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Creative Destruction Mechanism of Korean Industry from the Perspective of Industrial Dynamics

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이 논문을 경제학박사학위 논문으로 제출함

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Abstract

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Schumpeter's study on economic growth and technological progress in the capitalist system as a process of creative destruction has influenced many studies on industry dynamics. In addition to Schumpeterianism, evolutionary economics and organizational ecology also attempted to grasp the sources of industrial dynamics. Although each perspective is slightly different, they all perceived competition in the market as a major source of industrial dynamics. In particular, Schumpeterianism emphasized Schumpeterian competition that firms are competing their competitive advantage originated from innovation as a main source of industry dynamics. In this perspective, this study attempted to analyze the creative destruction mechanism of Korean industry. In particular, we tried to describe the selection criteria exists in the Korean industry through empirical analysis of exit firms.

First, we reviewed theoretical background and the empirical analysis on the survival of firms and derived stylized facts on firm survival. The stylized facts were classified into individual level, firm level, industry level, and macroeconomic level. At the individual level, it was possible to derive a stylized fact that the higher the level of education and experience of the organization members, the better the survival of the firm. At the firm level, the firm size, age, R&D investment, and exporting and were identified as significant determinants on the firm survival. At the industrial level, it was reported that the firm entry rate, industrial growth rate, which determine the degree of competition of the industry, and technology intensity as determinants on the survival of the firm. At the macroeconomic level, we were able to derive a stylized fact that firms' survival rate is procyclic to upturns and downturns of the economy.

Second, survival analysis was implemented to describe the selection criteria of Korean industry through firm level micro data. The results showed that the stylized facts on the survival such a as firm size, age, and R&D investment is also found in Korean industry. In addition, we found the changes in the firm selection criteria as a result of restructuring of the financial sector and the industry sector in the process of overcoming the Asian financial crisis. More specifically, it was found that there was a change in firm financial management behavior before and overall incentive in terms of firm survival for the firm's investment activity was reduced after the Asian financial crisis.

Third, we focused on the cleansing effect hypothesis in economic recessions. This study investigated two recessions in Korea, the Asian financial crisis and the global financial

crisis. We measured total factor productivity using micro level manufacturing plant data from 1993 to 2013 and decomposed the source of the changes in total factor productivity to measure the cleansing effect in two large recessions. During the Asian financial crisis, there was no evidence to support a cleansing effect hypothesis. In contrast, during the global financial crisis, we found the evidence of a cleansing effect. Additionally, we found differences in market selection criteria in the two recessions; by the global financial crisis, the market selection criteria had changed to enable a more conducive environment for the creative destruction process.

Fourth, the problem of zombie companies was investigated from a different perspective. Previous studies have recognized zombie companies as a factor that hinders the creative destruction process and recognized that they should be exited through restructuring. However, this study focuses on the fact that the problem of zombie firm may be different according to the financial system of the country. Specifically, we analyzed the characteristics of recovering firms and exiting firms in the credit based financial system such as Korea. Based on the firm level micro data, it was found that the firms with high amount of accumulated knowledge showed higher probability of recovering to the normal firms. Also, it is confirmed that the financial sector was not able to identify and support selectively firms between recovering firms and exiting firms.

Keywords: Creative Destruction, Firm Survival, Cleansing Effect, Zombie Firms

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Introduction

The market constantly demands new products and ideas, which provides firms with a range of opportunities and a field of competition. As a result, firms with innovative products grow, while those that are edged out of the competition are scaled down and ultimately exit the market. It is very difficult for a firm to continue to win and survive in the competition of the market. Foster & Kaplan's (2003) book Creative Destruction showed how difficult it is for a firm to prevail for long. Of the Forbes top 100 firms for 1917, 61 had disappeared by 1987, and only 18 of the 39 surviving firms remained on the list of the top 100 firms. In addition, the average survival time of firms listed on the S&P 500 decreased from 61 years in 1958 to 25 years in 1980 and to 18 years in 2010. McKinsey data confirm the same result. The proportion of long-lived survivors, which was above 60% in 1962, declined to 10% in 1998. Foster and Kaplan (2003) argued that while the shortened survival time for this phenomenon is noticeable, the speed of shortening is also accelerating; in other words, the process of creative destruction is accelerating. This tendency can be confirmed in Korea. According to figures released in 2014 by Statistics Korea, the national statistical office, the one year survival rate of firms was 62.4%, the 3-year survival rate was 38.8%, and the 5-year survival rate was 27.3%. Looking at the 5-year survival rate of firms by year, it can be found that the survival rate decreased by 30.9% in 2007, 29.0% in 2008, and 27.3% in 2009. As of 2012, the number of firms surveyed in Korea that had been in business for less than 5 years was 42.1%, compared with 34.4% (over 10 years) and 9.8%

(over 20 years). These figures show how difficult it is for a firm to survive in the long term. Geroski (1995) described the survival of an enterprise as follows: “Entry is easy, but survival is not. Entrants have been doomed to fail, and when firms that have survived 5 to 10 years after entry are close enough to compete with incumbent ones, it prevents firms from generating revenue.” In this sense, strategic decision making of a firm can be interpreted as an effort to survive. Efforts to strengthen market dominance, to increase sales, and to invest in employee education are all efforts to avoid exit.

Exit is the biggest tragedy for all firms. However, at the industry or national level, firms are required to be eliminated. Firms with weaker competitiveness, which do not exit and continue to occupy resources, degrade the efficiency of society as a whole and decrease productivity. The resources and the markets generated by the exit of incumbent firms serve as a platform for other firms to grow. In this perspective, Schumpeter (1942) sought the creative power of economic growth and technological improvement in capitalism. By competing in the market, efficient enterprises grow and inefficient firms decline. The selection function of this market is the outcome and result of the creative destruction process.

If economic growth and technological improvement arise through the process of creative destruction that Schumpeter has described, we need to look at the functioning of market selection as a premise and consequence. This study analyzed the exit and survival of firms as a result of Korea’s creative destruction process. We obtained the selection criteria of Korean industry through analysis and examined the relationship between

economic fluctuations, such as the economic crisis, and the process of creative destruction. Especially in the capitalist system, finance plays the role of supplying resources to enterprises. In this process, finance evaluates firms and selects firms in which to invest resources, based on the evaluation results. Firms that acquire resources can grow, but firms that for a long period of business have difficulty in securing resources will exit. In other words, finance can be interpreted as playing a role in selecting firms. This paper examines the role of finance in supporting the creative destruction process.

This study is structured as follows. In Chapter 1, we examine industrial dynamics, evolutionary economics, and organizational ecological perspectives as the theoretical background for the survival and exit of firms, and review stylized facts on firm survival through the empirical literature. In Chapter 2, we use data of Korean firms to identify the stylized facts related to the survival of firms in the manufacturing sector, and identify the changes of selection criteria in the market before and after the Asian financial crisis. In Chapter 3, we calculate the total factor productivity (TFP) of the Korean manufacturing sector and analyze its changes with a productivity decomposition using business-level micro data. In this chapter, we focus on two financial crises, the Asian financial crisis in the 1990s and the global financial crisis in 2000, to examine the effects of these events on the exit of firms. In Chapter 4, we approach "zombie firms" from a perspective that differs from the viewpoints of previous studies that have examined firms that are not profitable for a long time and should exit. We analyze those zombie firms, which are considered as obstacles to an efficient resource reallocation process; we also investigate the role of the

finance sector in supporting firms to overcome these issues faster.

Chapter 1. Research Background

Entry, growth, and exit of firms are considered important areas of research in industrial dynamics. In particular, the entry of new firms and the exit of incumbent ones have great significance in terms of the metabolism of the industry. Entry rate and exit rate of firms are recognized as indicators of the degree of metabolism of industry and are used as a tool to examine the industry dynamics. In Section 1, we examine the theoretical background underlying this perception. Also, we examine empirical studies on the determinants of firm survival; we then classify the determinants of firm survival as individual, firm, industrial, and macroeconomic and derive stylized facts on firm survival.

1.1 Theoretical background on firm survival

Research on the entry, growth, and exit of firms is one of the core themes of classical economics, with companies as the analytical units. In particular, the analysis has focused on the dynamics of business in terms of industrial organization, a field of microeconomics. In the field of industrial organization, research on the entry and exit of firms has been carried out, in reconciling the number of firms, production volumes, and prices in the market with major variables and shifting the system to an equilibrium state. More recently, Ackerberg et al. (2005) made an attempt to form a dynamic econometric model, based on the theory of industrial organization, that also has static characteristics. However, in essence, the industrial organization perspective has the analytical weakness that it

presupposes homogeneity of corporations or is biased toward static analysis. This section summarizes the theoretical background on the exit and survival of firms from the viewpoint of Schumpeter's creative destruction process, evolutionary economics, and organizational ecology, which perspectives are relatively free from microeconomic premises.

1.1.1 Firm survival from the Schumpeterian perspective

Schumpeter (1942) recognized the creative destruction process as the most fundamental force under which the capitalist economy operates, that is, new products, or new producers replacing existing products, or incumbent producers. In addition, he criticized the dynamic analysis of classical economics, based on premises such as profit maximization and perfectly competitive assumptions, arguing that these cannot account for the dynamics of capitalism in the real world. Rather, he tried to explain the dynamics of capitalism through risk-taking entrepreneurs and their innovations.

Schumpeter emphasized entrepreneurship as an important factor for the creative destruction process. Entrepreneurship is a spirit that is willing to accept uncertainty or risk and to challenge through new innovations. As innovation by entrepreneurial actors leads to continuous creative destruction, the economy and capitalism develop. Schumpeter also found the motivation in entrepreneurs to take a risk on the monopoly profits that arise when introducing new innovations. However, since the monopoly profits from the introduction of new innovations are temporary, entrepreneurs continue to strive for innovation. The power to make monopolistic profits a temporary phenomenon was recognized as

competition in the market. In other words, in order for the creative destruction process to continue, the entrepreneur's innovation efforts are important, but the competitive environment of the market is needed as well as the role of the entrepreneur. As the process of creative destruction is repeated through competition, the efficiency of society can be enhanced. The path through which a competitive market structure contributes to the efficiency and productivity of resource allocation can be summarized in three ways. First, competition improves the incentive structure of firms. Second, competition promotes innovation activities of companies. Third, competition plays an important role in the growth of efficient enterprises and the deselection of inefficient companies. In particular, the selection process through competition plays an important role in increasing the productivity of the entire market by moving the resources of the exiting firms to more productive firms.

From the perspective of industrial dynamics, studies on the process of creative destruction have taken the economic dynamics and technological progress dynamics of firms as the analytical framework of their research, which is captured by the entry and exit of firms or businesses. Studies by Nelson (1981), Aghion and Howitt (1992), and Ahn (2001) have shown that the economy grows on the basis of firms' entry and exit, and this process is recognized as the creative destruction process described by Schumpeter (1934). The process of entry and exit from a Schumpeterian perspective occurs as follows. New innovative firms enter the market with new technologies and compete with incumbent ones. If new innovations and technologies are successful, new firms will replace incumbent firms;

and if new technologies fail, firms will not survive and will exit. From the viewpoint of industrial dynamics, entrepreneurial entry, growth, and exit process are the main components of the dynamic competition process of companies, and this dynamic competition is perceived as a creative destruction process. In other words, when the entry and exit of companies is active, the high rate of substitution is the creative destruction process, and if the entry and exit rates remain low, the dynamics of the market will be degraded (Lee, 2015). Through this dynamic competition, capital and labor are redirected from ineffective firms that decline and exit and are redistributed to efficient, fast-growing firms. In this context, examining the degree of entry and exit of firms is a tool to see how creative destruction is active in a society. Through competition in the market, capital and labor are reallocated from inefficient firms that decline and exit to new entrants and to fast-growing, efficient firms.

1.1.2 Firm survival from an evolutionary perspective

Evolutionary economics attempts to explain the evolution of economic phenomena based on universal Darwinism. Universal Darwinism collectively refers to the attempt to apply Darwinian evolution to a variety of other fields of biology, positing that there is a common ontological basis for evolutionary processes in all systems, such as the natural world. The foundation of universal Darwinism can be explained through three processes: variation, selection, and replication (Hodgson, 2002; Aldrich et al., 2008). Attempts to explain economic phenomena from the perspective of universal Darwinism have evolved

into evolutionary economics. Evolutionary economics explanations of economic phenomena are often made at a figurative level. Attempts have been made to explain firm routines in terms of biological genes, or to compare the survival and growth of firms with evolutionary concepts such as survival of the fittest and natural selection.

However, these attempts have been criticized for not being able to take into account the intentions of the actors. The point of such criticism is that economic evolution cannot be interpreted in the framework of universal Darwinism, in which economic agents' intentions and economic behavior are irrelevant. Penrose (1952) argues that the subject's behavior in economics is not unconnected to their intentions, and that the Darwinian concept of evolution does not take into account the intentions of the actor; so, it is not appropriate to interpret economic phenomena from an evolutionary point of view. In addition, Foster (1997) argues that it is impossible to explain evolutionary phenomena economically, because cooperative behaviors of economic entities that can occur in the economic realm have a great differentiation from the survival competition in the biological realm.

Criticism of this disregard of intent of agent is caused by the narrow understanding of Darwinism as a natural biological theory, and making an intellectual distinction between the evolution of nature and the evolution of the economy. Hodgson (2004) argued that the core of universal Darwinism is causality, not intentionality; if economic phenomena can be explained causally because the intention of the economic subject is also the product of evolution, then the existence of intent is not a problem. The evolutionary theory of Nelson and Winter (1982) was made free from the intention problem through the introduction of

the concept of firm routine and its variation. In their theory, a firm is considered to be a satisfactory actor, and an enterprise tries to maintain existing routines or find new routines based on its aspiration level. The process of finding a new routine is an intentional search activity to satisfy the entrepreneurial aspiration level, and as a result it can be changed to a new routine. In other words, in the economic realm, the existence of intention is not necessarily a problem.

In the evolutionary model of Nelson and Winter (1982), the selection process of routines proceeds through the following process. There are different routines within an industry, and each firm gets different profits according to their routines. In the current market conditions, if a firm is earning enough profits in terms of its aspirations, a firm that sticks to its existing routines, but does not get enough profits, will try to explore new routines or imitate routines from other firms. Firms that fail to obtain appropriate routines in the search for new routines are exited from the industry. The routines of surviving firms are selected and become the dominant routines of the industry. As a result, the market reaches equilibrium among the routines of the firms that have survived the competition. In fact, however, firms in a equilibrium state start exploring new routines once again, or the routines of new entrants are introduced to the market.

1.1.3 Firm survival from an organizational ecology perspective

Organizational ecology has begun to answer fundamental questions about the existence

of various types of organizations and their motivations (Hannan & Freeman, 1977). Later, Campbell (1998) refined the concept of organizational change and focused on ecological processes such as the birth, growth, decline, and death of the organization over a long period of time. Organizational ecology recognizes the survival of the organization as a success of the organization. Also, organizational ecology recognizes organizational change as a three-stage process of variation, selection, and retention, based on modified Darwinism. In the course of the activities of each organization (firm), there are variations in the organization. Among the various types of organizations, the type of organization suited to the niche of the environment is discriminated by the environment. Choice implies the survival of specific clusters or specific organizations through interaction between environment and organization, and the environment defines the strategic decisions that an organization must follow to survive. The niche provides the resources that must be secured to survive. Finite resources limit the number of organizations that a niche can sustain, resulting in the death of some organizations and the survival of some organizations in the community. The variation by environment and niche is called the selection mechanism.

Based on these theoretical frameworks, researchers in organizational ecology sought causality for the processes of birth, growth, decline, and death within organizational communities. First, from this perspective, attempts have been made to explain causality through competition and legitimation in organizational communities. Competition is closely related to securing resources for the survival of an organization. At an early stage, organizational communities lay the foundation for growth for new entrants and give

legitimacy to organizational types. However, if the organization density exceeds the carrying capacity of the community, the effect of the environmental justification of the organization type is reduced and the resource competition for organization survival becomes more intense. On the other hand, the death of the organization has a negative correlation with the entry of the organization. In other words, until the acceptable capacity is exceeded, the exit rate of organizations decreases, while the exit rate of organizations increases as their number starts to exceed the proper capacity.

Second, researchers focused on organizational age as an important factor influencing the exit of the organization, and emphasized the existence of a "liability of newness" in that new organizations are more likely to exit than older ones. As a result of the burden of newness, the new organization generally recognizes its legitimacy issues and lack of coordination ability, when compared with incumbent organizations. Another factor creating liability of newness is that incumbent organizations have higher structural inertia. Structural inertia is perceived as a by-product of environmental choice, in that organizations chosen by the environment are able to acquire specific skills appropriate for the organization and that this is preserved as an inertia (Hannan & Freeman, 1984).

1.2 Empirical background on firm survival

Firms face continuous competition from incumbent firms as well as from new entrants. The exit of firms that have lost their market position as a result of this competition is perceived as a natural consequence of the evolutionary process (Ericson & Pakes, 1995).

From the 1990s, attempts have been steadily conducted to analyze the determinants of corporate survival, and various factors, both internal and external, have been analyzed. This section reviewed empirical studies on firm survival determinants according to their analytical level, including individual, firm, industrial, and macroeconomic levels. Also, based on the review, some stylized facts on firm survival have been derived.

1.2.1 Firm survival determinants: Individual level

Individuals are the smallest units that make up a firm. It is possible to assess the competence of a firm by means of the competence level of the organization's members, although there is a limit in recognizing the sum of the capacities of its individual members as the capacity of the organization. It is reasonable to assume that an organization with high levels of individual competence has a higher level of organizational competence than a non-competent organization. In this regard, Boden and Nucci (2000) emphasized the importance of intangible resources, such as human resources, for the survival of new firms. Existing analyses at the individual level have focused mainly on the degree of education and the level of prior experience of organization members. This is a resource-based perspective, since the degree of education and level of experience can be seen as intangible assets. Peña (2002) conducted a survey of Spanish companies and found that education levels and experience prior to startups contributed positively to firm survival and growth. Coleman et al. (2013) performed a survival analysis on 4,152 US companies and found that the owner's education level and work experience were intangible assets that contributed

positively to corporate survival. The results of the pre-startup experience have a positive impact on the survival of the firm, as can be seen in van Praag's (2003) study. In the case of young startups in the United States, this analysis found that experience in the same industry before startup had a positive impact on survival after startup. Brüderl et al. (1992) confirmed that past experience contributes positively to survival as a result of an empirical analysis of German businesses, and concluded that past experiences contributed to the productivity improvement of firms. In a recent study, Kato and Honjo (2015) analyzed Japanese firms and found that positive effects of entrepreneurial education level on firm survival were found in high-tech sectors.

However, some empirical studies have reported that experience and knowledge embedded in entrepreneurs is not related to survival of firms after startup. Bates (1995) analyzed the educational attainment level into four categories: "under high school," "high school graduation," "university graduate," "graduate school and above." In other words, educational level does not necessarily contribute to survival as a linear form; rather, it contributes according to an inverted U-shape. Gimeno et al. (1997) reported that the experience of founders differed in their effect on firm survival. The managerial experience of an entrepreneur has no significant effect on the survival of a firm, whereas supervisory experience has a positive contribution to the survival of a firm. These authors argued that the growth and survival patterns of firms are different according to their business or environment. In other words, it is necessary to consider the determinants of survival at the individual level as well as the determinants of survival at the firm level and the industry

level.

1.2.2 Firm survival determinants: Firm level

1.2.2.1 Firm size and age

The size and age of a firm has been recognized as an important factor in the process of entry, growth, and exit of industrial dynamics (Dunne, 1994; Hopenhayn, 1992). In particular, the size of a firm is considered to be one of the major factors influencing its survival, and various studies have analyzed this relationship (Geroski, 1995; Agarwal & Audretsch, 2001). The research of Jovanovic (1982) can be considered as a theoretical foundation in considering that the size of a firm contributes positively to survival. Jovanovic argued that new entrants did not know their cost structure before entering, but learned about their cost structure while doing production after entry. After entry, firms decide whether to increase the size of their firm as they become aware of their cost structure. In other words, if a firm gets to know the cost structure after entry and the profit is bigger than expected before entry, the firm will increase its size. On the other hand, if the profit is smaller than expected, the firm will reduce production. In addition, exit of firms can be recognized as the extreme reduction of production near zero. Therefore, the size of the firm at the time of entry can act as a buffer in learning the cost structure after entry, so that larger firms can have a better chance of survival. This argue has been proven by a number of empirical studies. Mata and Portugal (1994) found that firms of larger size at entry time had a higher survival probability than those of smaller size, and that the larger the firm size,

the higher the survival probability. Esteve-Pérez et al. (2004) analyzed Spanish firms and found that small firms are highly likely to exit. In addition, several studies have reported that the larger the firm size and the size of entry, the better the chances of survival (Tveterås & Eide, 2000; Esteve-Pérez et al., 2004). This phenomenon can be interpreted as the "liability of smallness," which is addressed in organization ecology (Hannan, 2005). From the above discussion, we can derive a stylized fact about the relationship between firm size and survival.

Stylized fact 1: Firm size positively contributes to firm survival (existence of liability of smallness).

Similar to the "liability of smallness," Freeman et al. (1983) argue for the existence of a "liability of newness." "Liability of newness" implies that the shorter a firm's age is, the more disadvantageous it is to survival or growth. This means that experienced firms are more likely to survive than less experienced ones. The rationale of "liability of newness" can be found in many studies, suggesting that organizational experience generates positive effects. The most typical example is the study of learning curves. The learning curve is a concept that Wright (1936) identified and introduced through the fact that the direct labor per capita was reduced by the cumulative production of airplanes in the American plane industry. It can be seen from Henderson (1984) that experiential knowledge acquired by production using a more refined learning curve contributes significantly to lowering costs. Cumulative processes within an organization do not simply contribute to lowering

production costs. Cohen and Levinthal (1990) argued that the learning process is cumulative within the organization. In the process of expanding existing knowledge, a firm with a large amount of accumulated knowledge in the organization is at an advantage to a small firm. Accumulated experience in the firm provides an advantage in the process of finding a more suitable routine for a firm (Richard & Sidney, 1982). Cressy (2006), investigating the existence of liability of newness, has shown through model studies that low performance in firms may be detrimental to survival. In addition, Thompson (2005) conducted a survival analysis of US shipbuilding companies and found that the longer the firm has been in business, the more profitable it needs to be to survive. Honjo (2000), Agarwal and Gort (2002), and Esteve-Pérez et al. (2004) also found startup companies disadvantaged in terms of survival. Some studies have reported that firm performance contributes to survival, presenting an inverted U-shape (Strotmann, 2007; Esteve-Pérez et al., 2008). Esteve-Pérez and Mañez-Castillejo (2008) reported that until the firm age reaches 20 years, the probability of exiting increases; it then decreases until 35 years, and increases again thereafter. Some studies have reported that the effect of firm age might be different depending on the industry and/or firm specific characteristics. Audretsch and Mahmood (1994) found that firms' size and survival are not related when the sample firms are new branches of existing firms. Based on UK firm level data, Disney et al. (2003) found that the positive contribution of firm age on firm survival only applies if the firm is a single plant firm. However, since the relationship between firm age and survival in the form of an inverted U-character is not denied, it is possible to derive a stylized fact about the

relationship between business performance and survival from the above discussion.

Stylized fact 2: Firm age positively contributes to firm survival (existence of liability of newness).

1.2.2.2 R&D and innovation activity

Schumpeter (1950) stressed the importance of innovation activities in the survival of firms. “Innovation does not contribute to the profit and production of the enterprise, but it affects the foundation and longevity of the enterprise.” The importance of innovation is also found in recent research. Baumol (2002) argued that “Innovation activities are mandatory in the capitalist system and are the factors that determine the life and death of companies.” Since the introduction of R&D activities as a major factor in the development of industry dynamics, many studies have analyzed the relationship between R&D investment, firm growth, and survival. In the resource-based view, it is perceived that the intangible resources obtained from R&D investment have a major influence on firm survival (Barney, 1991). From this perspective, it can be considered that more resources are accumulated in the enterprise due to R&D investment, and further, this process contributes positively to the survival of the enterprise. Kimura and Fujii (2003) analyzed the survival pattern of manufacturing and service industries in Japan and confirmed that firms that invest in R&D have a higher survival probability than those that do not. Esteve-Pérez et al. (2004) also confirmed that R&D investment positively influences firm survival, through an empirical analysis of Spanish companies. Fontana and Nesta (2009) analyzed

121 companies in the LAN switch industry and found that R&D investment contributes positively to the survival of the firm. Also, he found that the closer the firm's technology is to the technological frontier, the more likely it is to survive. On the other hand, there are also empirical results that the effect of R&D investment on survival varies. Esteve-Pérez and Mañez-Castillejo (2008) analyzed the relationship between R&D investment and firm survival in Spanish firms and found that the firms that bought R&D from out of the firm were disadvantaged to firms that conducted their own R&D to survive. Coleman et al. (2013) reported that R&D activities did not have a significant effect on firm survival.

It is necessary to consider the characteristics of R&D investment of a firm to distinguish between R&D investment and innovation activity. In other words, even if the same R&D investment is made, it may have a different effect on the survival of a firm depending on whether it is invested in product innovation or process innovation. Abernathy and Utterback (1994) argued that after the advent of a dominant design, the number of new entry declines and that existing firms focus on process innovation to lower the cost of existing products rather than create new ones. According to the dominant design theory, firms are expected to see little new entry at the stage where they focus on process innovation, and competition among existing companies will become intense. Cefis and Marsili (2005) in their survival analysis of Dutch firms found that firms that innovate are more likely to survive, and that the innovation premium, which is more likely to survive than the product innovation, is more likely to survive. The study of Cefis & Marsili (2012) has shown that both product innovation and process innovation increase the probability of

survival for the firm, and that it is advantageous to survive, especially by promoting product innovation and process innovation together. Børing (2015) also found that firms who invest on product innovation tend to acquired and merged by other firm rather than exit due to registration cancellation. There are also studies that distinguish innovation activities from firms with radical innovation and incremental innovation. Banbury & Mitchell (1995) argued that incumbent firms are likely to increase their market share when they continue to perform incremental product innovation activities, thereby contributing to a higher probability of survival. As a result of the analysis, radical innovation investment is financially valuable because it is an investment with high uncertainty, and as a result, it has a disadvantageous effect on survival. On the other hand, incremental innovation has been found to contribute positively to firm survival (see also Buddelmeyer et al. (2010)). In addition, Sinha and Noble (2008) analyzed UK firms and found that adoption of new manufacturing technologies increases the probability of survival of the firm and adoption when the newness of the technology is high. Helmers & Rogers (2010) analyzed the relationship between patent application, trademark registration, and firm survival as a means of protecting innovation. Both patent applications and trademark registrations have contributed to increasing the survival probability of companies. According to the literature reviewed, it is possible to derive the following stylized fact on the relationship between innovation and firm survival.

Stylized fact 3: Innovation activity of a firm contributes positively to firm survival

(existence of innovation premium).

1.2.2.3 Firm ownership and legal structure

Firm ownership and legal structure have been recognized as major factors influencing firm survival in many empirical studies. The following is a summary of previous studies related to ownership structure and legal structure. First, there is a difference in the survival of *de alio* firms, which are seen as the expansion of existing businesses, and completely new *de novo* firms. *De alio* firms are less likely to have an initial risk of entry after entry, because they have the resources to mobilize compared with *de novo* firms, as they can utilize the resources of the parent firm (Levinthal, 1991). Also, business experience is different between *de novo* and *de alio* firms in that *de alio* firms are more likely to survive than *de novo* firms (Helfat & Lieberman, 2002). Audretsch and Mahmood (1995), Mata et al. (1995), and Portugal and Guimaraes (1995) have shown that *de novo* firms are less likely to survive than *de alio* firms in empirical analysis using firm level data in the United States and Portugal. Harhoff et al. (1998) for German firms and Kimura and Fujii (2003) for Japanese firms also found that *de alio* companies are more advantaged than *de novo* firms. However, there are also contradictory findings. Bates (1995) found that firms entering as a franchise are less likely to survive than independent firms. In addition, Tveterås and Eide (2000) reported no difference in survival rates between single-plant and multi-plant firms. However, it is hard to see franchises as *de alio* firm, since franchisee firms can get support from franchisor firm. Likewise, it is unreasonable to reconcile single-plant firms and multi-

plant firms with *de alio* and *de novo* firms, respectively, since the distinction between *de alio* and *de novo* firms is based on differences in resources and experience at the time of entry. From the above discussion, a stylized fact is obtained on the effect of *de alio* or *de novo* firms for firm survival.

Stylized fact 4: *De novo* firms are disadvantaged in terms of survival compared with *de alio* firms.

Second, the probability of firm survival depends on foreign equity participation. However, the effect of participation of foreign capital on firm survival is not established. The positive effect on the survival of a firm is attributed to the fact that it can be expected that the potential performance will be better than the immediate result of the firm (Esteve-Pérez & Mañez-Castillejo, 2008). On the other hand, the argument that participation of foreign capital has a negative effect on firm survival is based on a study by Hymer (1976), that multinational firms may be less successful in terms of coordination. That is, due to the characteristics of the various capital players participating in the firm and the characteristics of the market, such as multinational factors, the adjustment cost may be high and the performance may be lower than that of the single national firm. The effect of foreign capital participation on the survival of firms shows different effects in empirical studies. For example, Mata and Portugal (2002) and Kimura and Fujii (2003) found that there was no difference between foreign or domestic capital investment on domestic companies' survival rates in Portuguese and Japanese firms. As a result of analysis of companies in Ireland,

Görg and Strobl (2003) found that multinational firms have a higher probability of survival in high-tech areas and a lower probability of survival in low-tech areas. The reason for the latter phenomenon is that this situation is more advantageous for domestic firms, because competition is made through price rather than technology capacity in low-tech areas. Bernard and Jensen (2007) found that multinational firms have a higher probability of survival than US firms in the United States. It is difficult to accept this as a stylized fact, since the effect of foreign investment on firm survival differs among previous studies.

1.2.2.4 Financial status

The deterioration of a firm's financial status is perceived as a leading precursor before a default occurs. In this context, attempts have been made to analyze the relationship between the occurrence of default and various financial indicators such as leverage, debt cost, debt structure, etc. (Altman & Saunders, 1997; Crouhy et al., 2000). The "distance to default" approach is a well-known model of the relationship between financial indicators and defaults that suggests how important financial status is to the growth and survival of the firm (Merton, 1974). Also, Beck et al. (2005) argue that the financial status of a firm is an important factor in introducing new capital from outside the firm. In other words, a sound financial status is essential for the firm to grow, and a consistent interpretation is made that financially sound firms are favored for survival. Empirical studies also report that the firm's financial health is directly linked to firm survival. Bottazzi et al. (2011) confirmed, based on Itaian firms, the improved probability of survival for firms in good

financial condition. Cooper et al. (1994) analyzed the impact of human resources and financial resources on firm survival in US entrarants. The result showed that firms with large capital at the time of entry are more likely to survive than small firms. This result is interpreted as favoring a large scale at the time of entry, because it facilitates the procurement of external resources after entry and is advantageous for firm operation. Bates (2005) investigated US SMEs and also found that firms with large capital at entry were more likely to survive (see also Liao et al. (2008) and Parker & Belghitar (2006)). Liu and Li (2015) found that firms under financial constraint are more likely to exit from an analysis of Chinese firm level data. In summary, the following stylized fact on firm's financial status and firm survival can be derived.

Stylized fact 5: A financially health firm is more likely to survive.

1.2.2.5 Strategic decisions: Entry timing, Advertising, and Export activity

Debates on the time of entry are discussed in terms of the first mover advantage and the late mover advantage. Firms that enter the industry early during the period when the industry is being formed have a disadvantage, because they have to operate under greater market uncertainty and technological uncertainty compared with the late entrants; however, there is also a monopolistic profit advantage. On the other hand, the perspective of the late mover advantage over the early entry firm—that it is advantageous to enter after resolving some degree of market and technical uncertainty—is also persuasive. However, empirical studies analyzing the relationship between the two perspectives suggest that the first mover

advantage exists in terms of firm survival. Robinson and Min (2002) compared the survival rates of 167 early-entry firms and 267 late-entry firms in the United States, confirming that the monopolistic profits after the early entry exceeded the burden as early entry firms. Agarwal and Bayus (2004) found that early-entry firms showed a higher survival rate than late entrants in an analysis of US firm level data. Their interpretation was that early entry firms have advantages in securing tangible and intangible assets that can act as an entry barrier to late entry firms, such as the establishment of industry standards and the development of distribution channels.

Some studies found that investment in firm advertising also has a significant impact on firm survival. Segarra and Callejón (2002) conducted a survival analysis of Spanish firms from 1994 to 1998, and found that the firms that invest in advertising are more likely to survive than those that do not. Esteve-Pérez and Mañez-Castillejo (2008) looked at a firm's advertising investment from a resource-based view. They argued that firm investment in advertising builds a firm specific asset and contributes to firm survival.

There are also studies that have focused on the relationship between firm export activity and survival. Melitz (2003), Bernard et al. (2003), and Bernard and Jensen (2007) argued that it is theoretically advantageous for firms to export to survive. Firms that are limited to their domestic markets will suffer a slowdown in growth if the market becomes saturated. In addition, exporting firms can expect that the value of products and services in the global market can be interpreted as having a competitiveness in global market and that their probability of survival is higher than that of non-exporting firms. Empirical studies such as

Esteve-Pérez and Mañez-Castillejo (2008), Kimura et al. (2004), and Fujii (2003) found that firms that generate sales through exports have a higher survival rate than those that focus on domestic markets. In summing up the above discussion, we can synthesize the following stylized facts.

Stylized fact 6: Early entrants are more advantaged than late entrants in terms of survival (existence of first mover advantage).

Stylized fact 7: Firm advertising investment has a positive impact on firm survival.

Stylized fact 8: Firms that export are more likely to survive than firms that focus on the domestic market.

1.2.3 Firm survival determinants: Industry level

Factors influencing firm survival at the industry level are industry characteristics, such as technological intensity, industrial cycle, and industrial entry rate. In this section, the factors influencing firm survival at the industry level are identified and classified as the static and dynamic characteristics of the industry.

1.2.3.1 Static characteristics of industry

Firm R&D investment and innovation activities have been treated as important variables in the analysis of survival factors at firm level. Similarly, there is an approach to find a difference in firm survival between industries where technology is intense and those where it is not. A representative empirical study on the relationship between industry-level

technology-intensive characteristics and firm survival is a study by Audretsch (1995). Audretsch reported that there is a systematic difference between industries where technological intensity is low and where it is high; specifically, the survival rate of firms is low in more technology-intensive industries. Agarwal and Audretsch (2001) and Agarwal and Gort (2002) reported that the same result was observed in highly technology-intensive industries, because the technology capacity at the time of entry is exhausted faster than with less technology-intense industries.

Second, the static nature of the industry derives from the view that there is a difference in the firm survival rate depending on the magnitude of the effect of economies of scale. Economies of scale is one of the basic concepts for analyzing industry in classical economics, and many studies have examined economies of scale through obtaining the size of the minimum efficient scale. The minimum efficiency scale is used as a measure to analyze the structure of the market in industrial organization theory. In an industry with a large minimum efficiency scale, the number of firms capable of producing a product exceeding the minimum efficiency scale is not large and natural monopoly is highly likely to result. On the other hand, in industries with a small minimum efficient scale, the effects of economies of scale are not so great and the probability of natural monopoly is low. In general, entrant firms present with a smaller size than the existing ones. In this case, in an industry with a small minimum efficient scale, entrants can easily reach a competitive level of production to challenge the incumbents. However, in an industry with a large minimum efficient scale, it is not easy for entrant firms to grow to a level that can compete with the

incumbent, because the size of the incumbent firm is dominated by the natural monopolistic production. Empirical analyses also support this tendency. Audretsch and Mahmood (1995) and Tveterås and Eide (2000) analyzed US firms and Strotmann (2007) analyzed German firms and found that firms have a higher survival rate in industries with small minimum efficient scale. However, some studies reported different results in that a small minimum efficient scale does not guarantee a high survival rate for firms. For example, Audretsch and Mahmood (1991) reported that the relationship between minimum efficient scale and firm survival is not significant for branch firms. Audretsch and Mahmood (1994) found that there is no significant relationship between these factors in high-tech industries. However, since these studies are based on the characteristics of the firm and the characteristics of the industry, respectively, they can be considered as an exception to the relationship between the size of the minimum efficient scale and firm survival. In this context, two stylized facts on firm survival about static characteristics of the industry can be derived.

Stylized fact 9: Firms in high-tech industry have a lower survival rate than firms in low-tech industry.

Stylized fact 10: Firms survival rate is low in industries with large economies of scale.

1.2.3.2 Dynamic characteristics of industry

There are particular analytic frameworks related to industry and the business cycle in terms of dynamic characteristics. For example, industry can be categorized into emerging

industry versus declining/mature industry, entrepreneurial regime versus routinized regime, and high entry industry versus low entry industry. Some studies show that the effects of industry dynamics on firm survival may vary. Entry rates vary greatly depending on the industrial cycle. In general, the entry rate is high in the period when the industry is emerging or growing, and low when the industry is declining. Abernathy and Utterback (1994) is a representative study of the change in entry rate according to these cycles. The study shows how the entry rate of the industry and the direction of innovation change with the emergence of dominant design products. In this sense, Geroski (1995) argued that higher entry rates in the industry will naturally affect the survival of the enterprise, because of higher competition in the market; higher industrial entry rates will lead to turbulence in the market. Mata and Portugal (2002) also found that a high entry rate in an industry has the effect of lowering the survival rate of firms. A high entry rate means that the entry barrier is low. Headd (2003) implemented an empirical analysis by classifying firms in the US into manufacturing, retail, and service industries. He found that firms in retail and service industries showed a higher mortality rate than firms in manufacturing industry, since retail and service industries have lower entry barriers than manufacturing industry, he concluded. Bates (2005) and Ejermo and Xiao (2014) also reported that the exit rate was high in industries with low entry barriers. On the other hand, Segarra and Callejón (2002) reported the existence of opposite effects from their results of an analysis of Spanish companies: a high industrial entry rate contributed to higher survival rates.

There is also an empirical analysis that classifies industry into entrepreneurial regimes

and routinized regimes. According to Winter (1984), the early stage of the industry life cycle, that is the process of forming the industry or entrepreneurial regime, shows high entry rates and exit rates. However, as the entrepreneurial regime changes into a routinized regime over time, the entry and exit rates decline. Agarwal et al. (2002) followed this classification and found that competition is severe in entrepreneurial regimes, while competition in the routine-regulated regimes is relatively weak (see also Agarwal & Audretsch (2001) and Agarwal et al. (2002)).

There are also studies that analyze the relationship between industrial growth and firm survival among the dynamic characteristics of industry. These studies point to the fact that during the growth of an industry, a firm can experience a positive impact on survival, because of the expanding size of the market in which it can generate sales. A growing industry, even if the entry rate is high, can be expected to have a positive impact on survival, because firms can occupy a larger market. Mata and Portugal (1994) found that firms in a growing industry were more likely to survive than those in a declining industry. Bellone et al. (2008) analyzed the results for French companies and found that the larger the market growth rate, the lower the probability of exit. Kaniovski and Peneder (2008) analyzed Austrian firms and found that the larger the growth rate of the industry, the more favorable were the chances of survival of the firm (see also Segarra & Callejón (2002)). It is possible to derive a stylized fact about the relationship between the dynamic characteristics of firms and their survival.

Stylized fact 11: Survival rate of firms is low when the industry entry rate is high.

Stylized fact 12: Survival rate of firms is high when the industry is growing.

1.2.4 Firm survival determinants: Macro level

At the macroeconomic level, empirical analysis is conducted mainly by using macro variables such as the unemployment rate and inflation rate. Audretsch and Mahmood (1995) analyzed the relationship between unemployment and firm survival and found that as unemployment increases, firm survival decreases. Everett and Watson (1998) found that increasing interest rates and increasing unemployment both negatively impacted the survival of firms in Australia. Box (2008) measured the effects of the macroeconomic environment in which the economy grew, using GDP growth as a variable. The analysis of Swedish firms showed that as the GDP growth rate increased, the survival rate of firms also increased. Fotopoulos and Louri (2000) found that firms entering during the recession period had a lower survival rate than those that did not. From the above discussion, the following stylized fact about the relationship between macroeconomic level and firm survival can be derived.

Stylized fact 13: Survival rate of firms is low in the economic downturn.

The factors that affect the survival of firms are categorized into individual level, firm level, industry level, and macro level. As many empirical studies along these lines have accumulated, some stylized factors on firm survival can be derived. Stylized facts and

empirical studies are summarized in Table 1 below. In addition, the literature reviewed in this study is summarized in Appendix 1.

Table 1. Stylized facts on firm survival from selected literature

Level	Stylized facts	Literatures
Firm level	Liability of smallness	Mata & Portugal, 1994; Tveterås & Eide, 2000; Esteve-Pérez et al., 2004
	Liability of newness	Freeman et al., 1983; Honjo, 2000; Agarwal & Gort, 2002; Thompson, 2005
	Innovation premium	Banbury & Mitchell, 1995; Cefis & Marsili, 2005; Sinha & Noble, 2008; Buddelmeyer et al., 2010; Cefis & Marsili, 2012
	De alio advantage	Audretsch & Mahmood, 1995; Mata et al., 1995; Harhoff et al., 1998; Agarwal et al., 2002; Agarwal & Gort, 2002; Kimura & Fujii, 2003
	Financial constraint	Cooper et al., 1994; Bottazzi et al., 2011; Liu & Li, 2015
	First mover advantage	Robinson & Min, 2002; Agarwal & Bayus, 2004
	Adverting advantage	Segarra & Callejón, 2002; Esteve-Pérez & Mañez-Castillejo, 2008
	Exporting advantage	Kimura & Fujii, 2003; Esteve-Pérez et al., 2004; Esteve-Pérez & Mañez-Castillejo, 2008
Industry level	Technology intensity	Audretsch, 1995; Agarwal & Audretsch, 2001; Agarwal & Gort, 2002
	Scale of economy	Audretsch & Mahmood, 1995; Tveterås & Eide, 2000; Strotmann, 2007
	High entry level	Agarwal & Audretsch, 2001; Agarwal et al., 2002; Mata & Portugal, 2002; Headd, 2003; Bates, 2005; Ejermo & Xiao, 2014
	Industry growth	Mata & Portugal, 1994; Segarra & Callejón, 2002; Bellone et al., 2008; Kaniovski & Peneder, 2008

Table 1. Stylized facts on firm survival from selected literature (continued)

Level	Stylized facts	Literatures
Macro level	Economy growth	Audretsch & Mahmood, 1995; Everett & Watson, 1998; Fotopoulos & Louri, 2000; Box, 2008

1.3 Sub-conclusion

In Chapter 1, we examined the theoretical background of firm survival and exit and reviewed the empirical studies on determinants of firm survival. In terms of the survival of firms, the emphasis on market competition is common, from the perspectives of Schumpeterian capitalism, evolutionary economics, and organizational ecology. Schumpeterian research has shown that even if an entrepreneur secures monopoly profits through innovation, the equilibrium of the market is broken by competitors, and the efforts to secure monopoly profits lead to innovation efforts of the firm. Evolutionary economics views the firm as an organic system that explores, imitates, and evolves new routines in order to achieve the desired level of profit. Organizational ecology aims to secure the necessary resources for growth and survival through competition within organizational communities, and those firms that have failed to secure the necessary resources consequently exit from the market. In relation to the survival of companies, Schumpeterians have regarded the market as a Schumpeterian competition environment and found that firms' survival and growth differed according to their innovation capabilities. In evolutionary economics, universal Darwinism suggests that a firm with the most suitable routines in the market environment will survive, and the routines of surviving firms will become the dominant routines of the industry. Finally, as in the case of evolutionary economics, organizational ecology recognizes that market selection is similar to natural selection in nature.

In the above theoretical background, empirical studies on the survival and exit of firms

are reviewed. The determinants of firm survival are classified into the individual, firm, industry, and macroeconomic levels, and stylized facts about the survival of firms are derived from a number of previous studies. At the individual level, it was found that intangible resources, such as level of education and experience, contributed positively to the survival of the company from the resource-based perspective. At the firm level, it was confirmed that size, age, innovation efforts, and export activities contributed to increase the firm survival rate. At the industry level, firm entry rate, economies of scale, and technology intensity were found to be factors affecting company survival. Identifying the determinants of survival of the firm is significant as a way to reveal what strategic decisions are needed to grow and survive in the competition. Also, from the policymakers' point of view, research on the determinants of survival is worthwhile as a tool to identify the selection criteria in the market and to observe how these criteria change over time, in order to create a better environment for business.

In Chapter 2, based on microeconomic data from Korea, we describe the selection criteria in Korean industry by examining some of the stylized facts derived in Chapter 1. Also, we examine how institutional change has affected firm behavior and market selection criteria by comparing the situations between before and after the Asian financial crisis in the 1990s.

Chapter 2. Evolution of Firm Selection Criteria in the Korean Manufacturing Sector

2.1 Introduction

Since the 1970s, it is hard to see that Korea's economic growth has been achieved through the dynamic process of creative destruction from the perspective of industrial dynamics, rather than through the economic growth of incumbent firms. In the 1980s, the government enacted the Industrial Development Act and tried to maintain the efficiency of the economy as a whole through the rationalization process of excess investment during the high growth period. At the firm level, intra-firm resource reallocation occurred from mature industries to emerging industries for sustainable growth. However, in the 1990s, after the high growth period, the problem of the disposal of low-performing firms and insolvency issues emerged. In particular, the Asian financial crisis of 1997 revealed the absence of a mechanism of exit for insolvent firms in Korean industry. As Stiglitz and Greenwald (2014) stressed, the absence of an appropriate exit mechanism caused a restructuring process to be carried out, regardless of the competitiveness of the company. During the crisis period, many competitive firms were bankrupted not because of their low competitiveness, but because of their vulnerable financial status.

While the massive and unsystematic exit of firms during the economic crisis period can be a problem, there can also be a problem even if the exit rate of firms is relatively low.

During the Lost Decade of Japan in the 1990s, productivity growth slowed down considerably. Hoshi (2006) and Caballero et al. (2008) pointed out that the cause of the stagnation of productivity was caused by the increase of "zombie" firms in Japan; in other words, firms that deserved to be exited were not exited and occupied resources. This was a problem because resources were not reallocated to other firms or new entrants and consequently productivity growth stagnated. In Korea, the problem of zombie firms is getting serious as well. According to the Bank of Korea (2016), 15% of Korean listed companies are zombie firms, and 11% of them are chronic zombie firms, which are identified as zombie firms for more than five years in a row. The issue with zombie firms is not just that zombie firms themselves have low productivity, but they also pose a serious problem in terms of impeding the appropriate reallocation of resources throughout the economy (Caballero et al., 2008).

From this point of view, this study analyzed the survival determinants of Korean firms. In particular, large-scale restructuring of the financial and industry sector proceeded while overcoming the Asian financial crisis in the late 1990s, and there were economic and institutional changes that could affect the industrial environment, such as the revision of the Bankruptcy Law. The purpose of this study is to identify firm survival determinants and their changes before and after the Asian financial crisis. Analyzing firm survival determinants provides a description of the market selection criteria, and from these, we can see the dominant routines existing in Korean industry. It is also worthwhile to observe changes in the dominant routines that exist in the industry to see what orientation Korean

industry has had. In addition, by identifying the characteristics of surviving firms, it can be ascertained which factors are causing the creative destruction process in Korean industry.

Chapter 2 follows the following configuration. In Section 2.2, we review the empirical studies on firm survival determinants that have focused on Korean industry. Section 2.3 investigates the legal and institutional changes in the financial sector during the Asian financial crisis. Section 2.4 reviews the survival analysis methodology implemented in the study. Section 2.5 describes the data and variables used in the study. In Section 2.6, we analyze the survival determinants of Korean industry and compare the change in selection criteria before and after the Asian financial crisis.

2.2 Literature review

Since the 1990s, survival analysis methodology has been applied to firm level micro data and there have been attempts to examine the determinants of survival of Korean companies. Section 2.2 reviews the empirical studies on the survival determinants of Korean firms.

The first attempt to analyze the survival determinant of Korean firms is the study of Lee (1998). In this paper, he analyzed 252 small and medium sized Korean firms in the electronics industry listed in the Korean Business Review of 1992. The Cox proportional hazards (PH) model was used as the analytical model. The model included variables such as productivity, profitability, capital structure, liquidity, and activity as the factors affecting the survival of firms. The study found that firms with higher value-added labor cost ratios

decreased the risk of exit, while those with higher fixed long-term adequacy ratios had an increased risk of exit. Also, the study argued that labor productivity should be increased for the survival of enterprises. However, Lee (1998) indicated that the analysis was implemented with no exact theoretical basis for identifying the survival factors of the firm,

Lee (2002) then analyzed the determinants affecting the growth and survival of 3,395 Korean firms from 1991 to 2000. Those firms were externally audited registered firms and belonged to the manufacturing sector. The size, age, market share, export status, and R&D investment of the firms were set as the main explanatory variables and the Heckmen two-stage estimation was performed, based on a probit model. He found that the size and the age of the firm have a positive effect on the survival of the company. Also, firms with high market share and R&D investment have a higher survival rate than those without. He varied the analysis period from 1991–1996 to 1991–2000 to identify the difference in firm survival rates before and after the Asian financial crisis. Before the crisis, the size and the age of firm contributed positively to survival; however, these effects were not observed in the analysis that covered the crisis period. The author interpreted these results as indicating a change in the growth and survival standards of Korean industry. However, this interpretation is problematic in that it does not consider the massive and unsystematic exit of firms during the Asian financial crisis period.

The study of Hong (2002) focused on the survival determinants of startup firms. He surveyed *de alio* firms newly established by the 30 *Chaebol* firms from 1988 to 1999. Regression analysis for 152 newly registered firms was conducted based on the logit model.

The result showed that firms are highly likely to survive in industries that are highly concentrated and growing. The relationship between industry concentration and firm survival is interpreted as a result of reflecting the characteristics of the Korean industry, in that the *chaebol* occupies a considerable portion of the monopoly market, and once it enters, it is difficult for independent startups to arrange business easily. Also, he found a tendency for firms with a large entry size to be more likely to survive; in addition, the higher the funding capacity of the entrants, the higher the survival probability. On the other hand, variables such as the possibility of resource sharing with the parent firm and the managerial capacity of the parent firm did not have a significant effect on the survival of the *de alio* firms. This implies that the survival of the firm is determined by the capacity of the firm itself, rather than the relationship with the parent firm, even though it is a subsidiary firm belonging to the *chaebol* firms.

Lee and Shin (2005) conducted a survival analysis of 1,780 firms established during the period from 1984 to 1994. They used the time varying Cox PH model to investigate survival determinants, using firm level financial data. Explanatory variables of firms were classified into firm level, industry level, and macroeconomic level. The firm entry size, current size, and entry type were used as firm level variables, and industry entry rate, market concentration, and economies of scale were used as industrial level variables. GDP growth rate was used as the macroeconomic level variable. They found that current size of firm contributes significantly to survival. On the other hand, the size of firm at entry contributes negatively to survival. The authors interpreted these results as determining the survival rate

of entry firms, rather than the resources required at entry. Also, the industry level variables showed that the higher the market entry rate and the higher the market concentration, the lower the risk of exit. As the minimum efficient scale (MES) increases, the risk of exit of the entering company increases.

Jang (2006) conducted a survey to identify the differences between companies that overcame the Asian financial crisis and those that did not. A logistic regression analysis was conducted for 115 venture companies based on two surveys, conducted in 1997 and 2000. The factors affecting the survival of firms were classified into human capital and social capital. As a result of the analysis, it was confirmed that firms with higher human capital and with strong external networking showed higher probability of survival.

Lim et al. (2008) analyzed the survival period and determinants of survival of 13,754 venture firm with 5 years or more in terms of firm age by 2001. They used the Cox PH model to analyze the effects of founder characteristics, corporate competence, external environment, and venture capital investment, on corporate survival. The characteristics of founders in their 50s were found to increase the survival time of venture companies. This was interpreted as implying that the socially diverse experience and existing network of the founder contribute positively to the survival of the enterprise. In terms of corporate competence factors, the longer the survival period is, the larger the size of company, gross profit, and net profit. On the other hand, the degree of R&D intensity, proxied by the number of innovations per employee, did not have a significant effect on survival. Cooperation with government and private research institutes has shown a positive

contribution to the survival of venture firms.

Kang and Lee (2009) conducted a survival analysis on 112 SMEs in the construction industry. The firms' financial indicators were used as the main explanatory variables, in the categories of profitability, stability, activity, growth, cash flow, and size of firms; and the Cox PH model was used. The higher the profit margin and the total asset value, the higher the probability of survival. On the other hand, the higher the reliance on borrowing, the more the probability of survival decreases. However, it is hard to generalize this result, since the study only focused on the construction sector.

Song and Noh (2011) analyzed the survival period and determinants of survival of venture firms, based on data of venture firms from 2006 to 2009. Their empirical strategy was to regress both the Cox PH model and a parametric model. This approach is also used in Cefis and Marsili (2005) to examine the robustness of the model. However, Song and Noh (2011) selected the Weibull distribution for their parametric model without statistical consideration of the data they used. The results of both the Cox PH model and the parametric model revealed that firms that are large and have patents showed better performance in terms of survival.

The study of Park et al. (2012) focused on the fact that the survival determinants of firms may vary in each industry. They collected firm level data from 1987 to 1996 and categorized observations into five industries: construction industry, light industry, wholesale and retail industry, heavy industry, and service industry. They analyzed the factors affecting the survival of firms in terms of liquidity, stability, profitability, growth

potential, and capital adequacy. Although the variables that had a significant effect on each industry were different, it was confirmed for all five industries that the probability of survival was higher as indicators of firm stability, such as capital adequacy ratio and current ratio, increased.

The study of Hwang (2012) conducted an empirical analysis focusing on the existence of innovation premiums in firm survival for Korean SMEs. The hypothesis of the research was that the innovation premium may be different according to the size and the age of firm; and also, that the innovation premium may occur differently, depending on the technology intensity of the industry. The analysis result using the Cox PH model revealed that innovation investment contributed negatively to survival for smaller firms. The author argued that while innovation investment may be a survival tool for small firms, at the same time, it is likely to be a risky investment. The study also confirmed that there is a strong innovation premium for survival in medium-high-tech industry, rather than in high-tech industry.

A recent study conducted by Kim and Lee (2016) noted that firm survival can be influenced by differences in the technical regimes of various industries. Variables such as size of firm at entry, R&D intensities, R&D stock, and timing of entry were used as explanatory variables. The technological regime of the industry was classified along two axes: technical opportunities and R&D appropriability. The Cox PH model was used for the analysis. The results show that the size of firms contributed positively to firm survival in industries with low technological opportunities and high appropriability. Also, the effect

of firm's knowledge through R&D investment for firm survival was largest in the industries with high technological opportunities and low appropriability.

As reviewed above, some empirical analyses have been conducted on the determinants that influence the survival of firms in Korean industry. However, it is difficult to generalize the results of these studies, because the analysis periods are short. Some studies that analyzed only entrant firms have an advantage in controlling for the cohort effect; on the other hand, they are limited in their description of the selection criteria of the whole industry at the same time. Finally, some studies have analyzed GDP growth rate variables to control for macroeconomic effects. However, controlling for macroeconomic effects cannot examine the changes in firm behavior patterns and firm selection criteria that may arise from institutional changes such as the Asian financial crisis. In the following sections in the chapter, we identify the selection criteria in Korean industry and compare their changes against the institutional improvements before and after the Asian financial crisis.

2.3 Research hypothesis

In the 1990s, the Asian financial crisis had a great impact on the Korean economy. As a consequence, a large number of firms went bankrupt, and the restructuring of surviving firms was a major event that changed the landscape of the Korean economy. In overcoming the financial crisis, the Korean government accepted the recommendations of the International Monetary Fund (IMF). As a result, there has been a great change in the Korean financial system. Before the Asian financial crisis, the Korean financial system was a

financial system based on close cooperation between government, financial institutions, and corporations. However, after the Asian financial crisis, the role of the government was reduced and the properties of the Anglo-American financial system were strengthened (Shin & Chang, 2003).

Before the Asian financial crisis, Korea's financial system had problems such as a decline in capital adequacy of banks, an increase in short-term corporate debt, and inadequate financial supervision functions (Hahm, 2007). In particular, Korean firms operated through a large amount of loans, and the high debt to equity ratios of these Korean firms was recognized as one of the causes of the massive bankruptcies that followed the outbreak of the crisis. Therefore, during the process of overcoming the financial crisis, the government implemented a series of measures to improve the high debt ratio of Korean firms. The government recognizes that the weakened competitiveness of Korean firms originates from their weak financial structure, and established the principle of improving the financial structure and reducing the debt ratio of firms. The government has implemented restructuring policies to enhance the transparency of corporate management, the establishment of core business units, and the strengthening of the responsibility of controlling shareholders and management. The high level of corporate debt has impaired both the financial sector and the industry sector since the outbreak of the crisis. Korean firms had to maintain high debts levels for growth, since Korea had a limited amount of capital accumulation in the course of its rapid growth over a short period of time. Table 2 shows the debt ratio and short-term and long-term debt ratios of Korean companies for the

period from 1991 to 2005. The average debt ratio of firms peaked in 1997 and has since declined steadily. This can be interpreted as the result of the immediate intervention of the government after the crisis. Thus, the government's policies seem to have been effective in the process of overcoming the Asian financial crisis. In particular, the policies adopted to improve the financial soundness of both the corporate and financial sectors have led to improvements in the debt ratio and capital adequacy ratio of firms in both the finance and the real sectors.

Table 2. Average debt ratio of firms in Korea: 1991 - 2005

Year	Debt ratio	Long-term Debt ratio	Short-term Debt ratio
1991	0.712	0.329	0.383
1992	0.720	0.328	0.392
1993	0.713	0.331	0.381
1994	0.714	0.320	0.394
1995	0.705	0.312	0.392
1996	0.719	0.322	0.397
1997	0.765	0.361	0.404
1998	0.715	0.341	0.374
1999	0.604	0.271	0.333
2000	0.601	0.243	0.358
2001	0.565	0.251	0.314
2002	0.550	0.234	0.316
2003	0.521	0.213	0.309
2004	0.498	0.192	0.306
2005	0.494	0.198	0.296

Source: Lee (2008)

This study focuses on whether institutional change through policy intervention has affected firm behavior and selection criteria in the market. In particular, changes in financial institutions can be expected to affect industrial dynamics such as entry, growth, and exit of firms, since the financial and industrial sectors are closely linked.

In his book "The theory of economic development," Schumpeter (1912) emphasized that finance sector and firm are closely related to each other. He stressed the importance of corporate innovation activities as a driving force for the creative destruction process. His idea that finance is essential for corporate social activities is well understood through the following sentence: "Credit is essentially the creation of purchasing power for the purpose of transferring it to the entrepreneur" (Schumpeter, 1912, p. 107). In other words, since finance forms the purchasing power of the market, companies can perform innovation activities based on this market. Finance also provides the venture capital needed for innovation by providing credit to companies performing innovation activities. Schumpeter explained the interaction between business and finance through the German banking system. Schumpeter argued that the German banking system played an important role in the industrialization of Germany in the nineteenth century and the Second Industrial Revolution, providing large-scale funding for technological innovation and investment. In addition, the expansion and contraction of the loans provided by the banks was also recognized as an important variable in generating the business cycle.

Perez (2002) looked at the link between the financial sector and the industry sector from a longer perspective than Schumpeter's view. Perez highlighted the interaction between

finance and the real economy at the business cycle level, arguing that the two interactions occur through four phases in total. The first phase is the *irruption* phase, which succeeds the phase of stagnation, during which the preparation for the next technological revolution is carried out. The second phase is the *frenzy* phase. The period of harmonious growth ends and financial capital completely dominates production capital. Polarization occurs and the real economy declines. The third phase is the *synergy* phase. The gap between finance and industry has narrowed, and the two sectors continue to grow in a harmonious way. The last phase is the *maturity* phase, during which idle financial capital is moving to new areas, sectors, and regions. Perez (2002) argued that all five major technological revolutions observed (industrial revolution, steam and rail, steel and electricity, petroleum and automotive, telecommunications) could be explained by these four phases of interaction between financial capital and production capital.

The pecking order theory proposed by Myers and Majluf (1984) argues that the relationship between firm and finance is close. The main idea of the theory is that since there are friction factors, such as information asymmetry, firms generally prefer internal funds rather than external funds as a source of investment. In other words, when a company invests, it considers internal financing to be a priority, and next in order, incurring debt or raising equity. If the regulations are strengthened to allow firms to raise loans, it implies that firms may become more reliant on the stock market for introducing financial resources.

As reviewed above, the Asian financial crisis has had a great impact on both the Korean industrial sector and the financial sector, and government intervention has been underway

to lower the high debt ratio and to ensure financial soundness, which has been pointed out as a problem in overcoming the crisis. This study focused on the fact that the institutional change caused by government policy may have affected the behavior of firms. In particular, it is possible to expect that adjusting the upper limit of the debt ratio of the firm and strengthening the financial soundness regulations may cause changes in firm behavior in terms of the introduction of resources. In this context, this study tried to compare the determinants of firm survival before and after the Asian financial crisis.

2.4 Empirical strategy

This study analyzed the determinants of survival of Korean manufacturing firms using survival analysis methodology. Survival analysis is a statistical method that identifies the factors that affect the time to the occurrence of a specific event, defined as its survival time. This approach has been widely used for empirical analysis using corporate data since the early 1990s. In particular, since the analysis of firm survival using the hazard model has been undertaken, an attempt has been made to analyze the survival period and the determinants of survival on an empirical analysis. Section 2.4 explains the parametric model of survival analysis methodology and the exponential and Weibull distributions, which are most frequently used in parametric survival analysis.

2.4.1 Survival function and hazard function

The survival function is the probability that an event will not occur until a certain point in time, or the probability that it will survive a point in time. Let T denote firm survival

time and t denote observed time of firm survival, then the survival function $S(t)$ is as follows:

$$S(t) = Pr(T > t) \tag{1}$$

Let N denote the total number of firms and n denote the number of firms that have survived by the time t, and $S(t)$ can have the value n/N. Theoretically, the survival function has the following properties: 1) $t = 0,\ S(t) = S(0) = 1$, there are no firms that exit when the time of observation starts and thus, the survival function has the value of 1; 2) $t = \infty,\ S(t) = S(\infty) = 0$, there is no firm that survives when sufficient time has passed, and thus the survival function has the value of 0. If the survival function is focused on the number of surviving companies up to a certain point in time, we can consider the number of firms that have exited by the time t. This is the definition of survival probability, $F(t)$, and its cumulative distribution function is as follows.

$$F(t) = 1 - S(t) = Pr(T \leq t) \tag{2}$$

The density function can be obtained by differentiating the cumulative distribution function of the survival probability as the general cumulative distribution function. The probability density function is defined as follows:

$$f(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T < t + \Delta t)}{\Delta t} \tag{3}$$

The probability density function of the survival probability has information about the slope of the tangent line at time t of the cumulative distribution function, that is, how quickly the survival probability changes at time t.

$$f(t) = \frac{d}{dt}F(t) = \frac{d}{dt}\big(1 - S(t)\big) = -\frac{d}{dt}S(t) \tag{4}$$

The hazard function $h(t)$, which is similar to the density function $f(t)$, is defined as:

$$\begin{aligned} h(t) &= \lim_{\Delta t \to 0} \frac{\Pr(t \le T < t + \Delta t | T \ge t)}{\Delta t} \\ &= \lim_{\Delta t \to 0} \frac{\Pr\,(t \le T \le t + \Delta t)}{S(t)\Delta t} \end{aligned} \tag{5}$$

In other words, the density function refers the risk of firm exit among all firms from the beginning by time t, while the hazard function refers the risk of firm exit among firms that have survived by time t. Therefore, the hazard function is called the conditional incidence rate and the density function is called the absolute incidence rate. From Equations (3) and (5), it can be seen that the following relation holds:

$$h(t) = \frac{f(t)}{S(t)} \tag{6}$$

Since $f(t)$ is a derivative of $F(t)$ and $F(t)$ is a complementary set of $S(t)$, $h(t)$ can be rewritten as:

$$\begin{aligned} h(t) &= \frac{1}{S(t)}\frac{d}{dt}F(t) = \frac{1}{S(t)}\frac{d}{dt}[1 - S(t)] \\ &= -\frac{1}{S(t)}\frac{d}{dt}S(t) \end{aligned} \tag{7}$$

Equation (7) can be replaced by the derivative form of the natural logarithm as:

$$h(t) = -\frac{d}{dt}lnS(t) \tag{8}$$

Equation (9) can be obtained by integrating Equation (8):

$$-\int_0^t h(x)dx = lnS(t) \tag{9}$$

From Equation (9), $S(t)$ can be rewritten as:

$$S(t) = \exp\left[-\int_0^t h(x)dx\right] \tag{10}$$

The survival function can be obtained by integrating hazard function $h(t)$ by time t and the cumulative hazard $H(t)$ is obtained as:

$$H(t) = \int_0^t h(x)dx \tag{11}$$

The survival function $S(t)$ and density function $f(t)$ can be rewritten as Equations (12) and (13) by using Equation (11).

$$S(t) = \exp\left[-H(t)\right] \tag{12}$$

$$\int_0^t h(x)dx = h(t)\exp\left[-\int_0^t h(x)dx\right] \tag{13}$$

Even if the hazard function $h(t)$ is not known, we can derive the survival function from Equation (12).

2.4.2 Parametric survival analysis model

Survival analyses can be categorized into parametric and non-parametric models according to whether the information on the distribution of the survival function is estimated. There is also another approach, the semi-parametric model, which has moderate properties of both parametric and nonparametric models. The parametric survival model used in this study has the advantage that model-based estimations can be performed at any time by estimating only the related parameters. That is, while nonparametric models cannot predict the survival probability beyond the longest surviving firm observed, parametric

models can estimate the survival probability beyond the longest surviving firm. For example, if the longest surviving firm observed is 20 years old, then nonparametric models cannot predict the survival probability after 20 years, but parametric models can. The distribution of the survival function is generally selected from among the exponential distribution, Weibull distribution, gamma distribution, Gompertz distribution, and log-normal distribution. Section 2.4.2.1 and Section 2.4.2.2 discuss the process of reviewing the most frequently used exponential distribution, and the fit of the Weibull distribution and its application in survival analysis studies.

2.4.2.1 Exponential distribution

The simplest hazard function is to assume that the hazard is a time independent constant. Let λ denote the time independent constant; $S(t)$ can then be obtained as Equation (14) by substituting in Equation (10). Also, $F(t)$ can be defined as Equation (15) through Equation (2).

$$S(t) = \exp(-\lambda t) \tag{14}$$

$$F(t) = 1 - \exp(-\lambda t) \tag{15}$$

$f(t)$ is rewritten through Equations (6) and (14) as:

$$f(t) = \lambda \exp(-\lambda t) \tag{16}$$

Assuming that the survival function follows the exponential distribution, there is only one parameter, λ, that determines the shape of the exponential distribution. Since the mean of the exponential distribution is the inverse of the parameter λ, the parameter of the

exponential distribution can be determined from the average survival time of the observations μ.

The exponential distribution has the advantage of being easy to estimate by setting the hazard function as a time independent constant. However, it is necessary to confirm whether the given survival data can be assumed to have an exponential distribution. The general method for this confirmation is to plot the log-log transformation of $S(t)$ onto a plane that has two axes: $\log t$ as the horizontal axis and $\log[-\log[S(t)]]$ as the vertical axis. If the curve shows a slope of 1, the hazard function can be assumed to have a constant value. If the hazard function has a constant value, $-\log[S(t)] = \lambda t$. The logarithmic transformation of Equation (14) is rewritten as:

$$\log[-\log[S(t)]] = \log\lambda + \log t \tag{17}$$

Let $y = \log[-\log[S(t)]]$, $a = 1, b = \log\lambda$, $x = \log t$; Equation (17) then has a linear form $y = ax + b$. If Equation (17) is drawn in the form of a straight line on the plane, it is not a problem to assume that the hazard function has a constant value.

2.4.2.2 Weibull distribution

The exponential distribution considered as a hazard function has a constant value regardless of time. However, if we assume the Weibull distribution for the hazard function, the hazard can change over time. The hazard function of the Weibull distribution is defined as:

$$h(t) = \gamma\lambda(\lambda t)^{\gamma-1} \tag{18}$$

λ and γ denote scale parameter and shape parameter respectively ($\gamma > 0$). The Weibull distribution is known to be highly flexible in survival analysis. If $\gamma = 1$, Equation (18) is a constant λ that is identical with the hazard function of the exponential distribution. If the hazard function is given as Equation (18), then the survival function $S(t)$ can be rewritten as:

$$S(t) = \exp\left[-(\lambda t)^{\gamma}\right] \tag{19}$$

Similar to the exponential distribution, we need to draw the log-log transformation of $S(t)$ on the plane, which has two axes: $\log t$ as the horizontal axis and $\log[-\log[S(t)]]$ as the vertical axis.

The log-log transformation of Equation (18) is as follows:

$$\log[-\log[S(t)]] = \gamma \log \lambda + \gamma \log t \tag{20}$$

Equation (20) is a linear equation that has γ as a slope, $\log t$ as an independent variable, and $\gamma \log t$ as an intercept. If the curve has the shape of a line and the slope is not close to 1, the data can be considered to be a Weibull distribution with the parameter γ as a slope. If the slope is close to 1, it is reasonable to look at the exponential distribution. This is because the exponential distribution is a special case of Weibull distribution, as described above.

2.5 Data and Variables

2.5.1 Data

This study used the KISVALUE database constructed by the NICE Information Service.

KISVALUE is the oldest and most reliable firm level micro database in Korea (Kim & Lee, 2016) and provides financial data for all the manufacturing firms listed on the KSE (Korea Stock Exchange) and the KOSDAQ (Korea Securities Dealers Automated Quotation) and on many non-publicly traded, but externally audited registered firms. In this study, observations from 1981 to 2014 were used for the analysis. All of the variables, such as sales, investment, etc., were converted into constant values using the producer price index (PPI) as of 2010.

To analyze the dynamics of an industry, the entry of new firms and the exit of firms must be accurately identified. In this research, if a firm was observed with a new identification code in the database, it was identified as a new entry of a firm, following the work of Mata et al. (1995). Exit of firm was identified if the firm was not observed from the database due to a bankruptcy or business closure or an impaired capital case (Kim & Lee, 2016). Table 3 shows the number of entrants and exits, entry rate, and exit rate identified by the above method. Also, the table summarizing the number of observations classified by industry is attached in Appendix 2.

Table 3. Number of observations

Year	Total	Entry	Exit	Year	Total	Entry	Exit
1981	131	N/A	N/A	1998	4,438	568	104
1982	185	59	5	1999	5,009	753	182
1983	286	122	21	2000	5,318	664	355
1984	707	422	1	2001	5,478	529	369
1985	858	153	2	2002	6,308	1059	229
1986	1,007	152	3	2003	6,812	728	224
1987	1,164	185	28	2004	6,855	519	476
1988	1,309	167	22	2005	6,835	437	457
1989	1,385	98	22	2006	7,009	561	387
1990	1,510	161	36	2007	7,109	516	416
1991	1,676	186	20	2008	6,986	480	603
1992	1,731	67	12	2009	6,770	341	557
1993	1,753	132	110	2010	6,529	278	519
1994	1,989	265	29	2011	6,209	275	595
1995	2,685	720	24	2012	6,185	319	343
1996	3,174	533	44	2013	5,976	332	541
1997	3,974	853	53	2014	5,917	315	374
				Total	131,267	12,949	7,163

2.5.2 Variables

The following five variables were set to examine the determinants of survival at the firm level. First, the size of firm was measured by the natural logarithmic transformation of the number of employees. Second, the age of firm was calculated from the database that has the information of establishment date. Third, firm investment was obtained from two variables in the database, investment on R&D and investment on tangible assets. Fourth, export activity was obtained as a dummy variable and has a value of 1 if sales as exports

are not zero. Firm financial character is considered with debt dependency, which is the ratio of total debt to total assets.

The technology level of the industry was included to examine its effect on firm survival at the industry level. The database has 24 industry classifications, based on the Korea Standard Industry Classification (KSIC). We reclassified these 24 industries into four industries, according to their technology level based on the classification of the OECD as the following Table 4. The following Table 5 summarizes the variables and operational definitions used in the study. The descriptive statistics of the variables used in the analysis are attached in Appendix 2.

Table 4. OECD industry classification based on R&D intensities

Classification	Industries
High-technology industries	Aircraft and spacecraft Pharmaceuticals Office, accounting and computing machinery Radio, TV and communications equipment Medical, precision and optical instruments
Medium-high-technology industries	Electrical machinery and apparatus, n.e.c. Motor vehicles, trailers and semi-trailers Chemicals excluding pharmaceuticals Railroad equipment and transport equipment, n.e.c. Machinery and equipment, n.e.c.
Medium-low-technology industries	Building and repairing of ships and boats Rubber and plastics products Coke, refined petroleum products and nuclear fuel Other non-metallic mineral products Basic metals and fabricated metal products

Table 4. OECD industry classification based on R&D intensities (continued)

Classification	Industries
Low-technology industries	Manufacturing, n.e.c.
	Recycling
	Wood, pulp, paper, paper products, printing and publishing
	Food products, beverages and tobacco
	Textiles, textile products, leather and footwear

Table 5. Variables and definition

Level	Variables	Definition
Firm level	Size	Logarithm of number of employees
	Age	Firm age
	R&D Expenditure	Natural logarithm of R&D expenditure
	R&D	R&D activity, Dummy variable
	Investment	Investment of tangible asset, Dummy variable
	Exporting	Export activity, Dummy variable
	Debt dependency	Ratio of total debt to total assets.
Industry level	Low Tech	Dummy variable
	Med-Low Tech	Dummy variable
	Med-High Tech	Dummy variable
	High Tech	Dummy variable

2.6 Results

2.6.1 Specification of parametric survival function

In order to implement the parametric survival analysis, the process of specification of the survival distribution from the data should precede. As noted in sections 2.4.2.1 and 2.4.2.2, the log-log transformation of the survival function $S(t)$ was plotted on a plane with $\log t$ as the horizontal axis and $\log[-\log[S(t)]]$ as the vertical axis.

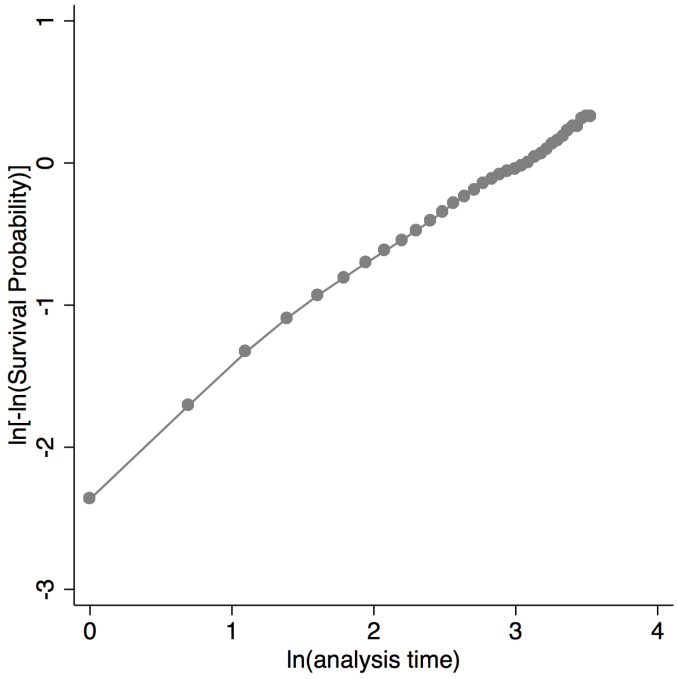


Figure 1. Log-Log transformation of survival function

As we can see in Figure 1, the log-log transformation of the survival function has the shape of a line. However, the linear regression result shows that the slope of the curve is 0.71 and the intercept is -2.15 (R^2: 0.992). Also, the null hypothesis was rejected that the slope has the value of 1 ($\chi^2 = 648.60$). Thus, the Weibull distribution was assumed for the survival distribution of the data.

2.6.2 Regression result of parametric survival model

This study analyzed firm level data from 1981 to 2014 before and after the Asian financial crisis. In order to identify the determinants of firm survival before the Asian

financial crisis, the observations from 1981 to 1996 were used, and the observations from 2000 to 2006 were used to examine the situation after the crisis. Observations after 2006 were not included since the global financial crisis effect might influence the result. Table 6 shows the analysis results.

The result confirmed some stylized facts on firm survival. First of all, the size of a firm has a positive effect on firm survival. In other words, we can confirm that there is a liability of smallness in Korean industry. This result can be interpreted through Jovanovic's (1982) passive learning model. Jovanovic argued that a firm is able to learn about its cost structure and competitiveness after entering the market and the decisions about the size of the firm follow. Under this framework, firm size can be a buffer during a firm's learning process after entry. Therefore, the size of the firm can be expected to have a positive effect on the survival of the firm, and the empirical analysis supports this. In addition, Korean industry has a difference in the ability to secure resources such as the financial networking capability of large enterprises and SMEs. Thus, it can be understood that the larger the size of a company, the higher the probability of its survival.

It is also found that firm age also contributes positively to firm survival. In similar fashion to previous studies, we found that liability of newness exists in Korean manufacturing industry. Firms with higher age are more experienced and have more accumulated knowledge than firms with lower age. In addition, as Cohen and Levinthal (1990) insisted, even in the process of acquiring new knowledge, firms with larger accumulated knowledge are more advantaged than those with smaller knowledge. In this

context, liability of newness can be quite clearly understood as a phenomenon.

Table 6. Regression results for parametric survival model

	Model I (1981-1996)	**Model II (2000-2006)**
Size	-0.5524***	-0.2328***
	(0.0201)	(0.0120)
Age	-0.012***	-0.0185***
	(0.0023)	(0.0013)
R&D	-0.0181***	-0.0090***
	(0.0054)	(0.0030)
Exporting	-0.1787	-0.1327
	(0.1111)	(0.0881)
Med-Low Tech.	-0.1626***	-0.0047
	(0.0565)	(0.0309)
Med-High Tech.	-0.4375***	0.0552
	(0.0623)	(0.0352)
High Tech.	-0.3186***	0.1090***
	(0.0648)	(0.0379)
Year dummy	Controlled	Controlled
Log likelihood	-3487.0824	-7639.0402
Number of Observations	21,550	44,615

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively. Standard errors are given in parentheses.

Firm R&D investment was used to analyze the existence of an innovation premium in the survival of firms. The result confirms that there is a strong innovation premium in Korean industry. R&D investment is considered as an investment with high uncertainty compared

with other investments. However, it is essential to improve productivity or invent new products to increase competitiveness of firms. In other words, R&D investment contributes not just to firm growth, but also to firm survival, as Cefis and Marsili (2005) found.

Unlike the determinants of firm level survival, the determinants of industry level survival changed before and after the Asian financial crisis. Before the Asian financial crisis, the survival rate in the low technology sectors was lower than that of the other sectors. However, after the Asian financial crisis, the survival rate in the high technology sector was higher than that of other sectors, which is a stylized fact derived from previous studies. One of the reasons for this change can be interpreted as the increase in technological innovation and the shortening of the technology life cycle. Compared with the past, Korean firms have increased investment in technology innovation, which means intense competition in the high technology sector. The findings captured this change in Korean industry.

Table 7 shows the estimation results of the model including the financial variables of the firms. The estimated models in Table 7 include debt dependency as an explanatory variable. R&D investment and tangible asset investment are also included as dummy variables.

Table 7. Regression results for parametric survival model

	Model I (1981-1996)	**Model II (2000-2006)**
Size	-0.8645***	-0.2243***
	(0.0441)	(0.0117)
Age	-0.0230***	-0.0195***
	(0.0034)	(0.0013)
Debt Dependency	-0.0045***	5.35E-05
	(0.0009)	(6.24E-05)
Export	-0.3168**	-0.1381
	(0.1539)	(0.0881)
R&D	-0.3365***	-0.1021***
	(0.0482)	(0.0223)
Investment	-0.3560***	-0.1679***
	(0.0376)	(0.0211)
Industry dummy	Controlled	Controlled
Year dummy	Controlled	Controlled
Log likelihood	-3762.8294	-7601.8291
Number of Observations	21,550	44,615

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively. Standard errors are given in parentheses.

From the results in Table 7, the debt dependency contributed differently in Models I and II. The debt dependency in model I contributed positively to firm survival before the Asian financial crisis. This means that those firms that borrow more financial resources from the outside showed a higher probability for survival. On the other hand, the debt dependency in model II was not significant for firm survival.

This difference can be interpreted as a result of institutional changes in Korean industry after the Asian financial crisis. After this crisis occurred, Korean firms tried to change their corporate structures through intensive restructuring. In particular, restructuring was carried out to reduce excessive borrowing, which was pointed out as a direct cause of massive and unsystematic exit of firms during the crisis. In other words, as a result of the restructuring policy of enhancing the capital adequacy of the financial sector and reducing the debt ratio of firms, the selection criteria of the market changed.

In addition, the incentive for firm export activity changed before and after the crisis. Exporting firms were about 1.37% more likely to survive than those that did not export before the crisis. However, this tendency was not observed after the crisis. Also, the comparison between the two results shows that the market had more favorable selection criteria for investment of firms in R&D and tangible assets before than after the crisis. Before and after the crisis, the marginal effects of investment in R&D and tangible assets decreased from 1.39% and 1.43% to 1.18% and 1.18%, respectively.

2.7 Sub-conclusion

In Chapter 2, some of the stylized facts about the survival of companies derived from Chapter 1 were examined through a survival analysis of Korean firm level data. We also investigated the change of selection criteria before and after the Asian financial crisis by comparing the selection criteria of two periods. First of all, firm size, age, R&D investment, and export activity were confirmed to contribute to firm survival in Korean industry. At

industry level, firms in low technology sectors showed a higher survival rate before the crisis. However, firms in high technology sectors showed a higher survival rate after the crisis. Second, it was confirmed that changes in the corporate and financial system caused changes in the corporate selection criteria after the outbreak of the Asian financial crisis. Before the Asian financial crisis, it was found that the there was a tendency for firms to operate with high levels of debt. However, firms' financial structures, which relied on external borrowing and were vulnerable to external shocks, led to a large number of bankruptcies during the Asian financial crisis. In the process of overcoming the Asian financial crisis, a series of measures was taken to improve the financial soundness of business and finance, and this institutional change also influenced the firm selection criteria of the market.

Generally, the high debt to equity ratios of firms in the credit based financial system were accepted as natural. However, the evaluation of firm credit has been strengthened and financial institutions have been improved to enhance the financial soundness of banks as a result of the Asian financial crisis. This institutional change has affected the corporate funding path. The funding path has changed from being heavily reliant on the main bank of each firm to introduce capital from the stock market. However, it has been argued that the supply of capital by the stock market is very limited in providing the growth funds needed by firms. Allen and Gale (1992) reported that the proportion of funds raised through the stock market in the US and UK were −8.8% and −10.4%, respectively. Considering that the US and the UK are countries with a representative market-based financial system, these

figures make us think again about the capital-supply function of the stock market. In this respect, the Korean financial system has contributed to the growth of firms by providing credit before the Asian financial crisis. However, it is observed that the Anglo-American properties of the Korean financial system were strengthened after the crisis. Recently, the growth rate of the Korean economy has slowed considerably. Even though we call such low growth the New Normal, it is necessary to remember that providing credit to firms for investment and growth played a key role in the high-growth period of Korea.

Chapter 3. Productivity Dynamics and Cleansing Effect of Two Economic Crisis in Korean Manufacturing Sector

3.1 Introduction

Inevitably, pressure is placed on every firm to survive once it opens for business. A firm's decision to exit a market is the last option and a fate that all stakeholders of the firm want to avoid. However, from the perspective of either the industry or the nation, a firm's exit decision has a different meaning. In general, less productive firms are replaced with more productive firms through competition, and the resources in the market can then be used in more productive ways. The process of the entry into the market of more productive firms and the exit of those less productive can be captured through Schumpeter's (1934) canonical model of creative destruction. Through the process of creative destruction, a new equilibrium is formed. When the old equilibrium is moving toward a new one, resource reallocation happens in a way that is more productive. Thus, to ensure a more productive use of resources, the exit of a less productive firm gains significance at the industry or national level. This may be one reason why researchers have focused on which firms are exiting the market. The well-known research, such as Jovanovic (1982), found that more productive firms have a survival and growth advantage and less productive firms are more likely to falter and then exit the market. Hopenhayn (1992) examined an equilibrium model

of firm dynamics in terms of market entry and exit. Propositions in the research showed that the productivity level of a firm was related to its survival. He also noted the necessity of the resource reallocation process in firm dynamics. Other research has pointed out that the market selection mechanism works to filter out less productive firms from more productive ones (Baily et al., 1992; Ericson and Pakes, 1995; Disney et al., 2003).

The process of selection and productivity-enhancing resource reallocation can be accelerated through the business cycle. Schumpeter (1942), a pioneer who researched the relationship between creative destruction and the business cycle, argued that the business cycle could influence the magnitude of creative destruction in recessions. In a period of economic downturn, less productive firms are more likely to exit markets and their resources then flow to more productive firms. Consequently, the productivity of the whole economy can increase with the more productive use of such resources. This is the reason that Foster et al. (2016) called silver lining of recession. However, empirical studies on the cleaning effect hypothesis do not show a definite result as theoretically established (Barlevy, 2002). This may be a problem originated from the measurement of resource reallocation. Many studies attempted to measure the resource reallocation through employment change. However, this method cannot precisely measure which firms have been exited and the released resources from firm's exit have been reallocated to which firms. Therefore, in order to find out which firms have gone out of business during the economic downturn and how the resources have been redistributed, an empirical analysis different from the employment change analysis is needed.

In this study, the empirical analysis of the cleaning effect hypothesis was analyzed through the productivity growth decomposition analysis based on the micro data of Korea. Korea suffered from the Asian financial crisis of the 1990s and the Global financial crisis of the 2000s. Thus, it can be considered as a good example for comparing the existence and size of the cleaning effect in Korea, which suffered two economic crises in a relatively short period of time.

The subsequent sections of the chapter are organized as follows. Section 2 briefly reviews the literature on economic downturn and creative destruction. Section 3 introduces the background of the two economic crises in Korea in the 1990s and 2000s. Sections 4 and 5 describe the empirical methodology implemented and the data analyzed in this study, respectively. Section 6 demonstrates the results. The final section, section 7, summarizes and concludes the research.

Chapter 3 follows the following configuration. In Section 3.2 briefly reviews the literature on economic downturn and creative destruction. In Section 3.3 investigates the legal and institutional changes in the financial sector during the Asian financial crisis and derive research hypotheses. In Section 3.4 reviews the survival analysis methodology implemented in the study. In Section 3.5 describes the data and variables used in the study. Section 3.6 demonstrates the results of productivity growth decomposition analysis and survival analysis. The final section, Section 3.7, summarizes and concludes the research.

3.2 Literature review

Generally, the profitability of a firm is the final determinant in its exit from the market in a period of economic downturn. Thus, the number of firms below the exit threshold increases in recessions as described in Figure 2. After a massive market exit of firms, the resources of these firms will be released and flow to survivor firms that are more profitable and productive than the ones leaving the market. Through the process of resource reallocation, the aggregated productivity will be increased and this is called productivity-enhancing reallocation or the cleansing effect.

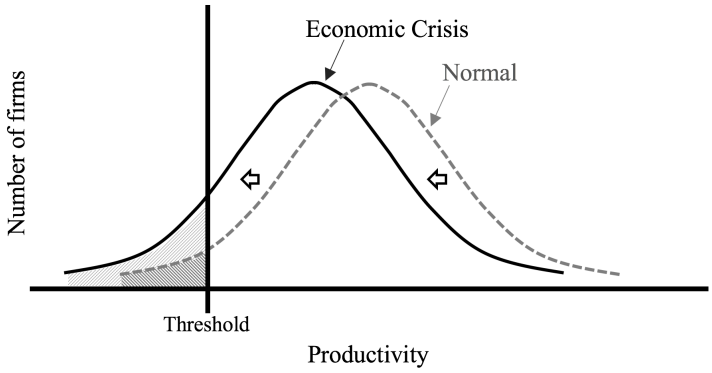


Figure 2. Cleansing Effect in an Economic Crisis

The existence of the cleansing effect has grabbed attention as a topic in previous literature. A number of studies have analyzed employment changes to investigate the existence of cleaning effects. That is, the layoff increases in economic downturn since from

exit and restructuring of firms increases and the increase of employment in the recovery phase follows after the downturn. Thus, it is reasonable to measure resource reallocation by gross employment change. Davis and Haltiwanger (1992) investigated gross job creation and destruction in the period 1972 to 1986. They analyzed plant level employment changes in the U.S. manufacturing sector to examine resource reallocation in terms of employment. Their research revealed that job reallocation rates showed countercyclical when the business cycle increases and the job reallocation rate decreases and vice versa. Caballero and Hammour (1994) examined industry response to demand fluctuation with job-flow data in the U.S. They found outdated production units are the most likely to have low profitability and to exit the market in a recession. In addition, they found that job destruction is more responsive than job creation and it leads to a recession's cleansing effect. Mortensen and Pissarides (1994) analyszed employment dynamics and found that an aggregate shock induces a negative correlation between job creation and job destruction, whereas a dispersion shock induces a positive correlation. Campbell (1998) studied the market entry and exit of U.S. manufacturing companies and provided evidence of the hypothesis that shocks to technological change can be a significant source of economic fluctuation. That is, these shocks replace old technologies with new ones. Davis et al. (2012) examined employment flows with several theoretical models. They analyzed business level data from 1990 to 2010 and found the existence of an increase of reallocation of labor in recession periods. On the other hand, some studies reported no clear evidence was founded to support the cleansing effect hypothesis in economic downturns. Bresnahan and Raff

(1991) researched industrial behavior during the Great Depression with business data from the U.S. motor vehicle industry in the period 1929 to 1935. They found no relationship between resource reallocation and recession; instead, they found businesses tend to contract proportionately in terms of size. Also, Baily et al. (2001) investigated cyclical dynamics of productivity and resource reallocation with manufacturing business data from 1972 to 1989. They found that the impact of the employment reallocation showed countercyclical behavior in a modest way (see also Schuh and Triest (2000)).

However, examining the existence of cleaning effect through changes in employment has the problem that it cannot accurately measure the flow of resource reallocation process. That is, it is impossible to identify where the resource come from and where the resource reallocated. It is only possible to observed the magnitude of resource reallocation. The main mechanism of the cleaning effect is that the less productive firms exit in the economic downturn and the resource they had occupied is reallocated to more productive firms. Barlevy (2002) pointed out the possibility of a problem of this measurement. According to Barlevy, the layoff increases during the economic downturn, yet the new employment increases in economic recession is only found in temporal or low-paying jobs. The sullying effect, introduced by Barlevy, refers that the resource reallocation increases in economic downturn, however, it does not guarantee the reallocation is productivity enhancing.

Productivity growth decomposition analysis could be more precise empirical alternative to examined the cleansing effect accurately. Griliches and Regev (1995) examined the source of productivity growth in Israeli industries and found that major growth in aggregate

productivity comes from productivity changes within firms rather than the entry or exit of firms in the market. Thus, the market exit of firms was not productivity enhancing. Foster et al. (2001) compiled business level data from 1987 to 1992. They measured and decomposed aggregated productivity year by year and found that there was a substantial reallocation generated by the market entry and exit of firms. Moreover, they also showed that there was no difference in the magnitude of reallocation between recession and non-recession periods. Recently, Foster et al. (2016) analyzed the survival determinants during the global financial crisis and found that firms with low productivity were more likely to exit. Also, they found that firms with high productivity were not only more likely to survive, but also showed higher growth rate.

As we can see from the previous studies, the cleansing effect rests on solid theoretical foundations, empirical research shows different results. That is, the cleansing effect was found differently from country to country: Griliches and Regev (1995) versus Davis et al. (2012), and differently by time even in same country: Baily et al. (2001) versus Davis et al. (2012).

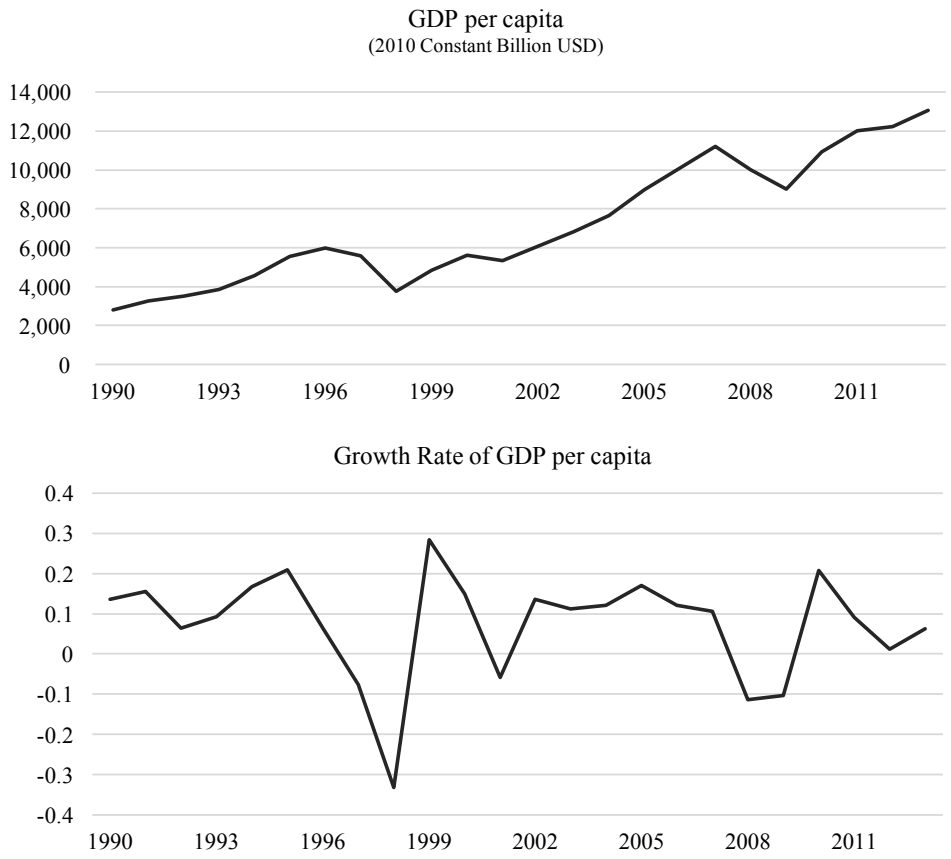
The contradictory results of these empirical studies have been sought to find in the surrounding environment of the economic downturn. Barlevy (2002) argued that the cleaning effect may not occur when the financial sector contracts in a downturn based on the credit market imperfection model of Bernake and Gertler (1989). When finance sector contracts, the liquidity of a firm strongly influences on firm survival during the economic downturn. Although highly productive firms may exit if firms failed to secure liquidity.

Also, Barlevy (2003) developed a model on resource reallocation behavior during recessions with credit market friction. The results show that reallocation might not cleanse, that is, resources could be reallocated to less productive firms. In other words, if the selection mechanism heavily relies on financial capability rather than productivity there will be no cleansing effects.

In summary, the reason for the presence of the cleansing effect relates to the market selection criteria in the recession. Without a financial contract, the market selection criteria would be heavily based on the productivity of firms, and thus productivity-enhancing reallocation would follow. Another possible explanation is that job creation and destruction may measure resource reallocation but not guarantee that a huge reallocation will be productivity enhancing. If a low productive firm shuts down and employees move to another low productive firm, then job flow increases but productivity does not. Thus, job reallocation may not be the best measure for the cleansing effect; rather, productivity growth decomposition may be a better way to observe where productivity growth comes from. In addition, previous studies have analyzed only one crisis and compared different countries or analyzed a crisis from long ago. Thus, differences of space and time might influence the analysis of the cleansing effect. In contrast to previous literature, this study analyzed two different economic downturns within a relatively short time period of 20 years in Korea.

3.3 Research hypothesis

The two economic crises studied here occurred in 1997 and 2008 and left a significant impact on the Korean economy. As Figure 3 describes, the Asian Financial Crisis in the 1990s and the Global Financial Crisis in the 2000s dropped the GDP and GDP per capita growth rates significantly in the recession periods.



Source: Bank of Korea (2016)

Figure 3. GDP and Growth Rate of GDP per capita in Korea: 1990 – 2013

The two crises were quite different in terms of their underlying causes and their aftermaths in many respects. For this reason, previous literature has compared the distinct causes and characteristics of these two crises (e.g., Sheng, 2009). In particular, during the Asian financial crisis, the domestic financial sector was vulnerable in terms of capital adequacy, and thus financial sector was restructured through active government intervention to overcome the crisis. On the other hand, the global financial crisis period was in better condition than the Asian financial crisis in terms of capital adequacy both finance and industry sector. The difference in the financial sector have had different effects on the survival of firms, especially in the Asian financial crisis (Stiglitz and Greenwald, 2014). We focused on the relationship between the finance sector stability and the occurrence of cleansing by comparing two crises.

Table 8. Comparison two financial crises

	Asian Financial Crisis	**Global Financial Crisis**
Cause of Outbreak	Endogenous factor by opening capital market	External factor spread from foreign countries
Restructuring Entity	Government	Creditors
Restructuring in Finance Sector	Disqualification of insolvent financial institutions Strengthening supervision system	Lowering the possibility of insolvency of in finance sector by institution

3.3.1 Cleansing effect in the Asian financial crisis

The main cause of the economic crisis in the 1990s was the unstable foreign exchange and financial market in Southeast Asia. On July 1997, Thailand announced that it would adopt a floating exchange rate system, posing a serious threat in the Asian region. As a result, Korea's sovereign credit rating dropped and this accelerated the outflow of foreign capital. The depletion of foreign-exchange reserves followed and thus, the Korean government requested emergency funding from the International Monetary Fund. In order to stabilize the surging exchange rate, the government increased the short-term interest rate from 12% in November to 31% in December. In addition to vulnerability in the financial markets, many firms' profitability fell, especially in the manufacturing industry, as of the mid-1990s. Chopra et al. (2001) indicated that a high dependency on external funding was the main cause of the drop-in profitability. From the industry dynamics perspective, before the Asian Financial Crisis in 1997, there was not a proper market exit system for insolvent firms and banks. Distressed assets were not properly managed and the restructuring mechanism did operate well. Consequently, the accumulation of insolvent firms during this period led to an increase in distressed-debt in the financial market. As a result, the Korean domestic market and the real economy went through a steep downturn after the Asian Financial Crisis. The drop in private consumption expenditure and investment were also a big obstacle to overcoming the crisis. With the financial support from the International Monetary Fund, a massive restructuring among firms and banks followed. Many firms were forced to liquidate and, therefore, the economy experienced an even more severe downturn.

However, the efforts to restructure insolvent firms ultimately improved the financial fundamentals of the Korean economy.

Table 9. Unemployment Rates and Interest Rates in Korea: 1993 – 2013

Year	Unemployment Rate (%)	Corporate Loan Interest Rate (%)		Corporate Bond Interest Rate (%)
		Large Enterprises	SMEs	
1993	2.9	N/A	N/A	12.63
1994	2.5	N/A	N/A	12.90
1995	2.1	N/A	N/A	13.79
1996	2.0	11.42	10.88	11.87
1997	2.6	12.19	11.63	13.39
1998	7.0	16.13	14.89	15.10
1999	6.3	9.49	8.75	8.86
2000	4.1	8.75	7.95	9.35
2001	3.8	7.69	7.38	7.05
2002	3.1	6.17	6.56	6.56
2003	3.4	5.98	6.21	5.43
2004	3.5	5.72	5.97	4.73
2005	3.5	5.20	5.76	4.68
2006	3.3	5.56	6.20	5.17
2007	3.0	6.09	6.72	5.70
2008	3.0	6.79	7.31	7.02
2009	3.4	5.61	5.65	5.81
2010	3.4	5.25	5.68	4.66
2011	3.0	5.50	6.00	4.41
2012	2.8	5.18	5.66	3.77
2013	2.8	4.46	4.92	3.19

Source: Bank of Korea Economic Statistics System (2015)

In summary, the Asian financial crisis was an economic crisis in which both the

industrial and financial sectors were exposed to shock. Specifically, as we can see in Table 9, the financial sector was under the very unstable condition during the Asian financial crisis. In order to stabilize finance sector, a strong restructuring of the government's financial sector was under way. Restructuring of the financial sector led to high interest rates for industry sector and restrictions on new loans, as a consequence, many firms exited due to the liquidity problem. Since the finance sector was unstable, the process of resource reallocation could not proceed desirably. Therefore, we can expect there was no cleansing effect in the Asian financial crisis period.

3.3.2 Cleansing effect in the global Financial Crisis

The financial crisis in the 2000s engulfed the whole world. Continuous low interest rates led to an increase in household loans; this created a global property bubble. Real estate related institutions and investment banks engaged in aggressive investment through leveraging risk. As Korea had undergone a rigorous restructuring after the Asian Financial Crisis, firms that survived this period were comparatively strong. The profitability as well as financial soundness of many firms improved after the Asian financial crisis. Additionally, the debt ratio of manufacturing companies significantly decreased after the Asian financial crisis as firms started to depend less on excessive loans, which generate high financial costs. The financial supervisory system also improved as of 1997. Before the Asian financial crisis, there was no integrated supervision system for banks, insurance, and the stock market; instead, these fell under different agencies. As a result of the Crisis, the Korean

government integrated their supervision under one umbrella known as the Financial Supervisory Service and also established a revised deposit insurance system. Moreover, an institution was established to deal with distressed assets and to work as a mediator to facilitate resource movement in the market. From these efforts, the financial soundness and profitability of banks and other firms improved. It is generally accepted that the Korean economy was more severely impacted by the Asian financial crisis than by the global financial crisis. There are two explanations for this, First, Korea was not the main trigger of the global financial crisis, and second, Korean firms were financially more stable during the crisis in 2008. The interest rates in Table 9 show the differences in the stability of the economy in the recession periods. The financial markets during the Asian financial crisis were far unstable than during the global financial crisis. In other words, unlike the Asian financial crisis, the global financial crisis did not severely influence to financial sector. Thus, the financial sector could support the restructuring process in industry sector during the crisis period. Therefore, we can expect that these was a cleansing effect in the global financial crisis.

3.4 Empirical strategy

This study used two empirical methodologies. The first measured aggregated productivity at the plant total factor productivity (TFP) level and decomposed the growth of the aggregated productivity. The result captures the link between industrial dynamics (e.g., market entry of new firms and market exit of incumbent firms) and productivity

growth. Moreover, more importantly, through decomposition, it is possible to observe the cleansing effect of the recessions. The second methodology implemented was to examine the determinants of the survival of plants. Generally, survival analysis is implemented to observe specific characteristics that strongly influence the occurrence of the interested event. In this research, we investigated plants to assess which variables influenced firm exit in the two crisis periods, and the analysis result would imply which determinant and manner worked during the market selection process.

3.4.1 Measure of Total Factor Productivity

The TFP of each plant can be measured using the chained multilateral index approach developed by Good et al. (1997). The methodology has been applied in works by Aw et al. (2001), Hahn (2004), and Oh et al. (2009). The greatest advantage of using the chained multilateral productivity index is that it enables a plant-to-plant comparison with cross-sectional data or panel data. It generates a hypothetical plant as a reference point for each cross-sectional observations and links hypothetical plants in each year over time. By linking hypothetical plants, the transitivity is ensured and it enables us to compare productivity levels between plants in different time periods. The reference point for a given year is constructed with the arithmetic mean of input shares and input levels, and equals the geometric mean of inputs over all cross-sectional plants.

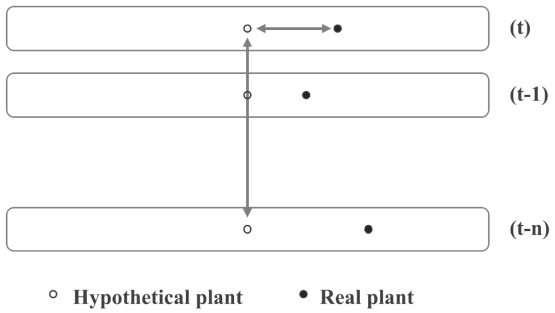


Figure 4. Transitivity in Chained multilateral index approach

The inputs, output, and productivity level of each plant can be measured relative to the reference point, hypothetical plant, of the base year. Thus, the productivity level of each plant in each year is measured relative to the hypothetical plant at the base year. This approach allows us to make transitive comparisons of productivity levels in panel data. The productivity index for plant i at time t is measured as follows:

$$lnTFP_{it} = \left(lnY_{it} - \overline{lnY_t}\right) + \sum_{\tau=2}^{t}\left(\overline{lnY_\tau} - \overline{lnY_{\tau-1}}\right) \tag{21}$$

$$-\left\{\sum_{j=1}^{J}\frac{1}{2}\left(S_{jit} + \overline{S_{jt}}\right)\left(lnX_{jit} - \overline{lnX_{jt}}\right) + \sum_{\tau=2}^{t}\sum_{j=1}^{J}\frac{1}{2}\left(\overline{S_{j\tau}} + \overline{S_{j\tau-1}}\right)\left(\overline{lnX_{j\tau}} - \overline{lnX_{j\tau-1}}\right)\right\}$$

where $Y, X, S,$ and TFP denote output, input, input share, and total factor productivity level, respectively. In this research, we considered three input factors of capital, labor, and intermediary inputs. In addition, the output was measured with the volume of production. Variables with the upper bar denote the corresponding arithmetic mean for input share and input levels. The subscripts t and n denote time and inputs, respectively.

3.4.2 Decompose TFP growth

TFP growth decomposition analysis is an appropriate methodology to link industrial dynamics and productivity growth. Ahn (2001) reviewed three widely used decomposition methodologies and summarized their advantages and disadvantages. In this study, the methodology introduced by Griliches and Regev (1995) was implemented. The first step is to calculate the aggregated productivity in the base and end years. The aggregated productivity is calculated as follows:

$$P_t = \sum_i \theta_{it} p_{it} \tag{22}$$

where P and p represent aggregated and individual plant TFP, respectively, and θ denotes the market share of the individual plant. Griliches and Regev (1995) suggested decomposing changes in productivity into four terms as follows:

$$\begin{aligned} \Delta P_t = & \sum_{i \in C} \bar{\theta}_i \Delta p_{it} + \sum_{i \in C} \Delta\theta_{it} (\bar{p}_i + \bar{P}) \\ & + \sum_{i \in N} \theta_{it} (p_{it} - \bar{P}) - \sum_{i \in X} \theta_{it-k} (p_{it-k} - \bar{P}) \end{aligned} \tag{23}$$

where $i, t,$ and $t-k$ denote the individual plant, the base year, and the end year, respectively, and, the set of plants, $C, N,$ and X denote continuing, entry, and exit plants, respectively. The continuing plants were plants that were observed in both t and $t-k$ periods. Entry plants were not observed in period $t-k$ but observed in period t, and vice versa for exit plants. The bar over a variable denotes the average of the variable over the base and end years. Looking from left to right, the equation denotes: 1) within productivity changes in continuing plants; 2) productivity changes resulting from changes in market

share; 3) productivity changes resulted from newcomers; and, 4) productivity changes resulted from plants exiting the market.

3.4.3 Survival analysis: Cox proportional hazard model

The proportional hazard model was proposed by Cox in 1972. The main idea of the model was to regress the failure or hazard rates onto explanatory variables. In this research, the model was implemented to observe the effects of covariates on the hazard rate of plants. Specifically, the model is a semi-parametric model for the hazard function that allows the addition of explanatory variables and it keeps the baseline hazard as an arbitrary, unspecified, nonnegative function of time. The hazard rate of plants at time t can be calculated as follows,

$$h(t_i) = h_0(t_i) \cdot exp\{\alpha' x_i + \beta' z_i(t)\} \tag{24}$$

where the function h_0 is the baseline hazard and it has the value of innate hazard without any effects from other covariates. x_i is a vector of time-independent covariates and $z_i(t)$ is a vector of time-dependent covariates. Some covariates are treated as having constant values such as the employees or sales at the time of entry. These covariates have the same value in all periods, which is why they are time-independent covariates. On the other hand, some covariates vary over time, for example, productivity level, sales, and production. The left hand side of Equation (24), $h(t_i)$ denotes the hazard function that is the failure rate for a small interval of time. It becomes the instantaneous failure rate as Δt becomes zero in equation (25).

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T < t + \Delta t | T \geq t)}{\Delta t} \tag{25}$$

The unique effect of a unit change in a covariate is multiplicative with respect to the hazard rate of plant. The effect of the covariates contributing to the instantaneous failure can be obtained by regression analysis. If the coefficient of the covariate is negative, it decreases the instantaneous failure, and if the coefficient is positive, it increases the instantaneous failure.

3.5 Data and variables

3.5.1 Data

The data used in this study were plant level data from the Annual Mining and Manufacturing Survey conducted by the Korean government covering the period of 1993 to 2013. The survey collects information on all plants with 10 or more employees. The number of observations varies each year but shows a gradual increasing trend except in the two recession periods. Table 3 shows the number of observations classified by size of plants. Small, medium, and large plants had 10 to 50, 51 to 300, and 301 or more employees, respectively. Since the survey covers all plants with 10 or more employees, small size plants represent a large portion of the data, which is why there are a total number of plant changes along with a number of small size plants.

Table 10. Number of observations by size

Year	Number of Plants			Total
	Small	Medium	Large	
1993	36,934	7,610	871	45,415
1994	37,993	7,734	850	46,577
1995	38,297	7,587	843	46,727
1996	37,816	7,246	828	45,890
1997	34,237	6,673	711	41,621
1998	30,796	5,846	584	37,226
1999	31,720	6,315	601	38,636
2000	35,210	6,710	636	42,556
2001	36,203	6,527	587	43,317
2002	37,316	6,598	572	44,486
2003	37,546	6,619	554	44,719
2004	38,618	6,502	555	45,675
2005	40,105	6,542	517	47,164
2006	43,258	6,436	519	50,213
2007	46,216	6,449	515	53,180
2008	45,061	6,339	499	51,899
2009	43,862	6,310	470	50,642
2010	43,052	6,949	502	50,503
2011	44,757	7,028	520	52,305
2012	46,711	7,269	538	54,518
2013	37,557	6,995	500	45,052
Total	823,265	142,284	12,772	978,321

Since this study aims to measure and decompose TFP growth over time from micro data, the most disaggregated unit of production data is needed in the study. In addition, the turnover of the plant can be an important source of aggregated productivity growth as we

discussed earlier. Therefore, the identification of the plant's market entry and exit has to be captured clearly. In this study, the market entry and exit of plants are identified based on the observed plants appearing and disappearing over time. Table 4 and Figure 3 show the market entry, exit, and turnover rate among the observations. We adopted the definitions of continuing, entering, and exiting plants on the basis of three time periods following previous literature (Bartelsman et al., 2003 and OECD, 2004). We defined the continuing plants that were observed in periods of $t-1, t,$ and $t+1$. The entry plants were plants that were not observed in period of $t-1$, however, observed in the period of t and $t+1$. The exit plants are plants that were observed in the period of $t-1$ and t, but were not observed in the period of $t+1$. Some plants entered and exited in the same year. In other words, they were not observed in $t-1$ and $t+1$, yet only observed in t. As OECD (2004) noted that these short-lived plants may have possible measurement errors and/or ill-defined data. Thus, we did not include these observations in the analysis.

Table 11 shows the entry and exit dynamics from 1994 to 2012. Entry and exit rate fluctuate with the economic upturns and downturns. The exit rate of plants increases and entry rate decreases in economic downturns. Moreover, the entry rate increase seems to have lagged after both recession periods. Additionally, we examined the entry, exit, and turnover rate by industry and observed similar rates to what we found for the whole manufacturing level.

Table 11. Entry, exit, and turnover rate

Year	Entry Rate	Exit Rate	Turnover Rate
1994	0.163	0.138	0.301
1995	0.195	0.191	0.386
1996	0.142	0.160	0.302
1997	0.104	0.197	0.301
1998	0.133	0.239	0.373
1999	0.194	0.157	0.351
2000	0.232	0.130	0.362
2001	0.152	0.134	0.285
2002	0.159	0.132	0.290
2003	0.201	0.196	0.397
2004	0.171	0.150	0.321
2005	0.161	0.128	0.289
2006	0.196	0.132	0.328
2007	0.147	0.088	0.235
2008	0.098	0.122	0.220
2009	0.087	0.112	0.199
2010	0.159	0.162[1]	0.321
2011	0.142	0.106	0.248
2012	0.121	0.079	0.201

[1] Capital of some plants was not collected in a 2010 survey. Since the survey collects the average book value of capital stocks at the beginning and end of the year, we could restore from the data of the end of 2009 and the beginning of 2011.

Figure 5. Entry, exit, and turnover rate

3.5.2 Variables

Some variables were used to measure TFP level of individual plants. As in Equation (21), input and output variables are required. For the output variable, we used gross production. Additionally, we measured input by three dimensions: capital, material, and labor inputs. The survey collects the average book value of capital stocks at the beginning and end of the year. We used both average values for the capital stocks. Oh et al. (2009) discussed how the capital in Korean manufacturing has been traditionally used intensively with very small losses in the rate of capacity utilization. From this perspective, the book value of capital stock can be used as an appropriate measure of capital input. For intermediate input, we used major and other production cost as the variable. The major production cost includes materials and parts, fuel, electricity, water, outsourced

manufactured goods, and maintenance costs. The other production cost includes the cost of advertising, transportation, communication, and insurance. Finally, the labor input was measured by the number of workers. The survey includes the number of production and non-production workers. All values, except labor input, were deflated to 2010. Specifically, the output was deflated by the producer price index (PPI), capital was deflated by the capital goods deflator, and the intermediary input was deflated by the intermediate input price index. All the deflators were obtained from the Bank of Korea Economic Statistics System. The descriptive statistics are attached in Appendix 3. Measuring TFP with a chained multilateral index requires a production function assumption of constant returns to scale. This assumption enables us to easily calculate factor input elasticities. In this study, labor and intermediate input elasticities were calculated as their average cost share within the same sized plant and same class in the five-digit industry code. Since the sum of the factor input elasticities equals one, the average cost share of capital can be computed by the deduction of labor and intermediate input elasticity from one.

3.6 Results

3.6.1 Calculation result of total factor productivity (TFP)

Table 12 shows aggregated productivity weighted by the market share of each plant. Since the base year of the research is 1993, the productivity of 1993 is normalized to zero; this enables a comparison of the growth achieved relative to the productivity in 1993. From 1993 to 2013, average annual productivity growth was 2.84%. Before the Global Financial

Crisis this average growth was 3.75% annually, but after the crisis it seems to have stagnated.

Table 12. Aggregated productivity by year

Year	Productivity	Growth
1993	0.0000	N/A
1994	0.0246	0.0246
1995	0.0415	0.0169
1996	0.0823	0.0409
1997	0.1598	0.0775
1998	0.1093	-0.0505
1999	0.0364	-0.0729
2000	0.0613	0.0249
2001	0.1987	0.1374
2002	0.2524	0.0537
2003	0.3343	0.0820
2004	0.4041	0.0698
2005	0.4439	0.0397
2006	0.4873	0.0434
2007	0.5302	0.0430
2008	0.6051	0.0748
2009	0.5102	-0.0949
2010	0.5602	0.0500
2011	0.5973	0.0371
2012	0.6211	0.0237
2013	0.5954	-0.0256

As Figure 6 describes, there were two productivity drops in the recession periods of both the Asian and Global Financial Crisis. The decrease in productivity seems to have had

a strong relationship with the business cycle as Basu and Fernald (2001) reported. They researched four possible explanations as to why productivity is pro-cyclical; in the Korean case, the pro-cyclic behavior may originate from the utilization of inputs that vary over the cycle and resource reallocation across plants with different marginal products may contribute to pro-cyclicality as well.

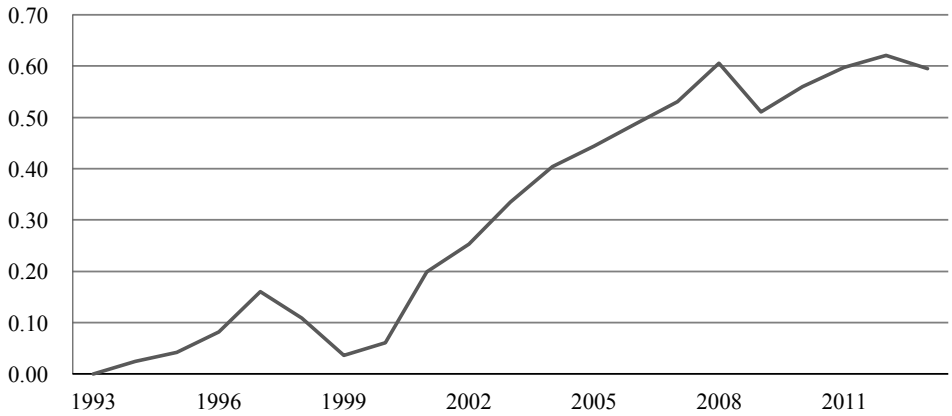


Figure 6. Aggregated productivity growth (Base year: 1993)

3.6.2 Decomposition analysis result of productivity growth

Table 13 shows the productivity decomposition results for: within effect (within productivity changes in continuing plants), between effect (productivity changes resulting from changes in market share), entry effect (productivity changes resulted from newcomers), and exit effect (productivity changes resulted from plants exiting the market), as in equation (3). The results show a significant negative value for the within effect, especially during periods of economic downturn. The within effect captures changes in

productivity as a result of research and development (R&D) investment, and innovation in the plants. As plants generally decrease their investments and spending during recessions, the negative within effect during an economic crisis is reasonable. Moreover, as our study uses production as a variable measuring output, the decrease in demand during an economic downturn would lead to a decrease in production for plants, thus creating a negative within effect.

Table 13. Productivity Growth Decomposition

Period	Within Effect	Between Effect	Entry Effect	Exit Effect
1993-1994	0.0622	-0.0414	0.0060	0.0022
1994-1995	0.0662	-0.0514	0.0077	0.0055
1995-1996	0.0246	0.0211	0.0016	0.0064
1996-1997	0.0580	0.0173	0.0045	0.0023
1997-1998	-0.0305	-0.0084	-0.0020	0.0096
1998-1999	-0.0024	-0.0456	-0.0109	0.0141
1999-2000	0.0452	-0.0173	0.0083	0.0114
2000-2001	0.0744	0.0565	0.0094	0.0029
2001-2002	0.0679	-0.0157	-0.0003	-0.0018
2002-2003	0.0593	0.0094	0.0519	0.0386
2003-2004	0.0649	-0.0026	0.0053	-0.0022
2004-2005	0.0121	0.0212	0.0016	-0.0048
2005-2006	0.0368	0.0028	-0.0005	-0.0043
2006-2007	0.0358	-0.0009	0.0010	-0.0071
2007-2008	0.0548	0.0208	-0.0012	-0.0004
2008-2009	-0.1031	-0.0012	0.0074	-0.0020
2009-2010	0.0576	-0.0112	0.0028	-0.0009
2010-2011	0.0472	-0.0060	0.0000	0.0041
2011-2012	0.0143	0.0082	0.0101	0.0087
2012-2013	-0.0302	0.0070	-0.0002	0.0023

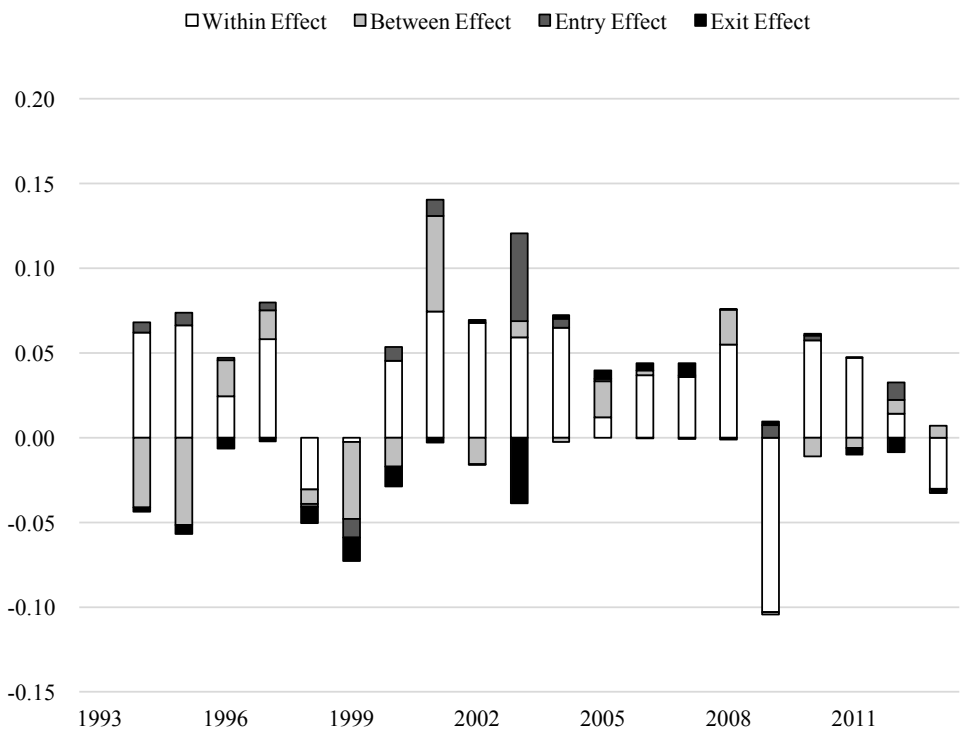


Figure 7. Productivity growth decomposition

The entry effect during the research period showed a mixed result, with both a positive and negative aspect. In the Asian financial crisis period, it shows negative for the aggregated productivity. On the other hand, the majority of the entry effect in the global financial crisis period contributed positively to the aggregated productivity. This can be understood from two perspectives. First, the cleansing effect happened in productivity enhancing ways in the second crisis. Since the cleansing effect is one form of resource reallocation, the resources possessed by less productive plants were moved to more productive plants including newcomers and the entry effect captured this. Thus, it is

possible to say that the resource reallocation was productivity enhancing in the global financial crisis period, yet it was not in the Asian financial crisis period. Second, the interest rate was remarkably high in the Asian financial crisis period, in contrast to the global financial crisis period. This high interest rate should have distorted the entry barrier by not promoting more productive plants to entry but instead it promoted plants with a huge owner's equity. Finally, as the exit effects shows during the whole period of the research, we found that the exit criteria in the 1990s were not productivity enhancing. If productive plants had exited the market, the exit effect would have had a positive sign. Therefore, we can conclude that during the research period, the market selection criteria were not effective in filtering less productive plants. A similar positive exit effect was observed during the Asian financial crisis in the 1990s. This implies that the cleansing effect of liquidating plants with low productivity did not occur during the Asian financial crisis. However, the cleansing effect did turn negative in the early 2000s. Thus, we can assume that a systematic exit mechanism began to filter out plants with low productivity in the market at that point. This was due to the effort of the government to improve legislation and implement new mechanisms to liquidate firms with low productivity following the Asian financial crisis, as shown in section 3.3. We can confirm that the cleansing effect occurred during the recession of the global financial crisis since the exit effect negatively contributed during this period of time. Plants with low productivity were liquidated during this period, which would be the major explanation of the negative sign of the exit effect. This result is consistent with previous literature that argues that the cleansing effect may falter when

firms face financial constraints. As reviewed in Section 3.3, Korean firms had problems with high debt ratios and over expansion prior to the Asian financial crisis in the 1990s. Therefore, firms that were burdened by high financial costs when interest rates spiked were forced to liquidate. Since plants were more financially stable during the 2000s compared to the 1990s, the major criteria forcing plants to exit the market were not financial costs but rather productivity. In addition, we analyzed industry level productivity decomposition to examine the difference of the cleansing effect by industries. We found small industry specific differences, however, the main force behind the cleansing in the two crises showed an opposite result from the whole manufacturing industry level analysis. The industry level decomposition result is attached in an Appendix 4.

3.6.3 Survival analysis result: Cox proportional hazard model

The result of productivity growth decomposition analysis showed that the exit effect in two crises was differently contributed on productivity growth. In other words, the negative exit effect during the Asian financial crisis means that exit of plants occurred regardless of the productivity of the plant. On the other hand, the positive exit effect during the global financial crisis means that exit of plants with low productivity were mostly exited. From this difference, we can suppose the selection criteria of two crises was different. Survival analysis was implemented to describe the selection criteria in two crises. The variables used in the survival model are describe in Table 14.

Table 14. Variables and description

Variables	Definition
TFP	Level of total factor productivity of plant
Sales	Logarithm of annual gross sales of plant
Assets	Logarithm of annual tangible asset of plant
Crisis	Dummy variable indicating whether the year was in crisis period or not (Crisis = 1, Otherwise = 0)

Two survival models were estimated as shown in following Equation (26) and (27).

$$h(t_i) = h_0(t_i) \cdot exp(\beta_1 TFP + \beta_2 Sales + \beta_3 Asset) \quad (26)$$

$$h(t_i) = h_0(t_i) \cdot exp\{\beta_1 TFP + \beta_2 Sales + \beta_3 Asset \quad (27)$$

$$+\beta_4 Crisis + \sum_{i=5}^{7} \beta_i Crisis(TFP + Sales + Asset)\}$$

Tables 15 and 16 show the Cox proportional hazard regression results. Table 15 shows the results of the Cox regression without stratification and Table 16 shows the results of the Cox regression with stratification by two-digit industry codes and plant size. The first and second columns of both Tables 15 and 16 have observations between 1993 and 2002. The third and fourth columns of both Tables 15 and 16 have observations between 2003 and 2013. Model I and II show the market selection criteria in the Asian financial crisis and Models III and IV show the market selection criteria in the global financial crisis. For example, equation (26) shows the regression equation of Model I and III.

Table 15. Cox PH regression result

	Model I (1993-2002)	**Model II (1993-2002)**	**Model III (2003-2013)**	**Model IV (2003-2013)**
TFP	0.2875***	0.2716***	0.0942***	0.1157***
	(0.0083)	(0.0097)	(0.0095)	(0.0100)
Sales	-0.2979***	-0.2870***	-0.1836***	-0.1710***
	(0.0057)	(0.0067)	(0.0046)	(0.0050)
Asset	-0.0569***	-0.0628***	-0.0199***	-0.0086**
	(0.0042)	(0.0050)	(0.0035)	(0.0038)
Crisis		0.2174***		1.3762***
		(0.0512)		(0.0669)
Crisis*TFP		0.0352*		-0.1351***
		(0.0185)		(0.0305)
Crisis*Sales		-0.0246**		-0.172***
		(0.0125)		(0.0137)
Crisis*Asset		0.0169*		-0.0733***
		(0.0094)		(0.0105)
Log likelihood	-756408.48	-710305.12	-942752.01	-755395.11
No. of Obs.	349,483	349,483	419,625	419,625

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively. Standard errors are given in parentheses.

As we reviewed in Section 3.4, the dependent variable, $h(t_i)$ is a failure rate of firm i in time t. The explanatory variables used in Equation (26) vary over time, and we treated all covariates, TFP, sales, and assets, as time-dependent covariates. Since, the dependent variable is a failure rate of plants, the signs of coefficients of explanatory variables capture the effect of TFP, sales, and assets on a firm's survival. First, the plant's sales and assets showed a positive effect on its survival. Since the dependent variable is a failure rate, the

increase in sales and assets decrease the failure rate. In other words, they increase the survival rate of a plant and thus, they have a positive association with the survival of the plant. On the other hand, the variable TFP showed a negative association with survival. This means that in the 1990s, the Korean market selection criteria relied heavily on the size of a plant's sales and assets rather than its productivity. In this environment, it is hard to expect that the continuing plants had higher productivity than plants that exited. As mentioned in section 3, in the 1990s, plants needed to be large to survive. Plants had to enlarge their assets and size to compete, and thereby, may have suffered more severely from the Asian financial crisis. The results are shown with the interaction term the dummy variable 'Crisis', which has a value of 1 in recession periods and 0 otherwise. Productivity and sales in a crisis showed the same effect in non-recession periods. This implies that even in the Asian financial crisis period, sales were more helpful than productivity to survive. However, the assets in the crisis period showed the opposite effect in the non-crisis period, Model I, on a survival of a plant. Excessive asset investment brought a boomerang effect for survival in the crisis period. Regression result of the stratified Cox PH model is summarized on Table 16. Since the model is stratified with industry and plant size, we can expect that the results in Table 16 is dependent from the industry and size effect. As we can see on Table 16, the results on Table 16 is not very different from the results on Table 15.

Table 16. Cox PH regression result: Stratified by size and industry

	Model I (1993-2002)	**Model II (1993-2002)**	**Model III (2003-2013)**	**Model IV (2003-2013)**
TFP	0.1233***	0.0977***	0.1097***	0.1330***
	(0.0138)	(0.0150)	(0.0099)	(0.0104)
Sales	-0.2599***	-0.2456***	-0.1911***	-0.1764***
	(0.0065)	(0.0075)	(0.0050)	(0.0053)
Asset	-0.0941***	-0.1015***	-0.0115***	0.0001
	(0.0052)	(0.0058)	(0.0037)	(0.0040)
Crisis		0.2853***		1.3778***
		(0.0560)		(0.6749)
Crisis*TFP		0.0425**		-0.1484***
		(0.0203)		(0.0304)
Crisis*Sales		-0.0325**		-0.1696***
		(0.0132)		(0.1376)
Crisis*Asset		0.0152		-0.0760***
		(0.0097)		(0.0105)
Log likelihood	-536995.20	-653314.29	-504740.53	-522146.94
No. of Obs.	349,483	349,483	419,625	419,625

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively. Standard errors are given in parentheses.

After the Asian financial crisis, the Korean government strived to strengthen their financial and market institutions. However, as Model III shows, it is difficult to determine whether this has been effective. Although the institutions still work in the same way as in the 1990s, the crisis period revealed a very different market selection process. Productivity, sales, and assets of a plant all showed a positive effect on survival. This means that the less productive plants with smaller sales and assets were more likely to exit in recession periods.

Thus, we can say that the global financial crisis brought the cleansing effect to the Korean economy. This study can be evidence that supports the argument that the cleansing effect may not occur when there are financial constraints. The Asian financial crisis was a period with financial constraints and, as a result, showed no cleansing effect. On the other hand, the global financial crisis originated from U.S. financial sector, so it had a very limited magnitude of influence in the Korean financial sector. This could be one explanation as to why the cleansing effect occurred then and not earlier in Korea in its two large recessions.

3.7 Sub-conclusion

This study examined the relationship between the business cycle and creative destruction. Specifically, we focused on the cleansing hypothesis that creative destruction occurs in economic downturns. We analyzed two large recessions in Korea, the Asian financial crisis in the 1990s, and the global financial crisis in the 2000s to find evidence to support the occurrence of the cleansing effect. We measured and decomposed the productivity dynamics in Korea rather than examine employment dynamics, as done in some previous literature to observe resource reallocation. We found no evidence in the period of Asian financial crisis, however, we did find evidence to support the cleansing hypothesis from the global financial crisis. Additionally, we described the market selection criteria in both crises with the Cox proportional hazard regression. After the Asian financial crisis, the selection criteria of the market evolved to encompass creative destruction. During the 1990s a plant with aggressive investments in assets had an advantage in growth and

survival, but in the crisis period the large amount of assets backfired. On the other hand, in the crisis of the 2000s, the selection criteria became productive enhancing, that is, less productive plants were more likely to leave the market rather than those with large amount of assets.

This study presents several policy implications. First, the cleansing effect or the process of creative destruction may vary depending on economic context. During the Asian financial crisis, financial institutions were not properly managed and did not lead to a productivity-enhancing reallocation. In contrast, with the improvement in the financial institutions after the first crisis, the process of creative destruction during the following economic downturn had a better outcome as productivity enhancing. Second, this study presents a new perspective on economic crises. It is generally accepted that every economy faces cycles, and therefore, economic downturns are unavoidable. Sometimes, a minor problem in a sector may trigger an economic recession at a macro level. It would be best if there was a way to escape such crises or minimize their impact on the economic system. However, such crises can also be viewed as opportunities for reallocating resources to enhance productivity. In short, there could be a silver lining to economic recessions. To facilitate such silver linings during economic downturns, institutional improvements are indispensable as a means to establish the environment in which creative destruction occurs in a desirable way.

Chapter 4. Identifying the Real Zombie Firms: The Role of Finance

4.1 Introduction

Firms experience the process of birth, growth, decline, and exit in a similar fashion to human beings. If a firm has accumulated competitiveness internally and the market environment is favorable to the firm, the firm will grow. Even if a firm is competitive, its growth can stagnate or decline if the market condition is unfavorable. The opposite also holds. In a booming market, a firm may not grow if it lacks competitiveness. Therefore, it is possible that the firm continues to grow only when both internal and external conditions are met. On the other hand, if either the internal or the external situation is disadvantageous to the firm, the firm is likely to stop growing and to become insolvent. In particular, when the growth of the economy as a whole slows down, corporate insolvency accelerates, because it is impossible for the company to cope with the decline of the economy. When a corporation becomes insolvent, the choice has to be made of whether to revive restructurethe corporation or allow it to exit. The discussion on restructuring is still debatable. There is a perspective that delaying restructuring is undesirable for the efficient use of resources (Baird & Jackson, 2002). On the other hand, there is also a view that excessive restructuring can reduce efficiency and negatively affect long-term growth (Crotty & Lee, 2001). If a firm becomes insolvent due to external shocks such as the global

financial crisis, the firm performance may improve as the economy recovers. However, if a firm loses its competitiveness, it is common for the firm to become insolvent over a long period of time. These firms are called zombie firms; firms that are unable to generate profits and introduce external funds through borrowing or the issuance of corporate bonds for subsistence. From the perspective of industrial dynamics, a number of studies on the issue of zombie firms argue that zombie firms need to be exited, not just because they are not productive, but also as they are a barrier to the process of resource reallocation in the market. From this perspective, it is reasonable to see that a zombie firm deserves to be exited from the market. However, the very heart of the zombie phenomenon is that there be a capacity to identify the real zombie firms and those firms that are in business difficulty and look like zombie firms. The definition of zombie firms is that firms that have a serious problem in their business activities and have a low probability of recovering, yet do not exit and rely on external financial support. On the other hand, firms that look like zombie firms face issues of liquidity due to problems in their operations in the short term. It is not uncommon that a firm experiences problem because of a large-scale investment for long-term growth, or when the market environment deteriorates and profit is not generated. Therefore, it is essential to identify these firms when discussing their exit from the market. Also, preferential support is required for firms that are expected to recover in the short term.

This study attempts to approach the problem of zombie firms from a different perspective than previous studies. Chapter 4 is composed as follows. Section 4.2 discusses previous research on zombie firms. Section 4.3 examines the status of Korean zombie

companies and draws research hypotheses. Section 4.4 describes the methodology used in this study. Sections 4.5 and 4.6 describe the data, variables, and empirical analysis used in the study. Finally, Section 4.7 presents a summary of the study and policy implications.

4.2 Literature review

4.2.1 Zombie firms in previous literature

The existing studies on zombie firms have mainly focused on the long-term recession period of Japan. Zombie firms are not merely insolvent firms, but firms that survive in a state of low productivity and depend on external financial support (Ahearne & Shinada, 2005). They have been called zombie firms, because their performance has worsened and they should have been exited or bankrupted; but they are still surviving with the help of banks and creditors.

Ahearne and Shinada (2005) analyzed the zombie problem, that is, the increasing number of zombie firms in Japan, by linking it with the causes of low economic growth in the 1990s, which is called the Lost Decade of Japan. They argued that if a bank provides an interest discount to a zombie firm to prevent bankruptcy, the bank has to provide the loan with a higher interest rate than it does to other normal firms. From the empirical analysis, the authors found that there was productivity growth stagnation, the main cause of which was a decreased degree of resource and market reallocation. In addition, productivity deteriorates in industries with a high proportion of zombie firms, since the resources that zombie firms occupy are not redistributed to normal firms. Hoshi (2006)

identified zombie firms in Japanese industry and analyzed the characteristics of zombie firms. He found that zombie firms have lower profit margins, higher debt ratios, and are more dependent on main banks than normal firms. In addition, it was confirmed that as the proportion of zombie firms increases, new employment decreases and the destruction of existing jobs increases. Caballero et al. (2008) also identified zombie firms in Japan in the same way as Hoshi's (2006) identification method. According to their identification, the proportion of zombie firms in the 1980s was 5–10%, but since the early 1990s, the proportion of zombie companies has increased and reached more than 30% by the mid-1990s. Also, they found that the productivity gap between zombie firms and normal firms was increasing over time, and both employment and productivity growth was decreasing in industries where the proportion of zombie firms was increasing.

The findings of Fukao and Kwon (2006) support the arguments of the above studies. They conducted a productivity growth decomposition analysis in the 1990s using Japanese firm level data. They found that productivity growth from firms' entry and exit contributes negatively, or by very little if positive, from 1994 to 2001. The productivity growth from resource or market reallocation decreased as zombie firms increased. Studies on zombie firms also have been conducted in Korea. Hoshi and Kim (2012) identified zombie firms in Korea in the mid-2000s based on two variables: financial cost to sales ratio and loan extension ratio. Empirical results show that their results are similar to those of Japanese zombie firms. Recently, Muge (2017) conducted a study on the increase of zombie firms in nine countries including Korea, Belgium, Finland, Spain, Italy, Sweden, France, the UK,

and Slovenia. The results confirmed the increase of the proportion of zombie companies in some countries, and revealed that productivity growth slowed down as the proportion of zombie companies increased.

From the above discussion, some facts about zombie firms can be summarized. First of all, zombie firms refer to firms that are underperforming and rely on external support not to exit or go bankrupt. Second, zombie firms are less productive than normal firms, and the productivity gap widens as the zombie duration continues. Third, zombie firms impair industrial or national level productivity by interrupting the process of resource reallocation. Finally, it can be seen that the problem of zombie companies is concentrated in some specific countries.

4.2.2 Role of finance and finance system

One factor that most countries with problems of zombie firms have in common is that they have a credit based financial system. Muge (2017) reported an increase in zombie firms except in the UK, France, and Slovenia, among the nine countries listed above. In this context, Dosi's (1990) classification of financial systems from the perspective of evolutionary economics sheds a light on zombie firms different from previous studies. He argued that the dynamics of an industry, including the exit of a firm, could vary according to differences in the financial system. Evolutionary economics recognizes that the evolution of the economy proceeds through two processes: learning and selection. Learning is a source of enabling firms to generate knowledge and performance through new initiatives.

Also, selection refers to the process of achieving efficiency of resource utilization through the process of reward and punishment by society in the evaluation of the performance of the firm. Dosi (1990) distinguished between credit based systems and market based systems. Learning and selection processes may differ in the two financial systems. The difference between the two systems is as follows.

First of all, a market based financial system is more responsive to the firm's revealed performance. The difference is also seen in the method of identification of zombie firms by the central banks of Korea and the UK. The Bank of England, the UK's central bank, identifies firms that have suffered losses over the last one year as zombie firms (Bank of England, 2013). In contrast, the Bank of Korea, Korea's central bank, identifies firms with a higher interest expenditure than operating income over the past three years in a row as zombie firms (Bank of Korea, 2016). We can observe the difference in patience with a firm as its profit decreases.

Second, firms in the credit based financial system have more opportunities for cumulative learning. In order for firms to introduce new innovations, learning processes must be preceded by trial and error, and during the process of trial and error, there can be only cost, but no profit. Credit based financial systems are less sensitive to the firm's revealed performance than market based financial systems. Even if the process of trial and error of firms is prolonged or learning outcomes are not accepted into the market, there is a strong tendency to be patient with firms to continue learning new strategies. On the other hand, the value of a firm whose learning outcomes are not accepted in the market declines

rapidly and its survival is under threat in market based financial systems.

Third, a credit based financial system shows a higher discretionality of resource allocative processes by financial agents. The main bank systems of Korea and Japan, and Hausbank of Germany, act as good examples. The relationship between the firm and the bank is based on close and long-term cooperation and that makes banks actively provide long-term investment funds to firms. In general, if a firm is not growing or performing poorly, the bank does not offer an additional loan or else it seeks to increase the interest rate for the risk. Hoshi's (2006) study revealed that zombie firms are more reliant on their main banks than are normal firms and this implies that banks have high discretionality in credit based financial systems.

Table 17. A taxonomy of features and properties of 'stylized' financial systems

Properties	Market based systems	Credit based systems
Selective pressure on the ground of revealed performances	Higher	Lower
Trial-and-error processes through birth of new firms	Higher	Lower
Opportunities of cumulative learning	Lower	Higher
Discretionality of allocative processes	Lower	Higher
Specialization versus diversification of incumbent firms	More specialization	More diversification

Source: Dosi (1990) p.315

Therefore, the difference between the two financial systems can be seen as a source of differences in the learning and exit processes of firms in the two systems. From this perspective, Dosi (1990) argued that finance plays a role in selection in the capitalist system and generates the dynamics of industry through two paths. The first path is a direct way: this is to induce more investment and growth of firms by providing more credit to firms with good performance. The second path is an indirect way: that is, the financial sector generates the information that the performance of the firm shows that it deserves to get financial support and this signal can influence other financial agents.

The selection role of the finance system can also be found in the general role of finance, as noted by Levine (2005). Levine summarized the operation of finance as comprising five functions. First of all, finance mobilizes and concentrates savings. It minimizes the transaction cost of mobilizing savings from multiple individuals and overcoming information asymmetry problems. Second, finance generates information and allocates resources based on the available information. Agents in the finance sector are more advantaged than are individuals in terms of information acquisition and its costs. Based on this information, agents invest and allocate resources. Third, finance exercises its control over the firm and its business. As a supplier of capital, it plays a role in managing and supervising how a firm uses the supplied resources. Fourth, finance spreads the associated risks through diversification. Financial institutions can significantly reduce their investment risk through diversification of risk. Fifth, finance enables easy exchange of goods and services.

To summarize the above discussion, it can be seen that finance plays a role in evaluating, selecting, and monitoring the object of investment by mobilizing the resources of society. Thus, it is possible to argue that the finance sector can exert influence over the survival and exit of firms by providing resources within the capitalist system.

4.3 Research hypothesis

Korea has a credit based financial system, and the pressure to exit the business is weaker than in the United States or the UK, which have central banking systems as reviewed above. Bank of Korea (2016) and Muge (2017) reported that Korea is one of the countries with a high proportion of zombie firms. As we reviewed in the literature, many studies on zombie firms recognized that such firms should be held liable, because they interrupt metabolism in the industry, this being the process of creative destruction claimed by Schumpeter. However, countries with serious zombie firm problems have a common financial system, that is, a credit based financial system. If the credit based financial system is more advantageous for cumulative learning and more patient with underperforming firms than the market based financial system, and thus the market pressure to exit is not strong, the increase of zombie firms might be a natural phenomenon that occurs in the credit based system.

When we consider the nature of R&D investment, which is the source of corporate learning processes, we can expect firms that have invested in R&D may underperform in the short run. Kay (1988) categorized the nature of R&D investment into four

characteristics: non-specificity, costliness, time lag, and uncertainty. First, non-specificity is also called externality, as opposed to appropriability. Non-specificity indicates that the result of R&D investment is not limited to R&D performers, but that the results may diffuse to other firms. Second, costliness means R&D investment requires a long time and a variety of resources from basic research to applied and development research. Third, there is a time lag until the R&D investment appears as a result. That is, R&D investment takes a certain period to be reflected in the product or service of a firm. Lastly, uncertainty of R&D investment is consistent with technological uncertainty and market uncertainty. Technological uncertainty indicates that new scientific knowledge may or may not be discovered at the time of investment. Market uncertainty refers to the possibility that new products or services may not be accepted in the market. In particular, Mazzucato (2013) argued that R&D investment is betting on the future, and that most attempts result in failure. Also, the uncertainty of R&D investment is a form of "Knightian uncertainty" (Knight, 1921), that is, unlike a lottery where the probability of winning can be calculated, R&D investment cannot be calculated as a probability.

In summary, a new perspective can be proposed on zombie firms. First of all, underperforming firms might be left as zombie firms because of a financial system that has low exit pressure. Second, a learning process is essential for companies to create new scientific discoveries and innovations, and R&D investment is necessary for learning. However, R&D investment is often unsuccessful because of high uncertainty. These failures deteriorate the profitability of the firm and make the firm insolvent in the worst

case. Therefore, a firm identified as a zombie firm may be not competitive and deserves to be eliminated or may be a firm that has invested in R&D, but failed to overcome uncertainty and worsened its performance. If these two types of firms are identified as zombie firms, we have to reconsider whether eliminating all of them is a desirable restructuring. Many zombie firms eventually exit, but some zombie firms overcome their zombie status and recover to become normal firms again. In this context, this study tries to identify the characteristics of firms that overcome their zombie status in terms of cumulative learning. Also, if the zombies are heavily reliant on external financial support, there is a need to investigate the kind of evaluation that financial institutions undertake in assessing the cumulative learning of firms with zombie status.

4.4 Empirical strategy

This study focused on answering two questions about zombie firms and financial support. The first question was to find out which of the zombie companies were exiting and which ones would overcome their zombie status in terms of cumulative learning. The second was to examine which zombie firms succeeded in getting additional financial support. In order to answer these questions, two empirical analyses based on the competing risk model and a probit model were implemented.

4.4.1 Competing risk model

The competing risk model is a multistate model used to explain the transition from one state to another. In our analysis, the competing risk model is used to identify characteristics

of overcoming firms and exiting firms among zombie firms. Since zombie firms face one of the three following consequences: eventually exiting, overcoming zombie status, or maintaining zombie status until the end of observation, therefore, the competing risk model is an appropriate approach to compare firm characteristics between the overcoming group and the exiting group. In this study, the cause-specific hazard model of Prentice et al. (1978) and the subdistribution proportional hazard model of Fine and Gray (1999) were reviewed for implementation.

4.4.1.1 Cause-specific hazard model

Competitive risk models require an understanding of risk sets and competing risks. The risk set at time t refers to a set of firms that have not experienced events, have not been censored, and are likely to be at risk in the future. If there are k hazards, event J is defined by the event occurring from hazard j. If event J occurs, the cause-specific hazard model treats it as if it was censored from all other events except J. The cause-specific hazard of hazard j is defined as:

$$h_j(t) = \lim_{\Delta t \to 0} \frac{\Pr(\, t \leq T < t + \Delta t \,, \epsilon = j | T \geq t)}{\Delta t} \tag{28}$$

Since the hazard function can be expressed with a probability density function and survival function, $h_j(t)$ can be rewritten as Equation (29):

$$h_j(t) = \frac{f_j^*(t)}{S(t)} \tag{29}$$

The cumulative distribution function of specific event J, $F_j^*(t)$ is defined as:

$$F_j^*(t) = \Pr(\mathrm{T} \leq \mathrm{t}, \epsilon = j) \tag{30}$$

According to the definition of the probability density function, the probability density function of specific event J is defined as:

$$f_j^*(t) = \frac{\partial F_j^*(t)}{\partial t} \tag{31}$$

Since $F_j^*(t)$ and $f_j^*(t)$ are improper distributions with $\int_t f_j^*(t)dt < 1$, they are denoted with a superscript asterisk. The survival function is given by the definition as:

$$S(t) = Pr(T > t) = \exp\left[-\int_0^t \sum_{k=1}^{K} h_k(u)du\right] \tag{32}$$

The proportional hazard model based on the cause-specific model can be written as:

$$h_j(t; Z) = h_{j0}(t)\exp\left(Z^t\beta_j\right), where\ \ j = 1,2, \dots, K \tag{33}$$

Holt (1978) derived the partial likelihood function of β_j from Equation (34) as follows in Equation (34):

$$\prod_{j=1}^{K}\left[\prod_{v=1}^{d_j}\frac{\exp\{z_{j(v)}^T\beta_j\}}{\sum_{l\in R\{t_{j(v)}\}}\exp\{z_l^T\beta_j\}}\right] \tag{34}$$

$t_{j(v)}$ $(v = 1, \dots, d_j)$ denotes d_j events from hazard j, $R\{t_{j(v)}\}$ denotes the risk set at time $t_{j(v)}$, and $z_{j(v)}$ denotes the covariates of $t_{j(v)}$, respectively. Estimates for Equation (34) can be obtained using maximum likelihood estimation.

The cause-specific model estimates the regression coefficient by treating events other than the event of interest as censored. That is, the events from $h_1(t)$ and $h_2(t)$ are considered as independent in the model. Thus, in some cases, this identification can be a problem. For example, a firm's investment on equipment can affect its growth, and also,

the investment can put the firm at risk for over-expenditure of cash. However, the cause-specific model cannot consider two paths of effect of a covariate at the same time. This means that the research has to determine between two cases: the firm's investment is helpful for the firm or obstructive for the firm.

4.4.1.2 Subdistribution model: Fine & Gray (1999) model

Unlike cause-specific hazards, the subdistribution hazard is obtained from a defined risk set. The risk set for cause 1 at time t includes all observations that have not experienced event 1 and are not censored. For example, if a firm is already exposed to cause 2 and we cannot observe the status of the firm, the firm is still included in the risk set of cause 1. In particular, the subdistribution of event J is defined as:

$$\lambda_j(t;Z) = \lim_{\Delta t \to 0} \frac{\Pr\{t \leq T < t + \Delta t, \epsilon = j | T \geq t \cup (T \leq t \cap \epsilon \neq j, Z\}}{\Delta t} \tag{35}$$

$$= \frac{f_j^*(t;Z)}{1 - F_j^*(t;Z)}$$

Let $T^* = I(\epsilon = j) \times T + \{1 - I(\epsilon = j))\} \times \infty$; then, the distribution function of T^* is $F_j^*(t;Z)$ and its probability density function $f_j^*(t;Z)$ can be written as equation (36).

$$f_j^*(t;Z) = \frac{\partial F_j^*(t;Z)}{\partial t} \tag{36}$$

When $t = \infty$, the following holds:

$$\Pr(T^* = \infty; Z) = \Pr(T < \infty, \epsilon \neq j; Z) = 1 - F_j(\infty; Z) \tag{37}$$

Fine and Gray (1999) suggested a competing risk survival model based on Cox's (1972) proportional hazard model as:

$$\lambda_1(t;Z) = \lambda_{10}(\mathrm{t})\exp\,(Z^T\beta) \tag{38}$$

λ_1 denotes the hazard for event 1; $\lambda_{10}(t)$ denotes the subdistribution of event 1 and is assumed to be a monotonically increasing function.

The cause-specific model has the problem of recognizing the effects of covariates differently. On the other hand, the subdistribution model includes the possibility that the effect of covariates can vary depending on the firm. Using the previous example again, the subdistribution model considers that a firm's investment can lead the firm to grow or can put the firm at risk at the same time. Therefore, when it is not possible to specify the effects of certain covariates precisely, it is more appropriate to use the subdistribution model than the cause-specific model.

4.4.2 Probit model

The probit model is a regression model that is widely used when the dependent variable is of binary form. In this study, we use the model to identify which firms in the zombie state are financially supported. The probit model is estimated by the maximum likelihood estimation method. Let P_i denote the probability that dependent variable Y_i has the value of 1; then the probability that dependent variable Y_i has the value of 0 equals $1 - P_i$. The maximum likelihood function can be expressed as:

$$L = \prod_{i=1}^{N} P_i^{Y_i}(1-P)_i^{1-Y_i} \tag{39}$$

Since P_i can be specified by $P_i = f(X_i'\beta)$, Equation (39) can be rewritten as

following Equation (40).

$$L = \prod_{i=1}^{N} f(X_i'\beta)^{Y_i}\{1 - f(X_i'\beta)\}^{1-Y_i} \tag{40}$$

Equation (41) is the logarithmic transformation of Equation (40).

$$lnL = \prod_{i=1}^{N} [Y_i lnf(X_i'\beta) + (1 - Y_i) lnf(X_i'\beta)] \tag{41}$$

4.5 Data and variables

4.5.1 Data

This study used two databases, namely KISVALUE and KIPRIS. KISVALUE is the oldest and most reliable firm level micro database in Korea (Kim & Lee, 2016) and provides financial data of the entire cohort of manufacturing firms listed on the KSE (Korea Stock Exchange) and the KOSDAQ (Korea Securities Dealers Automated Quotation) and on many non-publicly traded but externally audited registered firms. In this study, observations from 1981 to 2014 were used for analysis. All of the variables such as sales, investment, etc., were converted into constant values using the producer price index (PPI) as of 2010. The KIPRIS database provided by Korea Patent Information Service was used to observe the number of patent applications. The two databases were merged by using the unique corporation registration number.

The acting definition of a zombie firm is a firm that has a low possibility of overcoming from an underperforming status and that relies on external financial resources to subsist.

Since the low possibility of overcoming is a subjective evaluation, a specific identification method of zombie firms is required. Table 18 summarizes the identification methods for zombie firms used in previous studies. In this investigation, we will follow the identification method of Bank of Korea (2016), that is a firm whose interest coverage ratio (operating profit / interest expense) is less than 100% for the third consecutive year. This is because the identification method has not only been used widely in Korean zombie firm research (Nam & Jeong, 2015; Cho & Park, 2016), but also in international comparative studies (Muge, 2017).

Table 18. Identification of zombie firms in pervious literature

Literature	Identification
Caballero et al. (2008)	Firms with lower interest expense than market interest rate
Hefan and Zhuhe (2016)	Firms subject to interest rates lower than interest rates applicable to the most favorable firms
Bank of Korea (2016)	Firms with an interest coverage ratio (the ratio of operating income to interest expenses) less than one for three consecutive years
Bank of England (2013)	Firms with negative profit

Table 19 shows the number and proportion of zombie firm in Korea from 1981 to 2014.

Table 19. Number of zombie and non-zombie firms: 1981 - 2014

Year	Number of firms			Share of zombie firms
	Zombie	Non-Zombie	Total	
1981	12	119	131	0.09
1982	14	171	185	0.08
1983	25	262	287	0.09
1984	72	662	734	0.10
1985	87	803	890	0.10
1986	97	944	1,041	0.09
1987	123	1,083	1,206	0.10
1988	130	1,230	1,360	0.10
1989	201	1,243	1,444	0.14
1990	266	1,315	1,581	0.17
1991	341	1,444	1,785	0.19
1992	401	1,454	1,855	0.22
1993	409	1,455	1,864	0.22
1994	453	1,727	2,180	0.21
1995	534	2,423	2,957	0.18
1996	574	2,888	3,462	0.17
1997	690	3,637	4,327	0.16
1998	730	4,081	4,811	0.15
1999	744	4,730	5,474	0.14
2000	700	5,196	5,896	0.12
2001	727	5,661	6,388	0.11
2002	833	6,728	7,561	0.11
2003	943	7,406	8,349	0.11
2004	1,050	7,401	8,451	0.12
2005	1,209	7,426	8,635	0.14
2006	1,358	7,794	9,152	0.15
2007	1,498	8,176	9,674	0.15
2008	1,522	8,285	9,807	0.16

Table 19. Number of zombie and non-zombie firms: 1981 – 2014 (continued)

	Number of firms			Share of
Year	Zombie	Non-zombie	Total	zombie firms
2009	1,474	8,378	9,852	0.15
2010	1,239	8,490	9,729	0.13
2011	1,017	8,589	9,606	0.11
2012	877	9,080	9,957	0.09
2013	632	9,422	10,054	0.06
2014	569	9,921	10,490	0.05
Total	21,551	149,624	171,175	0.13

The proportion of zombie firms in Korea is maintained at over 10%, as we can see from Table 19. From 2012 to 2014, the number of zombie firms seems to decline, yet this is not an actual decline. This is because the identification method requires at least three years of observation; however, the observations from 2012 could not meet this requirement. Therefore, the estimated number of zombie firms will be smaller than the actual number, because it will not include zombie companies entering this state from 2012. The purpose of this study is to find the differences between the overcoming firms and the exiting firms in the zombie state. Therefore, accurate definitions of overcoming and exiting are needed. Among the identified zombie companies, overcoming firms were identified as zombie firms with two or more consecutive years of interest coverage ratio of 1 or more after zombie status. The reason for setting the period of interest coverage ratio as 1 or more for two consecutive years is that zombie firms that secure liquidity by selling off their assets have been observed. These firms seem to overcome zombie status, but they often fall back

into being zombies in the short term. Also, the exit of a firm was identified when one was observed at time t, but was not observed at time $t+1$.

Table 20. Number of zombie firms by overcome, exit, remain groups: 1981 – 2014

Year	Overcome	Exit	Remain	Total
1981	0	0	12	12
1982	0	0	14	14
1983	0	0	25	25
1984	2	0	70	72
1985	3	0	84	87
1986	2	3	92	97
1987	17	1	105	123
1988	25	1	104	130
1989	5	1	195	201
1990	7	1	258	266
1991	6	1	334	341
1992	29	17	355	401
1993	35	5	369	409
1994	43	4	406	453
1995	28	6	500	534
1996	37	7	530	574
1997	40	21	629	690
1998	67	16	647	730
1999	116	38	590	744
2000	89	14	597	700
2001	75	3	649	727
2002	71	5	757	833
2003	77	18	848	943
2004	88	20	942	1,050
2005	84	33	1,092	1,209

Table 19. Number of zombie firms by overcome, exit, remain groups: 1981 – 2014

(continued)

Year	Overcome	Exit	Remain	Total
2006	74	55	1,229	1,358
2007	69	131	1,298	1,498
2008	104	126	1,292	1,522
2009	141	128	1,205	1,474
2010	143	127	969	1,239
2011	133	109	775	1,017
2012	141	112	624	877
2013	0	9	623	632
Total	1,751	1,012	18,219	20,982

As we can see in Table 20 above, around 10% of firms annually overcome their zombie status. Also, it was found that the number of firms that overcome is greater than the number of firms that exit. These figures show that firms that are identified as zombies are not necessarily the real zombie firms.

4.5.2 Variables

In this study, we used the following variables to confirm the relationship between firm cumulative learning and overcoming zombie status. Variable R&D stock was included to measure the cumulative R&D investment of firms. R&D stock for a given year was measured by summing up annual R&D expenditures for the previous years, each depreciation rate being 0.15, following Griliches (1995) and Kim and Lee (2016). Patent activity of firm was measured as a dummy variable annually. If a firm applied for at least

one patent, the dummy variable has the value of 1 and is 0 otherwise. As a result of R&D investment, firms apply for patents as a means to protect new scientific discoveries. Since patent applications have a small time lag compared with patent registration, it is possible to recognize that the learning has occurred internally if the firm applied for a patent. The total liabilities variable was included in the analysis considering the characteristics of the zombie firms. As we have seen in Section 5.2, zombie firms are heavily reliant on external support. Firms with large liabilities mean that the firm has received much support from the financial sector, and we need to examine how this financial support affected the overcoming or elimination of the zombie situation. Also, the number of employees was included in the analysis to control the effects of the size of the firm. The above variables and definitions are summarized in Table 21 below.

Table 21. Variables and definition

Variables	Definition
R&D	Logarithm of annual R&D stock (depreciation rate: 0.15)
Patenting	Dummy variable for patent application
Debt	Logarithm of total debt
Size	Logarithm of employees

4.6 Result

4.6.1 Regression result of competing risk model

The estimation result of the competing risk model, Equation (42), is summarized in Table 22.

$$\lambda(t_i) = \lambda_0(t_i) \cdot exp(\beta_1 R\&D + \beta_2 Patent + \beta_3 Debt + \beta_4 Size) \quad (42)$$

Model I is the regression result for firms that have overcome zombie status, and Model II is the regression result for firms that have exited. If the regression coefficient shows a positive value, it increases the probability of overcoming (or exiting) from the zombie state, and if it has a negative value, it is interpreted as decreasing the probability of occurrence.

Table 22. Regression result: Competing risk model

	Model I (Overcome)	**Model II (Exit)**
R&D	0.013*	-0.026**
	(0.008)	(0.011)
Patenting	0.275***	0.084
	(0.079)	(0.104)
Debt	-0.355***	-0.014
	(0.029)	(0.041)
Size	0.307***	-0.473***
	(0.035)	(0.036)
Industry dummy	Controlled	Controlled
Year dummy	Controlled	Controlled
Log likelihood	-12500.049	-5810.8974
Number of Observations	17,586	17,586

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively. Standard errors are given in parentheses.

The results show that there is a significant difference between the firms that overcome zombie status and those that exit. First of all, R&D stocks of firms contribute positively to

recovering from zombie status to being normal status enterprises. In addition, the firms that applied for patents while in zombie status showed a higher probability for recovery than firms that did not apply for a patent. Despite the managerial difficulties such firms face, it has been found that actively engaging in cumulative learning through R&D investment and protecting their achievements can help them overcome their difficulties. Also, cumulative learning of firms has been shown to contribute to reducing the probability of exit. It can be seen that there is an innovation premium, which is one of the stylized facts on firm survival, even though it is applied to a company with the status of zombie. In terms of the size of the firm, it is found to be advantageous to overcome the zombie status when the company size is large. Also, the size of the firm contributes positively to firm survival, as we can see from Model II. This can be interpreted as the "liability of smallness" among the stylized facts on firm survival as reviewed in Chapter 1.

4.6.2 Regression result of probit model

The following Equation (43) was estimated based on the probit model to identify the factors that see zombie firms receive additional financial support. The dependent variable has the value 1 if total liability increased from last year, and has the value 0 otherwise.

$$y_{it} = \alpha + \beta_1 R\&D + \beta_2 Patent + \beta_3 Debt + \beta_4 Size + \epsilon_{it} \quad (43)$$

The estimation result is summarized in Table 23.

Table 23. Regression result: Probit model

	Model III (Probit)
R&D	0.003
	(0.003)
Patenting	0.053*
	(0.030)
Debt	0.061***
	(0.011)
Size	-0.076***
	(0.013)
Industry dummy	Controlled
Year dummy	Controlled
Log likelihood	-11562.894
Number of Observations	17,586

***, **, and * indicate significance at the 1, 5% and 10% levels, respectively.
Standard errors are given in parentheses.

As can be seen in Table 23 above, firm R&D stocks have no significant impact on receiving additional financial support. On the other hand, it has been confirmed that the patent applications of a firm contributed positively to receiving additional financial support. We can suspect that this result would originate from the nature of R&D, which is high uncertainty. It is difficult to expect that the finance sector would like to take on the burden of additional risk that comes from the high uncertainty of R&D investment, since zombie firms are already a big risk to the finance sector. On the other hand, the finance sector evaluates positively the firm characteristic that new scientific discoveries from R&D

investment are protected as a form of intellectual property. This is because the uncertainty is lower than that of R&D investment, and the value of the patent itself is worthwhile. However, the behavior of these financial sectors can be criticized. As noted above, R&D investments are high risk investments due to high uncertainties. However, rather than sharing and reducing the risks of these investments, the financial sector positively evaluates only those firms whose risk has already been partially eliminated. This behavior can be criticized in that the finance sector is not performing one of its major functions well, managing risk. Also, the finance sector might be blamed for the behavior of free riders.

4.7 Sub-conclusion

This study analyzed the characteristics of zombie firms, which are observed to be problems in Korean industry from the perspective of cumulative learning. Also, we examined the role of finance as a resource allocator by selecting which firms to support. As a result of the analysis, we found that 10% of firms were identified as zombie firms in the Korean manufacturing sector, among listed and externally audited registered firms. Unlike previous studies on zombie firms, this study approached the issue from the perspective of firm learning and its role in overcoming zombie status. In terms of the selecting role of the finance sector, finance can help a firm to survive or to grow by providing supporting resources, or conversely, it can lead to an exit by stopping its support. For a zombie firm, external financial support is critical for survival. In this context, we examined the selecting role of finance on zombie firms as well. From the analytical results,

certain evidence was found. First of all, the cumulative learning of firms contributes positively both to overcoming zombie status and to survival. Thus, it is possible to think that the cumulative learning of a firm can be an evaluation standard for selection by the finance sector in deciding whether to support it or not. However, it is found that the finance sector of Korea does not consider the cumulative learning of firms as an important indicator for firm evaluation. Rather, the finance sector should be criticized for encouraging free rider behavior in terms of risk averse attitudes.

Since Schumpeter observed the dynamics of capitalism, the process of replacing firms in the market as a result of competition over innovation, and introduced the concept of creative destruction, this whole process has been recognized as a value to pursue. However, while Schumpeter recognized the creative destruction process as the core of technological improvement and economic growth, he did not recognize this process as a purpose to pursue in itself. However, in contemporary Korea, these relations are reversed. We need to remember that creative destruction is one of the tools for driving economic growth and technological progress. Even if an industry is dynamic, this does not guarantee that the economy is necessarily growing, and the technology may not progress. Rather, we need creative destruction processes that consider the financial system of the country. The US and the UK are countries that have market based financial systems. We believe that the performance and potential of the company is reflected in the value of its stock. Creative destruction happens based on this belief. Firms with low value are exited or merged with other companies. A company that is being acquired is identified as an exit, but the

cumulative knowledge and resources embodied in the acquired firm will be reused or scaled up by the acquiring firm. On the other hand, Japan is a country where banks are developed. We believe that the performance and potential growth of a firm is reflected in the interest rate at which the firm borrows. Creative destruction in Japan is not as dynamic as in the US. Rather, Japanese zombie firms are pointed out as obstacles for economic growth. However, banks in Japan keep supporting underperforming firms to overcome and grow again, even if the banks cannot make profits in short periods of time. In this atmosphere, Japanese firms are able to learn from their failures and reuse resources or scale up for growth.

Korea has a credit-based financial system similar to that of Japan, and also has the problem of an increasing number of zombie firms. However, once again, we have to rethink cleaning out all zombie companies at once under the name of industry restructuring. Rather, we need to understand the properties of national finance systems for promoting creative destruction. Korea's credit based financial system is advantageous for the cumulative learning of firms, but at the same time has a weak market pressure to exit. Thus, agents in the finance sector have to be able to identify which firm is a real zombie firm and which firm is one with cumulative learning; and selectively support firms that are in the learning process. This intuition is not taken in a way that simply depends on financial indicators; instead, an in-depth understanding of industry and technology is required. Corporate evaluations should look to the future rather than at past and present figures and judge the potential of firms accordingly. The capabilities of the financial sector are needed to grasp

the insights of firms and industry-specific characteristics such as new investment and innovation.

Chapter 5. Conclusion

5.1 Summary of the study

This study focused on the exit and survival of firms and the industrial dynamics of entry, growth, decline, and exit of firms. We have examined the meaning of the exit of firms and market selection criteria from the perspectives of Schumpeterian competition, evolutionary economics, and organizational ecology on the exit of firms. From the theoretical flow reviewed, the exit of a firm is a decision that should be avoided for the firm, yet it is necessary in terms of efficiency improvement through resource redistribution. From this theoretical background, we can derive a set of stylized facts on firm survival by examining previous empirical studies. These stylized facts are classified into the individual level, the enterprise level, the industrial level, and the macro level. At the individual level, the educational level of the human resources such as the founder and organizational members, and their experience before the start of business, contribute positively to the survival of the company. At the firm level, firm size (liability of smallness), firm age (liability of newness), innovation premium, and export activity have positive influences on the survival of firms. The industry characteristics measured by entry rate, industry growth rate, and technology intensity were confirmed to affect the survival of firms. At the macroeconomic level, it was confirmed that the firm survival rate increased during economic upturns and decreased during downturns.

In Chapter 2, we analyzed with parametric survival model to confirm the selection criteria of Korean industry based on stylized facts derived from Chapter 1. The results showed that the size and age of firm, innovation, and exporting activities contributed positively to firm survival in Korean industry, in line with the previous literature. We also examined the relationship between finance and industry dynamics and how institutional changes in the financial sector caused changes in firm behavior and selection criteria before and after the Asian financial crisis. This crisis changed the tendency of Korean firms to operate through a large amount of loans and high debt. We can observe this change of selection criteria from the results as well. Before the crisis, firms with high levels of debt were advantaged with regard to survival; however, this tendency was no longer found after the crisis. This implies that the dominant routine of Korean industry has changed.

In Chapter 3, we focused on the relationship between the exit of the firm and the economic crisis, and examined the existence of a cleansing effect that could occurs in the economic downturn. The existing studies tried mainly to investigate the existence of a cleaning-out effect through employment changes, while this study applied a productivity growth decomposition analysis using plant level micro data for a refined analysis. The results revealed that during the Asian financial crisis of the 1990s, plant exits occurred regardless of the productivity of the business. On the other hand, during the global financial crisis of the 2000s, we were able to confirm that plants with low productivity had been exited. The difference in the cleaning-out effects in the two crises was presumed to be due to the stability of the macroeconomic environment, in particular, the stability of the finance

sector. During the Asian financial crisis, interest rates rose to a very high level compared with before the outbreak, and both the industry and financial sectors were unstable. In contrast, during the global financial crisis, the finance sector was stable relative to the Asian financial crisis and thus, plants were exited according to their productivity levels, not by their financial condition.

In Chapter 4, we approached the zombie firm problem from a different perspective to previous studies. Previous studies argue that zombie firms are less productive and impede resource reallocation in the market and this is why they should be exited from the market. However, we identified the fact that the problem of zombie firms is mainly concentrated in countries with credit based finance systems. Countries with a credit based finance system, such as Korea and Japan, can suffer from zombie firms, since the exit pressure of their markets is relatively weaker than the market based system. Also, in the capitalism system, finance has been seen to induce growth and exit of firms through selective support and provision of resources. In this context, we investigate the zombie firms and the behavior of the finance sector that provides zombie firms with additional resources. The result revealed that the cumulative learning of firms contributes positively toward overcoming zombie status. However, it has been found that the finance sector does not evaluate fairly the cumulative learning of firms identified as zombies. Rather, we found that there is an attitude within the finance sector to avoid risk.

5.2 Implications and limitations of study

This study provides some implications from the analysis results. The role of finance in support of the creative destruction process observed by Schumpeter begins with selective support for specific firms. These specific firms are those with competitiveness, innovation capability, and growth potential. Also, it is necessary to induce the exit of firms that are depleted of competitiveness by a lack of supporting resources. As Dosi (1990) stressed, finance may or may not support the process of creative destruction as a selection device in the capitalism system.

In Chapter 2, we investigate the effects of institutional change in the finance sector as a result of the Asian financial crisis. In the process of overcoming this crisis, the finance sector was improved in terms of soundness through restructuring and regulations. However, there was a side effect in that the finance sector has changed less actively in terms of provision of credit for firms. In particular, as Mazuccato (2013) has argued, long-term capital is essential for a firm to grow. In this respect, finance is required to function as a long-term capital provider. However, the finance sector, including banks, has turned to a passive attitude after the Asian financial crisis. At the same time, firms' investment has also decreased; instead, reserves held within firms have increased. This tendency raises concerns that it may hinder the long-term growth of companies and the economy. The passive and risk averse attitude of the finance sector was also found in Chapter 4 with regard to zombie firm issues. We found that the finance sector does not properly support firms in learning, since they are identified as zombie firms. The evaluation of the firm

should be based on expected growth and productivity in future, but due to a lack of deep understanding of industry and technology on the part of the finance sector, the zombie firm problem emerges in Korea. If the finance sector has a proper capability to evaluate and selectively support which firm is a real zombie firm and which firm is in the learning process, these zombie firms will not be a serious problem.

The upturn and downturn of the economy is repeated periodically. Generally, firms grow up in upturns. Every firm hopes the upturn will continue, but after the boom, recession always comes. In Chapter 3, we compared two economic crises in Korea and examined the cleansing effect of the two crises in terms of stability of finance and the economic environment. In a stable financial and business environment, the selection criteria worked properly. However, in the opposite case, we observed the massive and unsystematic exit of firms. As noted above, economic downturns are unavoidable. Sometimes, a minor problem may trigger an economic crisis at a macro level. It would be best if there is a way to minimize the impact of this on the economy. In contrast, such crises can also be viewed as opportunities for reallocating resources to enhance productivity. In short, there could be a silver lining to economic crises. In order to facilitate such silver linings during economic downturns, financial and macroeconomic stability is essential. Furthermore, a stable environment is essential for the investments of firms. No firm can move boldly in a situation where tomorrow is unpredictable.

Manufacturing industry now faces the paradigm shift of the fourth industrial revolution. As Perez (2002) argued, the great technological revolutions, such as the industrial

revolution, steam and rail, steel and electricity, oil and automobile, and telecommunications, have taken place through the interaction of industrial and financial capital. In the early days of the new technological revolution, finance played a role in supporting technological development. At this time, the finance sector is responsive in supporting firms that are constantly learning through trial and error to make new scientific discoveries, and this should help Korean industry to grow faster in the fourth industrial revolution.

This study has great significance in terms of the empirical description of creative destruction process in Korean industry from the viewpoint of industrial dynamics. However, this study also has some limitations. First of all, this study focused on the analysis of firms in the manufacturing sector. Firms in the service industry are excluded from many studies, because the heterogeneity between firms is greater than for firms in the manufacturing sector. For this reason, many studies that suppose homogeneity among firms exclude the service industry. However, considering the fact that the proportion of service industry of the national GDP is increasing, it is necessary to conduct research on the service industry that overcomes the high heterogeneity of this sector. Second, consideration of the economic environment was insufficient. When analyzing long-term series data, it is necessary to reflect the environmental changes in terms of macroeconomic and technological change in the model. In this study, the macroeconomic environment was controlled with a year dummy variable, yet we can expect that the behavior of firm will be different in slow growth periods and high growth periods. Also, it is expected that a more precise analysis will be possible when considering the technical environment. Third, the limitations of

databases have not been overcome. The analyses of Chapters 2 and 4 included the firm's financial variables in the model, and the micro data that could be obtained at a reliable level were the data of the listed firms and externally audited firms. Therefore, it was not possible to analyze SMEs and startups. Also, since not all firms were able to be observed at the time of entry, some firms were analyzed as if left truncated. If a complete set of data on startups and SMEs is established, a more precise empirical approach can be expected.

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Appendix 1: List of empirical studies on firm survival determinants covered in Chapter 1

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Agarwal and Audretsch (2001)	Cox PH model	US	3,431 firms	Not specified (10 year from entry)	Large firms at the entry showed higher survival rate than small firm at entry. The size effect was significant in formative industry rather than mature industry.
Agarwal and Bayus (2004)	Cox PH Probit Logistic	US	25,606 observations	Not specified	Early movers had advantage in terms of survival than late movers. *De alio* firms showed better survival performance than *de novo* firms. Inverted U-shaped effect of entry timing on firm survival.
Agarwal and Gort (2002)	Cox PH model	US	3,435 firms	Not specified	Firm age showed inverted U-shaped positive effect on survival. Larger firms were more likely to exit than smaller firms. Diversified firms were more likely to survive than non-diversified firms.
Agarwal et al. (2002)	Cox PH model	US	3,431 frims	1908 - 1972	Larger firms had a lower mortality rate than smaller firms. Age, age squared was insignificant for firm survival. Diversified firms showed lower mortality rate than de novo firms.
Audretsch and Mahmood (1994)	Logit	US	11,322 firms	1976 - 1986	Large firms were more likely to survive than small firms. Firms in growing market were more likely to survive. Firms in high MES industry were less likely to survive.
Audretsch and Mahmood (1995)	Cox PH model	US	12,251 establishments	1976 - 1986	Hazard rate tends to be greater for new firms than for new branch plants opened by existing enterprises. Firms in highly innovative environments were less likely to survive.
Bates (1995)	Logistic regression	US	20,554 firms	1984 - 1991 Entry of 1984-1987	Education level was not clearly contributed to survival in linear way. Owner age showed inverted U-shape to survival. Managerial experience showed negative effect on survival. Number of employees showed positive effect on survival. Franchise firms were more likely to fail than non-franchise firms.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Bates (2005)	Logistic regression	US	1,425 firms	1989 - 1996 1989 - 1992 entry	Entrepreneur's education level showed positive effect on survival linearly. Experience in the business positively contributed on survival. Capital at entry reduced firm mortality.
Bellone et al. (2008)	Complementary log-log model	France	174,416 observations	1990 - 2002	Low profitability negatively contributed on survival. Profitability and productivity became gradually more critical for firm survival over time.
Bernard and Jensen (2007)	Probit	US	236,092 observations	1987 - 1997	Plants that are part of a larger firm were less likely to exit than single-plant firms. Plants owned by a multinational were less likely to exit.
Børing (2015)	Competing risk model	Norway	409 firms	1995 - 2006	Product innovation oriented firms showed a higher probability of exit through M&A rather than closure.
Bottazzi et al. (2011)	Probit	Italy	19,628 firms	1998 - 2003	Poor financial status negatively contributed on firm default. Higher productivity and profitability reduced the probability of default.
Brüderl et al. (1992)	Multivariate log-logistic	Germany	1,849 establishments	1985 - 1990 1985 - 1986 Entry	Number of employees and invested amount of capital positively contributed on survival. Affiliated business was more likely to fail than independent business. Years of schooling positively contributed on survival. Prior experience showed inverted U-shape positive effect on survival.
Buddelmeyer et al. (2010)	Frailty model	Austrailia	299,038 observations	1997 - 2003	Radical innovation negatively contributed on firm survival. Incremental innovation positively contributed on firm survival.
Cefis and Marsili (2005)	Semi-parametric (Cox) and Parametric (Weibull, Exponential, Log-Normal)	Netherlands	3,275 firms	1996 - 2003	Firms who do innovation were more likely to survive than others. Process innovation positively contributed to firm survival.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Cefis and Marsili (2012)	Competing risk model	Netherlands	61,177 firms	1996 - 2003	Both product and process innovation positively contributed on survival. Innovation premium was stronger when product and process innovation were pursed in combination. Process innovation reduced the probability of exit by radical restructuring while product innovation.
Coad and Guenther (2012)	Cox PH model	Germany	1,674 observations	1953 - 2002	Firm age positively contributed on survival. Large firms were less likely to exit than small firms. Growth rate significantly reduced firm mortality.
Coleman et al. (2013)	Cox PH model	US	4,152 firms	2005 - 2009	Owner's education and work experience positively contributed on survival. Franchised firms were more likely to fail than independent firms. Startup capital showed positive effect on survival linearly. R&D activity was not significant on survival.
Cooper et al. (1994)	Probit	US	1,053 firms	1985 - 1987	Entrepreneur's education level showed positive effect on survival. Financial capital at entry increased the probability of survival.
Disney et al. (2003)	Cox PH model	UK	3,329,635 establishments	1986 - 1991	Large firms were more likely to survive than small firms. Old firms were more likely to survive than young firms. * Above trend was valid if the firm is a single plant firm.
Ejermo and Xiao (2014)	Logit	Sweden	1,254,034 observations	1991 - 2007 (1991 - 2002 entry)	Technology based firms faced lower hazard rate compared to other firms. Firms showed a pro-cyclical pattern of survival likelihood over the business cycle. New firms were more sensitive to business cycle than incumbent firms.
Esteve-Pérez et al. (2004)	Cox PH model	Spain	2,912 firms	1990 - 1999	Small firms showed higher probability of exit than large firms. Young firms were more likely to exit than mature firms. Exporting firms and performing R&D firms showed higher survival rates.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Esteve-Pérez and Mañez-Castillejo (2008)	Semi-parametric (Cox) Parametric (Weibull, Exponential)	Spain	2,028 firms	1990 - 2000	Advertisement and R&D showed positive effect on survival. Older firms were more likely to survive than younger firms ("liability of adolescence"). Large firms were more likely to survive than small firms. Firms who were more productive and oriented to international markets showed higher survival rate. Firms whose capital is participated were more likely to exit than non-participated firms.
Evernett and Watson (1998)	Logistic regression	Australia	5,196 firms	1961 - 1990	Interest rate and unemployment rate showed a negative effect on survival. Lagged employment rate showed a negative effect on survival.
Fontana and Nesta (2009)	Competing risk model	Not specified	121 firms in LAN switch industry	1990 - 1999	Old firms were more likely to survive than young firms. Large firms were more likely to survive than small firms. R&D efforts showed positive contribution on survival. Firms who located near the frontier were more likely to be acquired than to exit
Fotopoulos and Louri (2000)	Cox PH model	Greece	1,115 firms	1982 - 1992 (1982, 1983, 1984 entry)	Firms in Athens were more likely to survive than firms located out of Athens. Firms that higher profit and capital showed better survival rate.
Gimeno et al. (1997)	Pobit	US	1,547 firms	Three rounds of survey in 1985, 1986, and 1987	Supervisory experience showed positive effect on survival. Entrepreneur's age positively contributed on survival. Initial capital showed positive effect on survival.
Görg and Strobol (2003)	Cox PH model	Ireland	149,555	1973 - 1996	Large firms were more likely to survive than small firms. Multinational firms showed lower mortality rate than domestic firms in high-tech industries.
He et al. (2010)	Cox PH model Competing risk model	Hong Kong	89 firms	1986 - 2001	Firm with higher profitability were less likely to exit. Larger firms were more vulnerable to bankruptcy.
Headd (2003)	Logit	US	12,185 observations	1989 - 1992 entry	Higher education and firm size positively contributed on survival.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Helmers et al. (2010)	Probit	UK	162,000 limited firms	2001 - 2005	Intellectual property (both patent and trade mark registration) activity positively contributed on survival. Sectoral difference was found: patent lowered probability of exit but trade mark did not in some sector.
Honjo (2000)	Cox (based on a multiplicative intensity model)	Japan	2,488 firms	1986 - 1994	Small firms showed higher failure rate than large firms. Firms face more difficulty surviving in an industry with high entry rate.
Kaniovski and Peneder (2008)	Parametric (Gamma) model	Austria	431,380 observations	1975 - 2004	Entry size showed a significant positive effect on firm survival. Firms in mature industry showed less probability of survival. Market growth positively contributed on survival.
Kato and Honjo (2015)	Complementary log-log model	Japan	7,868 firms	1997 - 2009	Entrepreneur's education level showed positive effect on survival. The positive effect of entrepreneur's education level was significant in high-tech sectors. Entrepreneurs with high levels of human capital were more likely to voluntarily close businesses both in high- and low-tech sectors.
Kim and Lee (2016)	Parametric (Gompertz) model	Korea	1,067 firms	1991 - 1996 entry	Entry size positively contributed on survival under the regime low technological opportunity and high R&D appropriability. R&D effort was more crucial for firm survival than initial resource.
Kimura and Fujii (2003)	Cox PH model	Japan	16,700 firms	1994 - 1999	Affiliate firms showed less likelihood of survival than independent firms. Large firms were more likely to survive than small firms. Firms who invest on R&D were more likely to survive that others. Global market oriented firms were better for survive than others.
Liao et al. (2004)	Logistic regression	US	830 firms	Not specified	Financial capital significantly decreased the probability of exit. Industry specific experience of entrepreneur positively contributed on survival.
Liu and Li (2015)	Probit	China	648,704 firms	1998 - 2009	Financial constraints negatively affected on survival. Also weaken the market selection against inefficient firms on average. State-owned firms were more likely to exit than private firms.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Mata and Portugal (2002)	Cox PH model (Piece-wise constant hazard)	Portugal	12,885 firms	1994 - 1998	Foreign-owned firms were more likely to survive than domestic-owned firms. Larger firms were less likely to exit than smaller firms. Firms in high entry rate industry showed less likelihood of survival. The determinants of firm survival do not vary among domestic and foreign ownership.
Mata and Portugal (1994)	Cox (piecewise linear function for baseline hazard)	Portugal	3,169 firms	1983 - 1987	Large firms at the entry showed higher survival rate than small firms. Larger firms were more likely to survive than smaller firms. Firms in larger industry were showed higher survival rate than firms in smaller industry. The number of plants operated by the firm contributed positively for survival.
Mata et al. (1995)	Cox PH model	Portugal	17,612 plants	1983 - 1989	Large firms at entry were less likely to survive than small firms at entry. Current large firms were more likely to survive than current small firms. De novo firms faced more hazard than *de alio* firms.
Musso and Schiavo (2008)	Logistic regression	France	14,963 firms	1996 - 2004	Financial constraints increased the probability of exiting the market. Financial constraints positively contributed on productivity growth in the short-run.
Peña (2002)	Survey	Spain	114	1997-1998 Entry	Education, business experience positively related to firm survival. Business network with customer and financial market positively contributed to survival.
Robinson and Min (2002)	Logit	US	434 firms	Not specified (10 year from entry)	Survival rates of market pioneers were higher than early followers. No difference was found between high tech and low tech industry in terms of first mover advantage.
Segarra and Callejon (2002)	Cox PH model	Spain	12,885 firms	1994 - 1998	Advertisement and R&D showed positive effect on survival. The growth rate of the industry impacts positively on the likelihood of survival. Firms in R&D intense industry showed less likelihood of survival.

[1] Empirical studies on firm survival determinants

Literature	Methodology	Country	Data	Observation Period	Main findings
Sinha and Noble (2008)	Semi-parametric (Cox), Parametric(Gamma) model Frailty model	UK	1,127 firms	1981 - 1986	Adoption of manufacturing technologies positively contributed on firm survival. Adoption of manufacturing technologies prior to the inflection point (Bass diffusion curve) significantly reduced firm mortality.
Strotmann (2007)	Cox PH model Prentice-Gloeckler model	Germany	2,605 firms	1981 - 1994	Firms were more likely to exit in the industry that has larger minimum efficient scale. Entry size showed inverted U-shaped positive effect on survival.
Thompson (2005)	Semi-parametric (Cox), Parametric(Weibull)	US	273 firms	1825 - 1914	Large firms were more likely to survive than small firms. Old firms were more likely to survive than young firms.
Tsvetkova et al. (2014)	Parametric (Gamma) model	US	1,803 firms	1992 - 2008	Innovation investment decreased the probability of exit for small firms. Negative relationship between patenting activity and firm survival.
Tveterås and Eide (2000)	Cox (stratum-specific baseline hazard)	Norway	5,004 plants	1976 - 1986	Larger firms were more likely to survive than smaller firms. Higher capital-labor ratio plants more likely to survive than lower capital-labor ratio plants. No evidence was found to support different mortality rate between single-plant and multi-plant.
van Praag (2003)	OLS	US	271 observations	1985 - 1989 entry	Founder's age showed positive effect on survival. Prior experience in the same industry positively contributed on survival.
Wagner (1994)	Probit	Germany		1979 - 1990 (1979 - 1982 entry)	Hazard rates tend to increase during the first years and to decrease afterwards. No evidence was found for the relationship between entry size and probability of survival.
Wagner and Cockburn (2010)	Competing risk model	US	356 internet-related listed firms	1998 - 2001	Patenting of firm positively contributed on survival. Firms who applied for more patents were less likely to be acquired.

Appendix 2: Descriptive statistics of empirical data in Chapter 2

[1] Number of firms by 2-digit industry classification

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
1996	152	27	2	124	85	29	19	97	34	17	249	98	155	170	251	191	268	85	204	477	316	65	30	29	3,174
1997	182	30	2	149	108	35	24	112	39	23	298	115	213	197	303	246	364	126	243	606	397	91	35	36	3,974
1998	200	31	3	160	119	38	30	112	45	24	307	116	242	219	328	272	436	148	270	702	442	110	35	49	4,438
1999	221	34	3	180	138	43	37	116	47	24	340	124	277	241	355	295	542	174	304	790	499	121	47	57	5,009
2000	227	36	3	184	143	47	40	120	50	23	373	134	290	245	333	318	640	191	330	826	529	124	53	59	5,318
2001	229	38	3	189	147	49	38	123	51	24	381	131	288	250	332	329	693	205	337	864	536	128	52	61	5,478
2002	270	36	4	203	178	47	38	144	57	27	444	141	358	268	421	396	792	225	372	967	651	148	55	66	6,308
2003	301	39	4	222	202	53	40	156	64	29	462	155	386	286	443	425	883	232	392	1,032	714	165	56	71	6,812
2004	310	40	4	214	197	55	38	141	65	29	467	160	388	291	430	432	903	237	402	1,057	703	166	60	66	6,855
2005	322	38	4	224	200	53	33	133	62	28	458	160	385	289	420	432	899	240	393	1,074	685	173	62	68	6,835
2006	334	41	4	228	209	53	35	136	58	29	467	161	387	289	434	446	938	240	388	1,083	720	203	59	67	7,009
2007	343	38	3	233	206	52	34	132	64	28	480	160	394	288	453	457	961	240	377	1,086	739	219	58	64	7,109
2008	341	41	3	198	196	52	36	128	59	26	475	147	387	280	459	454	928	237	366	1,071	749	236	54	63	6,986
2009	329	38	3	172	182	52	38	126	55	24	469	145	363	270	452	459	879	229	363	1,052	734	225	51	60	6,770
2010	319	39	2	159	165	47	41	114	50	23	457	137	344	263	453	438	826	224	358	1,035	714	217	50	54	6,529
2011	312	39	2	155	163	45	34	107	45	25	445	141	318	248	435	422	757	201	324	993	694	209	45	50	6,209
2012	320	40	2	152	161	43	36	108	43	25	448	143	325	246	431	409	739	196	325	995	697	212	40	49	6,185
2013	329	36	2	157	168	39	37	108	42	29	435	132	328	235	415	390	684	194	315	941	674	204	38	44	5,976
2014	314	37	2	163	171	40	41	109	42	29	433	133	334	229	412	391	664	192	302	913	689	196	37	44	5,917
Total	6,591	1,008	68	4,386	3,609	1,062	736	3,050	1,166	625	9,788	3,636	6,951	6,027	9,179	8,178	15,176	4,124	7,378	19,115	13,705	3,434	1,038	1,237	131,267

[2] Number of employees by firms that survive and exit (Unit: person)

Year	Survive		Exit		Year	Survive		Exit	
	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.
1981	1,717.9	2,161.2	N/A	N/A	1998	202.1	1,161.7	84.5	112.0
1982	1,519.7	1,800.9	2,918.4	3,626.7	1999	197.0	1,262.0	69.3	160.7
1983	1,571.5	6,744.4	433.1	449.0	2000	201.2	1,258.3	102.1	290.2
1984	806.8	1,843.8	292.0	-	2001	194.4	1,214.5	55.8	117.9
1985	711.4	1,731.8	335.5	318.9	2002	180.0	1,188.9	47.1	89.6
1986	693.4	1,702.6	742.0	871.8	2003	181.0	1,242.8	34.1	34.2
1987	665.9	1,770.7	122.4	85.4	2004	185.7	1,320.1	33.2	37.6
1988	650.9	1,958.4	86.3	52.0	2005	190.6	1,473.9	33.0	27.9
1989	636.1	2,078.2	120.5	128.7	2006	188.8	1,501.4	49.7	119.8
1990	583.7	2,008.0	154.7	270.1	2007	192.1	1,506.6	84.3	775.3
1991	531.8	1,964.0	89.1	81.0	2008	192.0	1,510.1	59.3	85.1
1992	529.9	1,984.6	538.6	1,440.9	2009	195.1	1,535.0	77.2	176.1
1993	498.2	1,989.0	95.0	85.0	2010	212.2	1,689.4	61.4	77.4
1994	465.3	2,033.3	72.9	41.6	2011	223.5	1,786.0	62.0	165.2
1995	367.9	1,856.6	199.9	560.6	2012	220.7	1,709.1	53.7	94.2
1996	314.9	1,743.3	93.6	102.3	2013	227.5	1,795.7	263.9	1,653.3
1997	251.3	1,450.1	127.8	242.4	2014	222.5	1,800.4	73.7	120.9

[3] Firm age by firms that survive and exit (Unit: years)

Year	Survive		Exit		Year	Survive		Exit	
	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.
1981	23.6	11.5	N/A	N/A	1998	12.5	11.0	9.6	9.0
1982	23.4	11.0	15.4	5.8	1999	12.3	11.1	8.7	7.6
1983	20.0	10.9	9.9	5.2	2000	12.3	11.2	9.4	8.4
1984	15.5	10.5	24.0	-	2001	12.6	11.2	7.4	6.6
1985	15.3	10.5	13.5	4.9	2002	12.2	11.0	7.4	7.0
1986	15.2	10.4	15.3	4.0	2003	12.7	11.1	6.4	5.7
1987	15.0	10.4	10.5	7.3	2004	13.3	11.2	7.0	6.6
1988	14.9	10.5	10.1	7.7	2005	14.0	11.4	6.5	5.8
1989	15.4	10.7	9.0	7.3	2006	14.4	11.5	8.1	6.6
1990	15.4	10.7	9.9	5.8	2007	14.9	11.7	9.0	7.5
1991	15.4	10.7	8.7	6.1	2008	15.3	11.9	11.5	9.4
1992	16.4	10.9	13.0	13.0	2009	15.9	12.0	12.2	9.5
1993	16.6	11.1	11.2	7.6	2010	16.8	12.3	12.8	10.1
1994	16.2	11.2	12.0	8.6	2011	17.4	12.5	11.5	8.7
1995	14.3	11.2	7.5	9.0	2012	17.8	12.6	12.4	9.0
1996	13.5	11.3	9.5	8.8	2013	18.3	12.7	16.4	13.5
1997	12.6	11.0	11.0	8.9	2014	18.5	12.8	14.6	11.1

[4] Firm R&D expenditure by firms that survive and exit (Unit: 1,000 KRW deflated according to the 2010 price index)

Year	Survive		Exit		Year	Survive		Exit	
	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.
1981	5,521.2	19,977.5	N/A	N/A	1998	12,472.0	230,907.7	1,870.5	6,564.8
1982	3,263.9	20,935.4	12,288.1	26,323.5	1999	8,329.1	312,251.4	959.4	2,699.3
1983	3,222.2	19,124.7	2,850.7	12,866.6	2000	11,227.7	433,551.8	1,120.2	8,835.8
1984	2,327.6	15,668.7	-	-	2001	12,094.6	445,639.8	476.9	1,599.5
1985	2,959.3	23,341.6	30.6	43.2	2002	14,077.0	516,633.1	379.1	1,282.3
1986	3,782.3	33,077.3	3.5	6.0	2003	15,660.3	585,824.7	262.4	996.9
1987	4,347.5	39,227.0	103.5	384.1	2004	12,914.6	415,771.7	321.2	1,578.0
1988	4,619.8	39,178.4	140.0	329.7	2005	14,024.5	466,817.6	425.1	1,211.4
1989	6,597.0	76,755.8	1,598.7	6,366.3	2006	14,613.7	485,429.9	1,071.1	4,763.6
1990	9,006.0	119,950.7	154.0	451.9	2007	16,274.7	502,287.8	1,723.3	7,177.1
1991	10,490.0	166,524.9	418.6	674.2	2008	17,237.4	509,419.4	1,943.1	9,064.6
1992	13,473.0	193,393.1	242.5	591.6	2009	18,004.7	538,035.6	2,010.8	7,701.1
1993	16,458.1	247,386.8	368.4	862.8	2010	28,533.1	1,128,145.0	1,764.5	5,777.4
1994	11,615.6	133,608.3	846.5	2,428.1	2011	28,032.9	1,131,103.0	2,978.0	24,661.6
1995	11,462.3	170,121.9	1,586.1	4,845.9	2012	32,294.7	1,268,508.0	3,090.3	22,852.2
1996	11,896.3	177,757.0	377.3	770.9	2013	40,046.9	1,634,742.0	16,186.4	171,389.4
1997	13,454.0	214,598.8	2,476.5	10,657.4	2014	39,843.0	1,618,548.0	2,698.6	8,659.9

[5] Exporting rate by firms that survive and exit (Exporting: 1, Not-exporting: 0)

Year	Survive		Exit		Year	Survive		Exit	
	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.
1981	0	0	N/A	N/A	1998	0.844	0.363	0.827	0.380
1982	0	0	0	0	1999	0.850	0.357	0.835	0.372
1983	0	0	0	0	2000	0.856	0.351	0.794	0.405
1984	0	0	0	0	2001	0.856	0.352	0.770	0.422
1985	0.905	0.293	0	0	2002	0.837	0.370	0.760	0.428
1986	0.897	0.304	1.000	0.000	2003	0.837	0.369	0.670	0.471
1987	0.888	0.316	0.857	0.356	2004	0.839	0.368	0.676	0.468
1988	0.883	0.321	0.864	0.351	2005	0.837	0.370	0.678	0.468
1989	0.884	0.321	0.864	0.351	2006	0.824	0.381	0.677	0.468
1990	0.880	0.325	0.806	0.401	2007	0.818	0.386	0.731	0.444
1991	0.874	0.331	0.850	0.366	2008	0.811	0.391	0.706	0.456
1992	0.880	0.325	0.917	0.289	2009	0.809	0.393	0.707	0.455
1993	0.878	0.327	0.827	0.380	2010	0.815	0.388	0.671	0.470
1994	0.870	0.336	0.759	0.435	2011	0.811	0.392	0.657	0.475
1995	0.867	0.340	0.833	0.381	2012	0.794	0.404	0.688	0.464
1996	0.863	0.344	0.795	0.408	2013	0.790	0.407	0.773	0.420
1997	0.852	0.355	0.642	0.484	2014	0.770	0.421	0.545	0.499

Appendix 3: Descriptive statistics of empirical data in Chapter 3

[1] Descriptive statistics of output and input variables (Unit: Gross output, capital input, and intermediate input are Million KRW deflated according to the 2010 price index. Unit of labor is person)

	Gross Output			Capital Input			Intermediate Input			Labor Input		
Year	**Mean**	**Std.**	**Median**	**Mean**	**Std.**	**Median**	**Mean**	**Std.**	**Median**	**Mean**	**Std.**	**Median**
1993	8,717	176,761	1,220	4,518	63,515	572	5,296	74,061	698	53.1	288.1	22.0
1994	9,585	186,301	1,371	4,775	63,700	611	5,855	81,256	791	52.6	305.5	21.0
1995	10,877	213,452	1,555	5,091	66,200	656	6,533	86,752	888	52.9	316.8	21.0
1996	12,007	250,524	1,742	5,782	74,836	726	7,190	95,206	988	52.7	345.4	21.0
1997	14,598	353,811	1,988	6,850	96,115	805	8,341	105,013	1,123	54.5	561.6	21.0
1998	14,096	389,176	1,755	8,138	122,809	839	7,293	96,809	901	49.6	284.5	21.0
1999	14,629	387,135	2,008	8,496	133,837	847	8,526	110,318	1,169	49.8	278.3	21.0
2000	15,004	420,262	2,181	7,719	124,577	829	9,145	135,504	1,215	48.4	275.0	21.0
2001	15,446	390,012	2,327	7,467	116,242	852	9,409	141,116	1,336	45.9	259.8	20.0
2002	15,978	362,008	2,640	6,987	110,859	907	10,279	149,738	1,573	44.9	253.4	20.0
2003	16,241	349,623	2,785	6,451	99,839	885	10,283	147,864	1,617	44.8	255.0	20.0
2004	17,510	376,467	2,868	6,123	95,491	869	11,144	1707,18	1,656	44.6	274.0	20.0
2005	17,651	371,703	2,926	6,245	106,649	876	11,605	1884,84	1,698	44.1	289.2	20.0
2006	17,643	387,500	2,894	6,142	112,602	880	11,719	1965,98	1,725	42.2	287.5	19.0
2007	18,085	369,544	2,887	6,020	115,180	900	12,095	211,113	1,679	40.1	240.9	18.0
2008	20,866	556,602	3,000	6,368	119,153	945	12,647	253,788	1,632	40.3	261.1	18.0
2009	19,035	311,867	2,990	7,101	124,647	1,050	12,953	236,289	1,715	40.9	262.8	19.0
2010	22,781	385,677	3,480	7,576	123,731	1,110	15,039	271,700	1,993	43.1	261.5	20.0
2011	23,469	423,003	3,427	7,662	122,710	1,089	14,883	283,588	1,938	42.7	265.9	19.0
2012	23,205	433,954	3,375	7,639	127,503	1,138	14,616	285,624	1,868	41.9	240.3	20.0
2013	27,058	490,273	4,044	9,777	169,898	1,502	17,271	316,789	2,338	46.9	278.0	22.0

Appendix 4: Result of aggregated productivity growth decomposition analysis by industry

[1] Result of aggregated productivity growth decomposition analysis by industry

Industry Classification		Asian Financial Crisis					Global Financial Crisis				
No	Name	Period	Within Effect	Between Effect	Entry Effect	Exit Effect	Period	Within Effect	Between Effect	Entry Effect	Exit Effect
10	Food Products	1997-1998	-0.0063	0.0034	0.0014	0.0012	2007-2008	0.0015	0.0000	0.0003	0.0002
		1998-1999	-0.0002	-0.0021	0.0012	0.0016	2008-2009	0.0002	-0.0003	0.0001	0.0005
		1999-2000	0.0030	-0.0041	0.0016	0.0007	2009-2010	-0.0041	0.0003	0.0001	0.0001
11	Beverages	1997-1998	-0.0006	-0.0001	0.0002	0.0001	2007-2008	0.0004	0.0001	-0.0001	0.0000
		1998-1999	0.0017	0.0003	0.0001	0.0003	2008-2009	0.0012	0.0001	0.0000	-0.0001
		1999-2000	-0.0005	-0.0001	0.0001	0.0002	2009-2010	-0.0011	-0.0001	0.0000	0.0000
12	Tobacco Products	1997-1998	-0.0008	0.0001	0.0000	0.0004	2007-2008	0.0001	-0.0001	0.0000	0.0000
		1998-1999	-0.0022	-0.0030	0.0001	0.0016	2008-2009	0.0006	0.0000	0.0000	0.0000
		1999-2000	0.0010	-0.0001	0.0000	0.0000	2009-2010	0.0002	-0.0001	0.0000	0.0000
13	Textiles	1997-1998	-0.0005	0.0026	0.0013	0.0030	2007-2008	0.0004	0.0003	0.0002	0.0001
		1998-1999	0.0006	-0.0011	0.0014	0.0012	2008-2009	0.0005	0.0001	0.0003	0.0000
		1999-2000	-0.0006	-0.0016	0.0015	0.0012	2009-2010	-0.0011	0.0001	0.0000	0.0000
14	Clothing	1997-1998	0.0004	0.0006	0.0021	0.0018	2007-2008	0.0008	0.0002	0.0005	0.0005
		1998-1999	-0.0016	0.0002	0.0010	0.0027	2008-2009	0.0016	-0.0006	0.0008	0.0003
		1999-2000	0.0008	-0.0001	0.0027	0.0015	2009-2010	-0.0005	0.0004	0.0001	0.0005
15	Leather, Luggage and Footwear	1997-1998	0.0001	0.0009	0.0005	0.0010	2007-2008	0.0000	0.0001	0.0000	0.0000
		1998-1999	-0.0011	-0.0001	0.0005	0.0005	2008-2009	0.0004	0.0000	0.0001	0.0000
		1999-2000	0.0007	-0.0001	0.0009	0.0017	2009-2010	-0.0002	0.0000	0.0000	0.0002
16	Wood and Cork	1997-1998	-0.0003	0.0001	0.0002	0.0002	2007-2008	0.0000	0.0000	0.0000	0.0000
		1998-1999	-0.0002	0.0000	0.0002	0.0001	2008-2009	0.0001	0.0000	0.0000	0.0000
		1999-2000	0.0003	0.0001	0.0002	0.0001	2009-2010	-0.0003	0.0001	-0.0001	0.0000
17	Pulp, Paper Products	1997-1998	-0.0033	0.0007	0.0002	0.0010	2007-2008	0.0007	0.0000	0.0000	-0.0001
		1998-1999	-0.0002	-0.0003	0.0004	0.0004	2008-2009	0.0002	0.0000	-0.0001	-0.0001
		1999-2000	-0.0018	-0.0004	0.0003	0.0003	2009-2010	-0.0008	0.0002	-0.0001	-0.0002
18	Printing, Recorded Media	1997-1998	-0.0028	0.0003	0.0001	0.0013	2007-2008	0.0001	0.0000	0.0000	0.0000
		1998-1999	0.0000	0.0000	0.0002	0.0052	2008-2009	0.0001	0.0001	-0.0001	0.0000
		1999-2000	0.0002	0.0001	0.0005	0.0002	2009-2010	-0.0002	0.0000	0.0000	-0.0001

[1] Result of aggregated productivity growth decomposition analysis by industry (continued)

Industry Classification		Asian Financial Crisis					Global Financial Crisis				
No	Name	Period	Within Effect	Between Effect	Entry Effect	Exit Effect	Period	Within Effect	Between Effect	Entry Effect	Exit Effect
19	Coke, Refined Petroleum Products	1997-1998	-0.0015	0.0069	0.0008	0.0004	2007-2008	-0.0130	0.0034	0.0001	0.0001
		1998-1999	-0.0063	-0.0067	0.0002	0.0003	2008-2009	0.0163	0.0125	0.0000	0.0000
		1999-2000	-0.0025	0.0035	0.0002	0.0068	2009-2010	-0.0736	-0.0066	-0.0002	0.0002
20	Chemical Products	1997-1998	-0.0051	0.0020	0.0055	0.0105	2007-2008	0.0003	-0.0003	-0.0008	-0.0001
		1998-1999	-0.0007	-0.0017	0.0020	0.0043	2008-2009	0.0023	-0.0007	-0.0001	-0.0003
		1999-2000	0.0028	-0.0006	0.0056	0.0010	2009-2010	-0.0010	0.0003	0.0000	-0.0001
21	Pharmaceutical, Medicinal Products	1997-1998	0.0000	0.0000	0.0141	0.0012	2007-2008	0.0005	0.0000	-0.0001	0.0000
		1998-1999	-0.0051	-0.0048	0.0005	0.0010	2008-2009	0.0010	-0.0002	0.0000	0.0005
		1999-2000	0.0015	0.0003	0.0004	0.0000	2009-2010	-0.0014	0.0004	0.0000	0.0002
22	Rubber and Plastic Products	1997-1998	-0.0023	0.0014	0.0022	0.0025	2007-2008	-0.0034	-0.0001	0.0003	0.0004
		1998-1999	-0.0014	0.0002	0.0052	0.0025	2008-2009	0.0004	0.0000	0.0000	0.0002
		1999-2000	0.0021	-0.0005	0.0039	0.0046	2009-2010	-0.0041	0.0000	-0.0003	-0.0002
23	Non-metallic Mineral Products	1997-1998	-0.0012	0.0002	0.0002	0.0002	2007-2008	0.0013	0.0003	0.0005	-0.0001
		1998-1999	0.0001	-0.0008	0.0001	0.0002	2008-2009	0.0005	0.0002	0.0001	-0.0002
		1999-2000	0.0031	-0.0003	0.0005	0.0004	2009-2010	-0.0016	0.0002	0.0000	-0.0001
24	Basic Metal Products	1997-1998	-0.0012	0.0069	0.0043	0.0043	2007-2008	-0.0079	-0.0009	0.0015	0.0000
		1998-1999	-0.0035	-0.0052	0.0025	0.0052	2008-2009	-0.0062	-0.0020	-0.0002	0.0009
		1999-2000	0.0029	-0.0024	0.0045	0.0022	2009-2010	-0.0014	0.0022	0.0002	0.0004
25	Fabricated Metal Products	1997-1998	-0.0020	-0.0020	0.0030	0.0052	2007-2008	0.0008	-0.0001	0.0009	0.0004
		1998-1999	-0.0033	-0.0005	0.0050	0.0039	2008-2009	-0.0001	-0.0001	0.0000	0.0001
		1999-2000	0.0004	-0.0011	0.0051	0.0040	2009-2010	-0.0051	0.0003	-0.0005	0.0001
26	Elecric, Computer, TV and Comm. Equipment	1997-1998	0.0150	-0.0387	-0.0244	-0.0182	2007-2008	0.0434	-0.0057	-0.0014	-0.0083
		1998-1999	0.0221	-0.0192	-0.0281	-0.0120	2008-2009	0.0100	0.0090	-0.0042	-0.0040
		1999-2000	0.0148	-0.0125	-0.0208	-0.0088	2009-2010	0.0164	-0.0011	0.0073	-0.0030
27	Medical, Precision and Optical Instruments	1997-1998	0.0000	0.0003	-0.0002	-0.0003	2007-2008	0.0012	0.0001	-0.0001	-0.0006
		1998-1999	-0.0002	-0.0001	-0.0004	-0.0002	2008-2009	0.0011	0.0000	0.0000	-0.0008
		1999-2000	0.0007	0.0001	-0.0001	-0.0008	2009-2010	-0.0002	0.0001	-0.0001	-0.0003
28	Electrical Equipment	1997-1998	-0.0001	0.0010	-0.0118	-0.0062	2007-2008	0.0039	0.0002	-0.0006	-0.0012
		1998-1999	0.0007	-0.0015	-0.0062	-0.0077	2008-2009	0.0042	0.0006	-0.0012	-0.0010
		1999-2000	0.0052	0.0000	-0.0038	-0.0044	2009-2010	0.0011	0.0004	-0.0001	-0.0009

[1] Result of aggregated productivity growth decomposition analysis by industry (continued)

Industry Classification		Asian Financial Crisis					Global Financial Crisis				
No	Name	Period	Within Effect	Between Effect	Entry Effect	Exit Effect	Period	Within Effect	Between Effect	Entry Effect	Exit Effect
29	Other Machinery and Equipment	1997-1998	-0.0021	-0.0040	0.0075	0.0147	2007-2008	-0.0022	0.0007	-0.0001	-0.0003
		1998-1999	-0.0007	0.0019	0.0064	0.0072	2008-2009	0.0012	-0.0004	-0.0007	-0.0007
		1999-2000	0.0033	0.0021	0.0085	0.0042	2009-2010	-0.0057	0.0012	-0.0009	-0.0005
30	Motor Vehicles, Trailers	1997-1998	-0.0056	0.0031	-0.0001	-0.0016	2007-2008	0.0035	0.0002	-0.0005	-0.0006
		1998-1999	0.0036	0.0003	-0.0007	0.0002	2008-2009	0.0093	0.0030	-0.0001	-0.0011
		1999-2000	0.0069	0.0008	0.0003	0.0002	2009-2010	-0.0074	0.0003	-0.0006	-0.0002
31	Other Transport Equipment	1997-1998	0.0004	0.0008	0.0004	0.0005	2007-2008	0.0026	0.0006	-0.0014	0.0001
		1998-1999	-0.0030	-0.0007	0.0004	0.0005	2008-2009	0.0072	-0.0006	0.0003	0.0002
		1999-2000	0.0001	-0.0006	0.0004	0.0004	2009-2010	-0.0083	-0.0007	0.0000	0.0005
32	Furniture	1997-1998	-0.0002	0.0000	0.0000	0.0002	2007-2008	0.0000	0.0001	0.0000	0.0000
		1998-1999	0.0005	-0.0002	0.0006	0.0000	2008-2009	0.0007	0.0001	0.0000	-0.0001
		1999-2000	0.0004	0.0002	0.0003	0.0003	2009-2010	-0.0007	0.0001	-0.0001	0.0000
33	Other Manufactur-ing	1997-1998	0.0003	0.0003	0.0001	0.0001	2007-2008	0.0001	0.0000	0.0000	0.0000
		1998-1999	-0.0008	0.0000	0.0000	0.0004	2008-2009	0.0002	0.0001	0.0000	-0.0001
		1999-2000	0.0006	0.0000	0.0003	0.0002	2009-2010	-0.0003	0.0000	-0.0001	0.0000

Appendix 5: Descriptive statistics of empirical data in Chapter 4

[1] R&D Investment by overcome, exit firms and all firms (Unit: 1,000 KRW deflated according to the 2010 price index)

Year	Overcome Firms		Exit Firms		All Firms	
	Mean	Std.	Mean	Std.	Mean	Std.
1981	2505.6	3429.0	N/A	N/A	2505.6	3429.0
1982	1378.5	2339.6	457.5	-	1307.7	2254.5
1983	7531.0	26384.9	171.3	242.2	6830.1	25128.7
1984	7108.1	30182.0	509.2	850.1	6426.4	28621.7
1985	14457.9	69501.6	352.7	615.2	13262.9	66574.3
1986	19535.8	102159.0	3395.5	7052.8	17984.1	97480.3
1987	21729.7	110300.6	3370.8	6410.9	20061.4	105473.6
1988	20267.5	90338.6	2933.9	5606.2	18119.6	84946.5
1989	7788.5	45165.2	1086.3	2734.0	6592.6	40879.5
1990	7642.7	42008.6	959.3	1867.4	6509.1	38192.9
1991	8575.8	56544.4	1210.7	2590.6	7431.8	51985.2
1992	11192.7	88554.9	2124.4	4368.2	9668.5	80903.6
1993	14893.5	131735.4	3061.8	7048.1	13108.9	121633.0
1994	16461.5	153757.7	4042.2	9749.0	14434.8	141065.6
1995	17635.4	176562.1	4294.7	10941.5	15202.6	160265.8
1996	20746.5	208642.0	5164.0	15979.1	17873.6	189410.7
1997	26289.3	280352.3	4092.5	11829.3	21946.6	252050.0
1998	21710.9	192150.9	5148.2	17452.3	18656.3	172246.5
1999	9238.2	75101.5	1083.9	3114.7	7771.6	66799.1
2000	15257.4	149064.6	3088.9	13692.0	12493.6	130239.2
2001	10003.6	72785.1	3047.3	8949.9	8172.4	61518.0
2002	12658.2	95035.6	4524.3	15501.0	9715.5	75974.5
2003	12697.3	127294.2	3534.3	12698.0	8783.5	96913.3
2004	9302.1	92684.0	2874.0	9869.1	6221.9	67152.6
2005	11216.2	101196.3	3475.2	17176.4	7350.2	70989.1
2006	9964.6	102922.3	3245.2	9836.5	6767.2	70159.1
2007	8030.2	90170.3	2829.7	7943.9	5818.6	60293.1
2008	4128.4	19618.6	2271.8	5898.6	3783.0	17317.6
2009	4142.0	18917.0	1578.7	4604.7	3435.6	15656.5
2010	4724.4	20861.7	25359.3	380403.9	10055.8	193216.8
2011	4766.5	25205.0	29512.4	342106.2	9392.7	150717.8
2012	5455.8	25814.8	50308.7	429424.8	12106.7	148219.0
2013	13652.2	43717.4	17360.8	34635.5	8026.4	47263.8

[2] Patent activity by overcome, exit firms and all firms (Patent application: 1, Non: 0)

Year	Overcome Firms		Exit Firms		All Firms	
	Mean	Std.	Mean	Std.	Mean	Std.
1981	0.000	0.000	N/A	N/A	0.000	0.000
1982	0.000	0.000	0.000	-	0.000	0.000
1983	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.923	0.269	1.000	0.000	0.930	0.258
1986	0.900	0.302	0.800	0.447	0.896	0.307
1987	0.894	0.310	0.714	0.488	0.883	0.322
1988	0.875	0.332	0.800	0.422	0.872	0.336
1989	0.860	0.348	0.680	0.476	0.835	0.372
1990	0.857	0.351	0.727	0.452	0.838	0.369
1991	0.858	0.349	0.744	0.442	0.843	0.364
1992	0.853	0.355	0.729	0.449	0.836	0.370
1993	0.858	0.350	0.711	0.458	0.839	0.368
1994	0.879	0.327	0.717	0.455	0.857	0.350
1995	0.867	0.340	0.750	0.436	0.851	0.357
1996	0.870	0.337	0.714	0.455	0.849	0.358
1997	0.850	0.357	0.708	0.457	0.831	0.375
1998	0.854	0.354	0.725	0.449	0.835	0.372
1999	0.845	0.362	0.713	0.455	0.824	0.382
2000	0.845	0.362	0.728	0.447	0.822	0.382
2001	0.853	0.355	0.777	0.418	0.838	0.369
2002	0.864	0.343	0.817	0.388	0.849	0.359
2003	0.880	0.326	0.830	0.376	0.863	0.344
2004	0.865	0.342	0.831	0.375	0.851	0.357
2005	0.851	0.357	0.814	0.390	0.837	0.370
2006	0.864	0.344	0.815	0.389	0.840	0.367
2007	0.863	0.344	0.820	0.384	0.838	0.369
2008	0.854	0.353	0.819	0.385	0.827	0.378
2009	0.864	0.344	0.807	0.395	0.827	0.379
2010	0.847	0.361	0.805	0.397	0.821	0.383
2011	0.853	0.355	0.825	0.381	0.825	0.380
2012	0.848	0.361	0.843	0.366	0.823	0.382
2013	0.893	0.315	0.667	0.500	0.813	0.390

[3] Total amount of debt by overcome, exit firms and all firms (Unit: 1,000 KRW deflated according to the 2010 price index)

Year	Overcome Firms		Exit Firms		Total Firms	
	Mean	Std.	Mean	Std.	Mean	Std.
1981	605,982	440,872	N/A	N/A	605,982	440,872
1982	650,098	511,839	592,672	-	645,681	490,307
1983	1,156,792	2,189,023	373,661	324,848	1,082,208	2,091,269
1984	855,008	1,997,116	245,956	252,289	790,973	1,899,681
1985	902,122	2,176,743	256,823	256,857	846,953	2,090,276
1986	930,227	2,171,475	369,433	310,284	876,096	2,077,774
1987	1,096,846	2,938,097	356,743	307,494	1,030,110	2,815,009
1988	1,149,344	3,454,279	295,714	323,095	1,045,928	3,253,451
1989	992,549	3,164,144	323,889	392,719	867,504	2,873,485
1990	1,025,271	3,482,453	435,199	603,345	919,448	3,176,018
1991	1,379,510	6,398,492	432,506	622,700	1,229,923	5,888,713
1992	1,360,207	6,241,299	514,166	785,986	1,225,304	5,714,142
1993	1,410,118	6,565,012	604,258	816,576	1,286,750	6,071,109
1994	1,474,810	6,886,209	656,733	890,756	1,339,287	6,328,974
1995	1,188,850	5,197,970	582,441	889,912	1,076,998	4,733,473
1996	1,367,511	6,062,295	685,577	1,189,730	1,238,235	5,524,409
1997	1,427,436	6,984,966	667,803	1,402,422	1,272,636	6,308,552
1998	1,547,092	6,364,948	943,917	2,426,741	1,400,504	5,782,385
1999	1,433,894	5,284,956	878,030	2,703,092	1,288,104	4,816,214
2000	1,502,907	5,683,852	797,520	2,475,388	1,304,050	5,075,896
2001	1,199,529	4,224,242	802,904	2,955,935	1,044,595	3,811,566
2002	922,038	3,369,950	611,537	2,393,681	780,705	2,963,012
2003	712,736	2,671,505	540,754	2,771,032	610,322	2,554,443
2004	508,318	2,524,121	412,349	2,696,250	439,704	2,423,621
2005	395,020	1,700,468	370,405	2,556,262	367,345	1,976,381
2006	422,916	1,927,466	357,305	2,623,979	376,902	2,093,342
2007	362,922	1,675,147	280,329	862,246	314,161	1,222,405
2008	283,649	683,965	268,418	649,492	289,807	684,844
2009	310,610	844,611	274,870	591,965	299,441	676,231
2010	361,950	1,006,752	816,800	8,091,263	464,502	4,149,889
2011	332,263	889,809	1,145,829	9,987,896	627,534	6,120,651
2012	370,135	908,853	1,874,866	13,900,000	746,696	6,698,353
2013	643,533	1,652,695	152,151	193,480	712,157	6,223,382

Abstract (Korean)

자본주의 체제에서 경제 성장과 기술 진보 과정을 창조적 파괴 과정으로 설명한 슘페터의 연구는 기업의 진입, 성장, 쇠퇴와 퇴출로 발생하는 산업 동학(industry dynamics)에 관한 많은 연구에 영향을 주었다. 슘페터주의 뿐만 아니라 진화경제학, 생태조직론 등의 관점에서도 산업 동학을 발생시키는 원인을 파악하고자 하는 시도가 이어졌다. 각각의 관점은 약간의 차이는 있으나 모두 시장에서의 경쟁이 산업 동학을 발생시키는 주요한 원인으로 인식하였다. 특히 슘페터적 관점에서는 기업 경쟁력의 원천을 기술 혁신으로 인식하는 슘페터적 경쟁(Schumpeterian competition)을 강조하였다. 본 연구는 이러한 시각에서 한국 산업의 창조적 파괴 메커니즘에 대한 실증 분석을 시도하였다. 특히 퇴출 기업에 대한 실증 분석을 통해 한국 산업계에 존재하는 선별 기준(selection criteria)을 확인하고자 하였다.

첫째로 기업의 생존에 대한 이론적 배경과 실증 분석을 고찰함으로써 기업 생존에 관한 정형화된 사실을 도출하였다. 선행연구의 생존 결정 요인을 개인 수준, 기업 수준, 산업 수준, 거시경제 수준으로 구분하여 고찰하였다. 개인 수준에서는 조직 구성원의 교육 수준, 경험 정도 등이 높을 수록 기업의 생존에 유리하다는 정형화된 사실을 도출할 수 있었다. 기업 수준에서는 기업의 규모, 업력과 함께 기업의 수출, 연구개발 투자 등이 기업의 생존에 유의한 영향을

주는 연구가 주를 이루었다. 산업 수준에서는 산업의 경쟁 정도를 결정하는 기업 진입률, 산업 성장률와 산업의 기술 집약도 등이 기업 생존에 영향을 주는 것으로 확인되었고, 거시 경제 수준에서는 경기가 하강할 때 기업의 생존률이 낮다는 정형화된 사실을 도출할 수 있었다.

둘째로 한국 산업계의 선별기준을 묘사하기 위해 생존 분석 방법론을 활용하여 외감기업과 상장기업에 대한 생존 분석을 실시하였다. 분석 결과 한국의 산업계에서도 기업의 규모, 업력, 연구개발 투자와 같은 기업 생존에 관한 정형화된 사실들을 확인할 수 있었다. 특히 아시아 금융위기를 극복하는 과정에서 금융부문과 기업부문의 구조조정의 결과로 기업 선별기준에 발생한 변화를 확인하였다. 분석 결과 아시아 금융위기 전후로 기업의 자금 운용 행태에 변화가 발생하였으며, 전반적으로 기업의 투자 활동에 대해 시장의 생존에 관한 유인(incentive)이 감소한 것을 확인하였다.

셋째로 경기 하강기에 발생하는 청소효과 가설에 대해 분석하였다. 아시아 금융위기, 글로벌 금융위기 기간의 생산성 변화 분해 분석을 통해 기업 퇴출에 의한 생산성 증대를 비교하였다. 사업체 수준의 미시 자료를 바탕으로 분석을 실시하였으며, 생존 분석을 실시하여 두 위기기간의 퇴출 결정 요인에에 대해 분석하였다. 분석 결과 아시아 금융위기는 청소효과가 발생하지 않았고, 글로벌 금융위기는 청소효과가 발생한 것을 확인할 수 있었다. 또한 아시아 금융위기 기간에는 사업체의 생산성 수준과 무관한 퇴출이 발생하였으나, 글로벌 금융위기 기간에는 생산성 수준이 낮은 사업체의 퇴출이 두드러지는 것을 확

인하였다. 이러한 차이를 두 위기 기간의 금융 부문 안정성 차이에서 기인한 것으로 해석하였다.

넷째로 좀비 기업에 관한 문제를 기존의 연구와 다른 시각에서 접근하였다. 기존 연구는 좀비 기업을 창조적 파괴 과정을 저해하는 요인으로 인식하였고, 신속한 구조조정을 통해 퇴출되어야 할 대상으로 인식하였다. 그러나 본 연구는 국가의 금융 시스템에 따라 좀비 기업 문제가 다르게 나타날 수 있다는 점에 착안하여 한국과 같은 신용 기반 금융 시스템에서 좀비 상태의 기업들 중 극복하는 기업과 퇴출하는 기업의 특성을 분석하였다. 외감기업과 상장기업을 바탕으로 분석한 결과 축적된 지식의 양이 많은 기업들이 정상기업으로 회복할 확률이 높은 것을 확인하였다. 또한 좀비 상태의 기업에 대한 금융 부문이 정상상태로 극복하는 기업과 퇴출하는 기업을 명확하게 선별하여 지원하지 못하고 있는 것을 확인하였다.

주요어 : 창조적 파괴, 기업 생존, 청소 효과, 좀비 기업
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