0.009 (0.028)	0.004 (0.032)	-0.004 (0.029)	0.004 (0.030)	-0.011 (0.029)
Others	-0.033 (0.031)	-0.006 (0.031)	-0.003 (0.031)	0.045 (0.023)	0.060 (0.025)	0.045 (0.024)	0.009 (0.031)	-0.014 (0.028)

Note: Numbers in the parenthesis are standard errors.

Table 12. Pre-exit productivity performance of deaths relative to survivors

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Deaths 1990	-0.044								
Deaths 1991	-0.042	0.015							
Deaths 1992	-0.033	0.022	0.027						
Deaths 1993	-0.021	0.027	0.041	0.072					
Deaths 1994	-0.027	0.032	0.048	0.079	0.107				
Deaths 1995	-0.014	0.038	0.049	0.078	0.112	0.154			
Deaths 1996	-0.021	0.034	0.046	0.072	0.117	0.164	0.156		
Deaths 1997	-0.022	0.033	0.048	0.066	0.110	0.166	0.163	0.177	
Survivors until 1998	0.015	0.068	0.087	0.113	0.153	0.206	0.209	0.242	0.258

Table 13. Pre-exit productivity performance of deaths relative to survivors by industry

	Year							
	1990	1991	1992	1993	1994	1995	1996	1997
Food and Beverages	-0.153 (0.039)	-0.161 (0.038)	-0.118 (0.031)	-0.105 (0.037)	-0.120 (0.032)	-0.124 (0.041)	-0.118 (0.039)	-0.209 (0.035)
Textile and Apparel	0.007 (0.021)	-0.015 (0.018)	-0.014 (0.018)	-0.029 (0.017)	-0.017 (0.017)	0.001 (0.017)	0.002 (0.017)	-0.053 (0.018)
Wood and Pulp	-0.015 (0.016)	-0.014 (0.016)	-0.033 (0.016)	-0.079 (0.016)	-0.053 (0.016)	-0.040 (0.015)	-0.033 (0.016)	-0.066 (0.015)
Chemical Products	-0.099 (0.024)	-0.080 (0.025)	-0.090 (0.026)	-0.099 (0.025)	-0.087 (0.025)	-0.070 (0.025)	-0.077 (0.025)	-0.099 (0.024)
Non-metallic Mineral Products	-0.067 (0.025)	-0.039 (0.020)	-0.080 (0.020)	-0.066 (0.020)	-0.055 (0.020)	-0.054 (0.020)	-0.075 (0.020)	-0.086 (0.019)
Basic Metals	-0.082 (0.036)	-0.145 (0.037)	-0.107 (0.037)	-0.110 (0.037)	-0.077 (0.037)	-0.061 (0.037)	-0.065 (0.037)	-0.073 (0.036)
Fabricated Metal Products	-0.065 (0.020)	-0.066 (0.020)	-0.049 (0.020)	-0.030 (0.021)	-0.022 (0.021)	-0.023 (0.021)	-0.022 (0.020)	-0.029 (0.019)
Machinery and Equipment	-0.031 (0.014)	0.006 (0.15)	-0.017 (0.015)	-0.001 (0.015)	-0.023 (0.015)	-0.034 (0.015)	-0.035 (0.015)	-0.025 (0.014)
Communication Equipment	-0.048 (0.041)	-0.070 (0.042)	-0.032 (0.041)	-0.052 (0.044)	-0.059 (0.031)	-0.092 (0.041)	-0.085 (0.030)	-0.094 (0.030)
Medical and Precision Instruments	-0.049 (0.068)	-0.064 (0.048)	-0.082 (0.058)	-0.041 (0.053)	-0.056 (0.055)	-0.073 (0.046)	-0.055 (0.053)	-0.045 (0.045)
Transport Equipment	-0.075 (0.026)	-0.102 (0.028)	-0.110 (0.028)	-0.112 (0.029)	-0.076 (0.028)	-0.068 (0.028)	-0.055 (0.028)	-0.088 (0.028)
Others	-0.019 (0.027)	-0.041 (0.027)	-0.073 (0.028)	-0.048 (0.029)	-0.030 (0.019)	-0.023 (0.019)	-0.030 (0.020)	-0.069 (0.027)

Note: Numbers in the parenthesis are standard errors.

Table 14. 1993 productivity differential between deaths and survivors

	Continuing plants that survived (α)	Births that died (β_1)	Births that survived (β_2)	Switch-ins that died (γ_1)	Switch-ins that survived (γ_2)
All	0.038	-0.039	-0.033	0.017	0.040
Food and beverages	0.080	-0.115	-0.039	0.091	0.026
Textile and apparel	0.025	-0.058	-0.044	0.020	0.041
Wood and pulp	0.037	-0.001	0.004	0.048	0.071
Chemical products	0.060	-0.070	-0.030	-0.028	0.022
Non-metallic mineral Products	0.088	-0.053	-0.061	-0.025	0.133
Basic metals	0.053	-0.071	-0.055	0.031	-0.006
Fabricated metal products	0.027	-0.033	-0.032	0.020	0.035
Machinery and equipment	0.005	-0.055	-0.048	-0.007	0.004
Communication equipment	0.057	-0.074	-0.081	-0.024	0.066
Medical and precision instruments	0.048	0.000	0.031	0.034	0.074
Transport equipment	0.037	-0.042	-0.043	0.008	0.040
Others	-0.007	-0.035	-0.038	0.005	-0.020

Test results of productivity difference

	(α > 0)	($\beta_1 = \beta_2$)	($\gamma_1 = \gamma_2$)
All	13.1	1.8	14.5
Food and beverages	4.9	6.7	1.8
Textile and apparel	3.0	0.8	1.1
Wood and pulp	4.5	0.2	1.7
Chemical products	7.2	9.6	10.0
Non-metallic mineral products	8.7	0.1	14.3
Basic metals	3.2	0.4	1.4
Fabricated metal Products	3.2	0.0	0.9
Machinery and Equipment	0.8	0.8	1.2
Communication equipment	3.3	0.1	6.6
Medical and precision Instruments	2.7	1.6	1.2
Transport equipment	3.3	0.0	1.5
Others	-0.5	0.0	0.6

Note: The first column in the lower panel shows t-statistics and the second and the third columns show F-statistics.

Table 15. 1994 productivity differential between deaths and survivors among 1991 births

	1991 Births that died before 1998	1991 Births that survived until 1998
All	0.126 (0.004)	0.027 (0.006)
Food products and beverages	0.070 (0.033)	0.016 (0.042)
Textile and apparel	0.160 (0.012)	-0.022 (0.018)
Wood and pulp	0.199 (0.010)	0.036 (0.016)
Chemical products	0.174 (0.013)	0.037 (0.018)
Non-metallic mineral products	0.080 (0.015)	0.084 (0.021)
Basic metals	0.212 (0.025)	0.048 (0.035)
Fabricated metal products	0.112 (0.011)	0.034 (0.017)
Machinery and equipment	0.133 (0.008)	-0.001 (0.012)
Communication equipment	0.005 (0.015)	0.033 (0.024)
Medical and precision instruments	0.105 (0.028)	0.027 (0.040)
Transport equipment	0.103 (0.014)	0.042 (0.020)
Others	0.057 (0.011)	0.037 (0.019)

Note: Numbers in the parenthesis are standard errors.

Table 16. Five-year transition matrix of relative productivity rankings: weighted by employment

(Unit : %)

	Top 20	20-40	40-60	60-80	80-100	Switch- out during 1990-95	Death during 1990-95
Top 20	28.53	13.42	5.98	1.96	1.06	26.45	22.61
20-40	16.74	16.59	10.23	5.23	1.68	23.20	26.33
40-60	12.09	16.65	7.66	6.16	3.91	20.26	33.26
60-80	4.49	5.95	5.91	6.57	4.74	30.04	42.31
80-100	3.06	4.09	12.68	5.40	6.02	25.27	43.48
Switch-in during 1990-95	28.28	24.52	19.81	16.64	1074	0.00	0.00
Birth and alive During 1990-95	25.63	22.09	18.90	16.91	16.47	0.00	0.00

Table 17. Five-year transition matrix of relative productivity rankings: number of plants

(Unit : %)

	Top 20	20-40	40-60	60-80	80-100	Switch-out during 1990-95	Death during 1990-95
Top 20	11.55	7.16	5.06	3.05	1.84	25.35	45.98
20-40	6.73	6.96	6.61	4.65	2.68	25.32	47.05
40-60	4.43	5.64	6.17	5.74	3.75	24.10	50.17
60-80	3.15	4.18	4.71	5.74	4.76	24.02	53.44
80-100	2.28	3.17	3.83	4.95	7.04	21.70	57.03
Switch-in during 1990-95	20.25	21.56	20.51	20.47	17.20	0.00	0.00
Birth and alive During 1990-95	19.84	19.25	19.69	20.06	21.15	0.00	0.00

Table 18. Decomposition of total factor productivity growth in Korean manufacturing

	Total	Within effect	Entry and exit	Share effect
1990-1995	0.230	0.132	0.105	-0.007
	(1.00)	(0.57)	(0.46)	(-0.03)
1995-1998	0.047	-0.001	0.031	0.018
	(1.00)	(-0.02)	(0.65)	(0.38)

Note: Decomposition is based on the methodology by Baily, Hulten, and Campbell (1992). Numbers in the parenthesis are the relative contributions.

Table 19. Comparison of productivity decompositions between Korea and the United States

Source	Data	Period	MFG Total (%)	Relative Contribution from		
				Within Effect	Entry and Exit	Share Effect
Upturn						
This Study	Korea	1990-95	23.0	0.57	0.46	-0.03
Baily, Hulten, and Cambell (1992)	U.S.	1982-87	15.6	0.87	-0.07	0.20
Foster, Haltiwanger, And Krizan (1998)	U.S.	1982-87	7.3	0.52	0.14	0.33
Downturn						
This Study	Korea	1995-98	4.7	-0.02	0.65	0.38
Baily, Hulten, and Cambell (1992)	U.S.	1977-82	2.4	-0.46	0.40	1.06
Foster, Haltiwanger, And Krizan (1998)	U.S.	1977-82	2.7	-0.09	0.25	0.84

Note: The figures from Foster, Haltiwanger, and Krizan are those based on methodology modified from Baily, Hulten, and Campbell (1992).

APPENDIX A. DATA AND MEASUREMENT OF PLANT PRODUCTIVITY

Data

This study uses the unpublished plant-level data underlying annual Report on Mining and Manufacturing Survey (Survey henceforth) during 1990-98 period. The Survey covers all plants with five or more employees in mining and manufacturing industries and contains information on outputs and inputs that are necessary to calculate plant-level total factor productivity. In this paper, we focused on manufacturing sector. Plant codes are consistently followed over time so that it is possible to identify which plants first appeared in the data set and which plants disappeared. In addition, the industry code for each plant allows us to identify which plants moved to another industry.

Since the Survey covers only those plants with five or more employees, there may be observations that intermittently appear in the data set within our sample period. Even though the Statistical Office conducts census on all plants every five years, it was not possible to incorporate the information on plants with less than five employees into our analysis because they apply entirely different plant coding system to those plants. Since most of our results do not change qualitatively on the inclusion or the exclusion of those borderline observations, which accounts for about 15 per cent of the total number of plants, we decided not to discard those observations. The inescapable cost of such decision is that inaccurate exit and entry status might be assigned to those observations around intermittent period, even though we tried to correct for this problem as far as we can.

Measurement of Plant Level Productivity

We estimate plant productivity using the chained-multilateral index number approach as developed in Good (1985) and Good, Nadiri, and Sickles (1996) and employed in Aw, Chen, and Roberts (1997). It uses a separate reference point for each cross-section of observations and then chain-links the reference points together over time as in Tornqvist-Theil index. The reference point for a given time period is constructed as a hypothetical firm with input shares that equal the arithmetic mean input shares and input levels that equal the geometric mean of the inputs over all cross-section observations. Thus, the output, inputs, and productivity level of each firm in each year is measured relative to the hypothetical firm at the base time period. This approach allows us to make transitive comparisons of productivity levels among observations in a panel data set.[15]

15. Good, Nadiri, and Sickles (1996) summarise the usefulness of chaining multilateral productivity indices succinctly. While the chaining approach of Tornqvist-Theil index, the discrete Divisia, is useful in time series applications, where input shares might change over time, it has severe limitations in cross-section or panel data where there is no obvious way of sequencing the observations. To the contrary, the hypothetical firm approach allows us to make transitive comparisons among cross-section data, while it has an undesirable property of sample dependency. The desirable properties of both chaining approach and the hypothetical firm approach can be incorporated into a single index by chained-multilateral index number approach.

Specifically, the productivity index for firm i at time t in our study is measured in the following way.

$$\ln TFP_{it} = (\ln Y_{it} - \overline{\ln Y_t}) + \sum_{\tau=2}^{t} (\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}})$$

$$- \left\{ \sum_{n=1}^{N} \frac{1}{2}(S_{nit} + \overline{S_{nt}})(\ln X_{nit} - \overline{\ln X_{nt}}) + \sum_{\tau=2}^{t} \sum_{n=1}^{N} \frac{1}{2}(\overline{S_{n\tau}} + \overline{S_{n\tau-1}})(\overline{\ln X_{n\tau}} - \overline{\ln X_{n\tau-1}}) \right\},$$

where Y, X, S, and TFP denote output, input, input share, TFP level respectively, and symbols with upper bar are corresponding measures for hypothetical firms. The subscripts τ and n are indices for time and inputs, respectively. In our study, the year 1990 is the base time period.

As a measure of output, we used the gross output of each plant in the Survey deflated by the producer price index at disaggregated level. As a measure of capital stock, we used the average of the beginning and end of the year book value capital stock in the Survey deflated by the capital goods deflator. As a measure of labour input, we used the number of workers, which includes paid employees (production and non-production workers), working proprietors and unpaid family workers. Here, we allowed for the quality differential between production workers and all the other type of workers. The labour quality index of the latter was calculated as the ratio of non-production workers' and production workers' average wage of each plant, averaged again over the entire plants in a year. As a measure of intermediate input, we used the "direct production cost" in the Survey. However, the intermediate input to output ratio calculated this way was much lower than corresponding figures in Input-Output Table due probably to the fact that the direction cost in the Survey does not include much of the purchased services, such as insurance, transportation, communication, advertising costs, for example. Thus, we adjusted the amount of the intermediate inputs of all plants by the same proportion such that the manufacturing aggregate intermediate input to output ratio become equal to corresponding figure from Input-Output Table. The estimated intermediate input was again deflated by the intermediate input price index.

We assumed constant returns to scale so that the sum of factor elasticities equals to one. Labor and intermediate input elasticities for each plant are measured as average cost shares within the same plant-size class in the five-digit industry in a given year. Thus, factor elasticities of plants are allowed to vary across industries and size classes and over time. Here, plants are grouped into three size classes according to the number of employees: 5-50, 51-300, and over 300.

APPENDIX B. SUPPLEMENTARY TABLES

Table B-1. Eight-year transition matrix of relative productivity rankings: weighted by employment

(Unit : %)

	Top 20	20-40	40-60	60-80	80-100	Switch-out During 1990-98	Death During 1990-98
Top 20	15.89	9.95	5.98	2.40	1.02	27.02	37.75
20-40	9.96	12.66	6.70	6.15	1.84	22.49	40.21
40-60	8.54	14.87	4.46	3.99	2.86	16.97	48.31
60-80	3.27	4.48	3.04	4.26	2.91	23.57	58.47
80-100	2.00	8.81	2.69	2.95	3.76	19.74	60.04
Switch-in during 1990-98	33.57	23.00	20.33	13.85	9.24	0.00	0.00
Birth and alive During 1990-98	25.48	21.98	19.41	18.09	15.03	0.00	0.00

Table B-2. Eight-year transition matrix of relative productivity rankings: number of plants

(Unit : %)

	Top 20	20-40	40-60	60-80	80-100	Switch- out during 1990-98	Death during 1990-98
Top 20	6.41	4.65	3.59	2.27	1.57	17.78	63.73
20-40	4.10	4.43	3.84	3.15	2.21	18.23	64.04
40-60	2.96	3.47	3.36	3.32	2.47	15.90	68.53
60-80	1.95	2.54	2.76	3.18	2.90	15.42	71.24
80-100	1.30	1.78	2.19	2.90	3.78	13.49	74.56
Switch-in during 1990-98	20.17	21.41	20.93	20.52	16.97	0.00	0.00
Birth and alive During 1990-98	20.20	19.46	19.78	20.01	20.54	0.00	0.00

Table B-3. Decomposition of productivity growth by industry

	Total	Within Effect	Entry and Exit	Share Effect
Food and beverages				
1990-1995	0.158	0.098	0.043	0.017
1995-1998	-0.054	-0.062	-0.008	0.016
Textile and apparel				
1990-1995	0.160	0.046	0.107	0.008
1995-1998	0.076	0.017	0.010	0.070
Wood and pulp				
1990-1995	0.026	-0.001	0.071	-0.049
1995-1998	-0.012	-0.026	-0.016	0.030
Chemical products				
1990-1995	0.153	0.090	0.087	-0.025
1995-1998	-0.114	-0.145	0.027	0.005
Non-metallic mineral Products				
1990-1995	0.260	0.086	0.177	-0.004
1995-1998	0.025	-0.005	-0.025	0.056
Basic metals				
1990-1995	0.222	0.169	0.100	-0.047
1995-1998	0.003	-0.004	-0.023	0.030
Fabricated metal products				
1990-1995	0.245	0.082	0.204	-0.045
1995-1998	0.057	0.006	-0.003	0.055
Machinery and equipment				
1990-1995	0.228	0.090	0.161	-0.024
1995-1998	0.137	0.074	0.086	-0.023
Communication				
1990-1995	0.520	0.328	0.119	0.073
1995-1998	0.178	0.051	0.095	0.032
Medical and precision Instruments				
1990-1995	0.258	0.126	0.128	0.005
1995-1998	0.070	0.022	0.030	0.019
Transport equipment				
1990-1995	0.264	0.225	0.053	-0.014
1995-1998	0.183	0.135	0.051	-0.003
Others				
1990-1995	0.141	0.025	0.129	-0.014
1995-1998	0.152	0.038	0.009	0.113

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