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Structural Changes in Japanese SMEs: Business Dynamism in Aging Society and Inter-Firm Transaction Network*

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Abstract

Smooth business succession is vital not only to the survival of a firm, but also to aggregate growth, employment and productivity in Japan. In this paper, we use a rich dataset of Japanese firms to document the changing patterns of firm exits in the context of the aging population and assess the economic costs of business succession issues. We find that the overall health of Japanese firms improved in recent years, with bankruptcy rate and the ratio of zombie firms both decreasing. However, the voluntary exit rate of firms, including profitable ones, has increased in recent years as elderly CEOs cannot find business successors. This has resulted in a deterioration of resource allocation and productivity at the aggregate level. Furthermore, voluntary exits have spillover effects through inter-firm networks and increase the likelihood of exits of connected firms, even when these connected firms are healthy. These findings underscore the importance of addressing business transition issues in a rapidly aging society.

Keywords: firm growth, business succession, population aging, firm exits, inter-firm-network, zombie firms
JEL classification: D22, G33, L10, L14, R11

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1. Introduction

Business dynamism is the key to efficient allocation of resources, which determines aggregate employment, growth and productivity (Acemoglu 2008). New businesses create jobs, raise productivity and promote innovations by replacing older and less productive firms (Prescott and Ohanian 2014, Decker et al. 2014, and Karahan, Pugsley, and Şahin 2019 to name a few). As new and young businesses are the drivers of productivity and growth, studies focused on firm entry and on how government policies could help promote the entry of potentially productive startups. On the other hand, firm exit has received relatively less attention, despite the important role that firm exit plays in determining efficient resource allocations and aggregate productivity.[1,2]

In this paper, we study the evolving exit patterns of Japanese firms, using a unique firm-level dataset that contains information on firms' balance sheets, firm exits (if firms exited during the sample period) as well as inter-firm transactional data. The dataset covers observations from 2007 to 2017 for a sample of listed and unlisted firms. Our findings suggest that aging population has resulted in structural changes in firm exit patterns in Japan. Overall financial health of Japanese firms improved in recent years. However, voluntary exit of firms has increased for firms with old CEOs due to their challenges in finding business successors. Such pattern is broad-based and is observed across sectors and across regions. Inter-firm network also matters in voluntary exits, as firms with fewer connections are more likely to choose voluntary exits.

Voluntary exit has important implications for business dynamism and cleansing mechanism of firm exits. Traditionally, banks played a key role in screening and monitoring firm's performance and assessing whether a firm should stay or exit. In this traditional mechanism, the variables that mattered for firm exit (often bankruptcy) decisions were firm profitability and productivity. For voluntary exits, these variables might be less relevant. Rather, it is the characteristics of owners (age of CEOs) and the likelihood of finding business successors that enter the decision of CEOs when they decide to exit voluntarily or not. In such case, whether banks can ensure efficient

[1] Hsieh and Klenow (2014) show life-cycle dynamics of firms in the economy are closely linked to aggregate productivity. The paper, however, focuses on entry barriers that prevent productive firms from entering and other distortions which prevent entrants from growing.

[2] Research on firm exits focus on the exit patterns of economically and financially distressed firms (Bhattacharjee et al. 2009 and Balcaen et al. 2012).

cleansing mechanism of voluntary exits can be questioned. Relatedly, absent these market mechanisms for voluntary exits, search frictions that prevent firms from finding suitable business successors could generate potential welfare losses. Search frictions create costs for potentially productive and profitable firms in finding successors. This may lead to voluntary exits of potentially healthy firms whose costs of searching exceed the benefits of finding successors and continuing business.

Furthermore, due to highly-persistent inter-firm networks among Japanese firms, an exit of a firm, whether it be voluntary exits or bankruptcy, triggers the exit of other firms connected through firm networks, resulting in larger macroeconomic implications. The exact magnitude of the propagation effects of a firm's exit depends on exit type and varies across industries. On the other hand, one can infer that firms in rural areas are more prone to voluntary exits and are more likely to face difficulties of finding business successors for several reasons. First, population is aging and shrinking faster in rural areas compared to urban areas. Second, given everything else equal, it is more difficult for firms in rural areas to find alternative business partners when a partner firm exits, as firms are less densely populated in those regions.

These findings highlight the importance of addressing structural issues of Japanese firms related to demographic trends, as those issues will become more serious going forward with shrinking and aging population. According to the 2017 White Paper on Small and Medium Enterprises in Japan published by the Small and Medium Enterprise Agency (SMEA), one third of the Japanese medium-sized firms mentioned 'cannot secure successor' as a reason that could make them consider business closure. This was the second highest responses by firms for considering closing their business. The number one reason for considering for business closure was "poor earnings." When the survey was conducted specifically for small firms, challenges in finding successor was the number one reason for considering business closure, with nearly half of the respondent firms checked 'cannot secure successor.' The same survey conducted for 2018 also reported that nearly half of the CEOs over 60 years old have not determined who will succeed them (SMEA 2018).

This study contributes to several strands of literature. First, the paper contributes to a large literature that discusses the determinants of firm growth and the importance of business dynamism in aggregate productivity and employment. Studies highlight the importance of business dynamism as a source of growth (Davis et al. 2007), focusing on the importance of looking at firm age

distribution to understand implications for aggregate productivity and employment (Hsieh and Klenow 2014). Fujii, Saito, and Senga (2017) confirms that younger firms create more jobs than older firms in Japan and the existence of unproductive old firms suggests inefficiency in firm dynamism. Second, there is a growing literature that analyzes the importance of inter-firm network in firm growth and propagation of shocks. For instance, Bernard, Moxnes, and Saito (2019) show that an increased connectivity through transportation, namely, the Kyushu Shinkansen line, led to firm growth. Also, Fujii, Saito, and Senga (2017) shows that the relationship between transaction network and firm growth differs by firm age, highlighting the importance of building appropriate transactional relationship for younger firms. Recent studies also focus on how inter-firm network serves to amplify macroeconomic fluctuations. As observed during the Global Financial Crisis (GFC) and large-scale natural disasters, propagation of micro-level shocks could generate in macroeconomic fluctuations (Acemoglu et al. 2012, Carvalho 2014, Ogura, Okui, and Saito 2015, and Carvalho et al. 2017). While these studies mainly pay attention to effects of repercussions of temporary negative shocks, this also implies that a propagation of positive shocks could promote firm growth, spreading inter-firm network and contribute to macroeconomic growth. It is therefore worth considering policies that initiate macroeconomic growth by making use of inter-firm network. Third, this study contributes to the literature of zombie firms issues in Japan. Low exit rate of Japanese firms is well-documented in the literature (Caballero, Hoshi, and Kashyap 2008, Fukuda and Nakamura 2011, Imai 2016, and Goto and Wilbur 2019). The congestion created by zombie firms reduces the profits of healthy firms, which distorts efficient resource allocations by discouraging entry and investment of potentially healthier and more productive firms.[3] Finally, this contributes to the relatively under-researched area of firm exit patterns. Studies focus on distressed firms and how different types of exits (bankruptcy, voluntary liquidation and M&A) are suitable for firm characteristics. Harhoff, Stahl, and Woywode (1998) and Prantl (2003) consider different types of exits, while Bhattacharjee et al. (2009) and Balcaen et al. (2012) focus on the exit process of old and mature firms, as opposed to young firms. Our study contributes to this literature by exploring a unique phenomenon in Japan where voluntary exits are not necessarily related to financial health of firms, but to business succession.

[3] See Davis et al. (2007) and Haltiwanger, Jarmin, and Miranda (2011, 2012) for the importance of firm age and aggregate productivity and employment.

The paper is organized as follows. Section 2 describes the datasets used for our analysis. Section 3 discusses the changing patterns of firm exits in Japan and factors driving these trends, including elderly CEOs and business succession issues. Voluntary exit patterns are discussed. Section 4 shows empirical results on the impact of a firm's exit on other firm's performance and exit patterns, when firms are connected in production network. Section 5 looks at recent government policies adopted to address this issue and policy implications. Finally, Section 6 concludes.

2. Data Description

We draw upon the dataset provided by Tokyo Shoko Research, LTD (TSR, hereafter) for our analysis. This is a rich longitudinal firm-level data for both listed and unlisted Japanese firms. The TSR data consists of firm information and transactional relationship information at annual frequency. It covers about 1.2 million firms from 2007 to 2017. Firm information includes basic information for the firm, including industry classification (Japanese Standard Industrial Classification 4-digit), location address, number of employees, the amount of sales, year of establishment, CEO's name and his/her birthday. Transactional relationship information includes the most important suppliers and customers, each up to 24.[4] In addition, for firms that exited, TSR provides information on the type of exits, which can be categorized into three groups: *tosan* (bankruptcy), *gappei* (merger), and voluntary exit.[5,6] 91 percent of total firms are small and medium-sized enterprises (SMEs) in 2017 in the dataset, depending on the number of employees per firm.[7,8] Annex I reports summary statistics.

[4] See Carvalho et al. (2017) and Bernard, Moxnes, and Saito (2019) for more details on TSR data.

[5] The TSR data distinguishes three different types of voluntary exits: *kyugyo* (temporarily suspension of business), *haigyo* (business closure), and *kaisan* (dissolution of company).

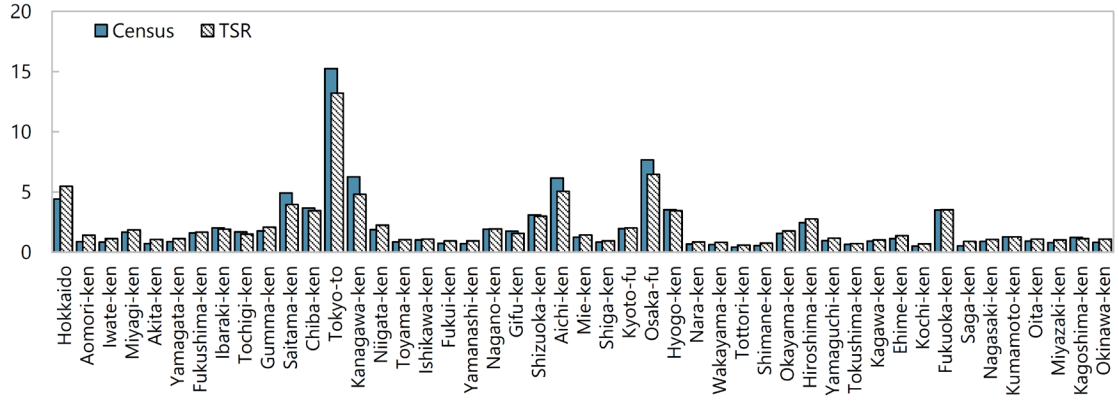
[6] TSR also includes credit rating scores, ranging from 1 to 100, 1 with the highest default risk and 100 with the lowest default risks, based on various source of information including firm's balance sheets, age, network, governance, and other qualitative information.

[7] For retail industry, we define a firm to be an SME if total number of employees is less than 50 persons. For wholesale and service industry, we define a firm to be an SME if total number of employees is less than 100 persons. For the rest, including manufacturing, transportation and all other categories not mentioned above, we define a firm to be an SME if total number of employees is less than 300 persons.

[8] The definition of an SME by the Ministry of Economy, Trade and Industry differs across industries. For wholesale trade industry, an SME is a company whose capital or total amount of investment does not exceed 100 million yen or hires less than 100 employees. For service industry, an SME is a company that has capital or investment that does not exceed 50 million yen or has less than 100 employees. For retail industry, an SME is a company that has capital or investment that does not exceed 50 million yen or hires less than 50 persons. For

Although the TSR data does not cover the universe of firms in Japan, it resembles closely the distribution of the Census data in terms of geographic coverage and firm size. We show this by presenting results of the distribution of firms by prefecture and by firm size. Chart 1 displays the fraction of firms in each of the 47 prefectures as of October 1, 2016. The Census data come from the 2016 Economic Census for Business Activity conducted by the Ministry of Internal Affairs and Communications and the Ministry of Economy, Trade and Industry. The percentage figures based on the TSR dataset are nearly equal to the ones based on the Census survey for many prefectures. Exceptions include Tokyo, Kanagawa, Osaka, Aichi, and Hokkaido, where there exist small differences ranging from 1 to 2 percentage points between them.

Chart 1. Comparison of Geographical Distribution: Census Data vs. TSR data



Sources: Ministry of Internal Affairs and Communications, Ministry of Economy, Trade and Industry, Tokyo Shoko Research, LTD and authors' calculations

Note: The figure plots the percentage of firms in each of the 47 prefectures in Japan in 2016. Census denotes the 2016 Economic Census for Business Activity. TSR denotes the 2016 TSR dataset.

Table 1 compares the distribution of firms by firm size using the Census survey and the TSR dataset. The firm size distribution of the TSR data closely resembles that of the Census data. The largest gaps are found for micro-enterprises where total number of employees is less than 10 persons. However, if we adopt an alternative grouping of these firms (for instance, less than 10 employees), the gap between the two datasets decreases.

the rest of the industry including manufacturing, construction and transportation, an SME is a company whose capital or total amount of investment does not exceed 300 million yen or hires less than 300 persons.

Table 1. Comparison of Firm Size Distribution: Census Data vs. TSR

	Number of Employees									
	0-4	5-9	10-19	20-29	30-49	50-99	100-299	300-999	1000-1999	2000-
Census	56.2	17.5	11.8	4.7	3.9	3.0	2.0	0.6	0.1	0.1
TSR	49.3	21.6	13.3	4.9	4.2	3.3	2.4	0.8	0.1	0.1

Sources: Ministry of Internal Affairs and Communications, Ministry of Economy, Trade and Industry, Tokyo Shoko Research, LTD and authors' calculations
Note: The table reports the percentage of firms with the number of employees in each of the respective bins in 2016. Census denotes the 2016 Economic Census for Business Activity. TSR denotes the 2016 TSR dataset.

3. Some Facts of Japanese Firm Exit Patterns in Aging Society

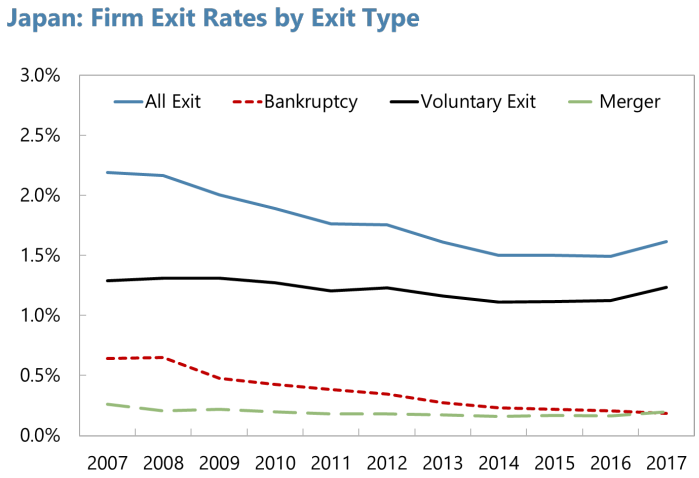
In this section, we document several facts about the changing patterns of firm exits by Japanese firms and how aging society can explain these emerging trends. Patterns of voluntary exits are extensively discussed. Next, we explore how the share of zombie firms has changed over time in Japan and what this implies for business dynamism.

3.1. Exit Patterns of Japanese SMEs

It is known that the exit rate of Japanese firms is low compared to other countries. The SMEA (2019) reports that the firm exit rate in Japan is 4 percent, whereas firm exit rates are close to 10 percent in the United States and the United Kingdom in 2011. In the TSR data, firm exit rate is around 2 percent in 2017 (Chart 2).[9] Over time, firm exit rate continued to decline, although it began to increase mildly since 2016. We find that this recent upward trend in firm exit rate is driven by an increase in voluntary exits. On the other hand, exits due to bankruptcy has declined steadily since 2008, while exits due to merger have the lowest ratio and remain constant over time.

[9] Firm exit rates are calculated as total number of firms that exited from October (current year) to September (next year) out of total number of firms at the beginning of October for each year.

Chart 2. Evolution of Firm's Exit Rates by Exit Type

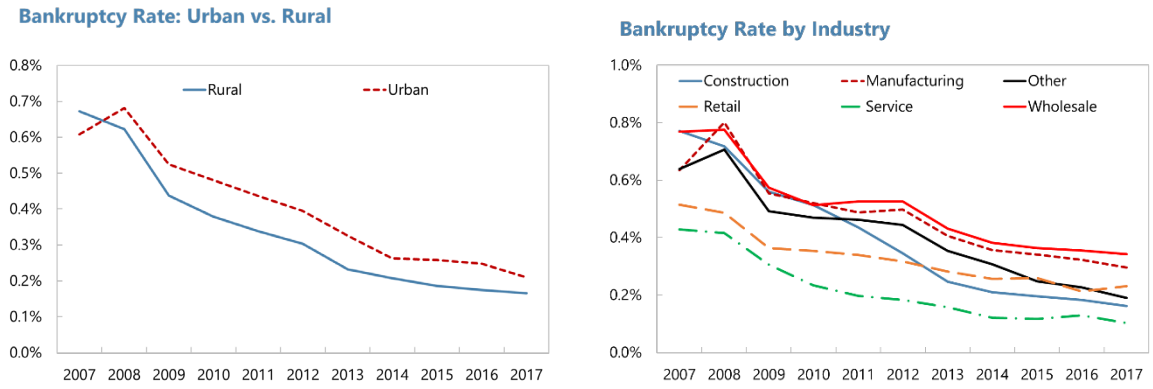


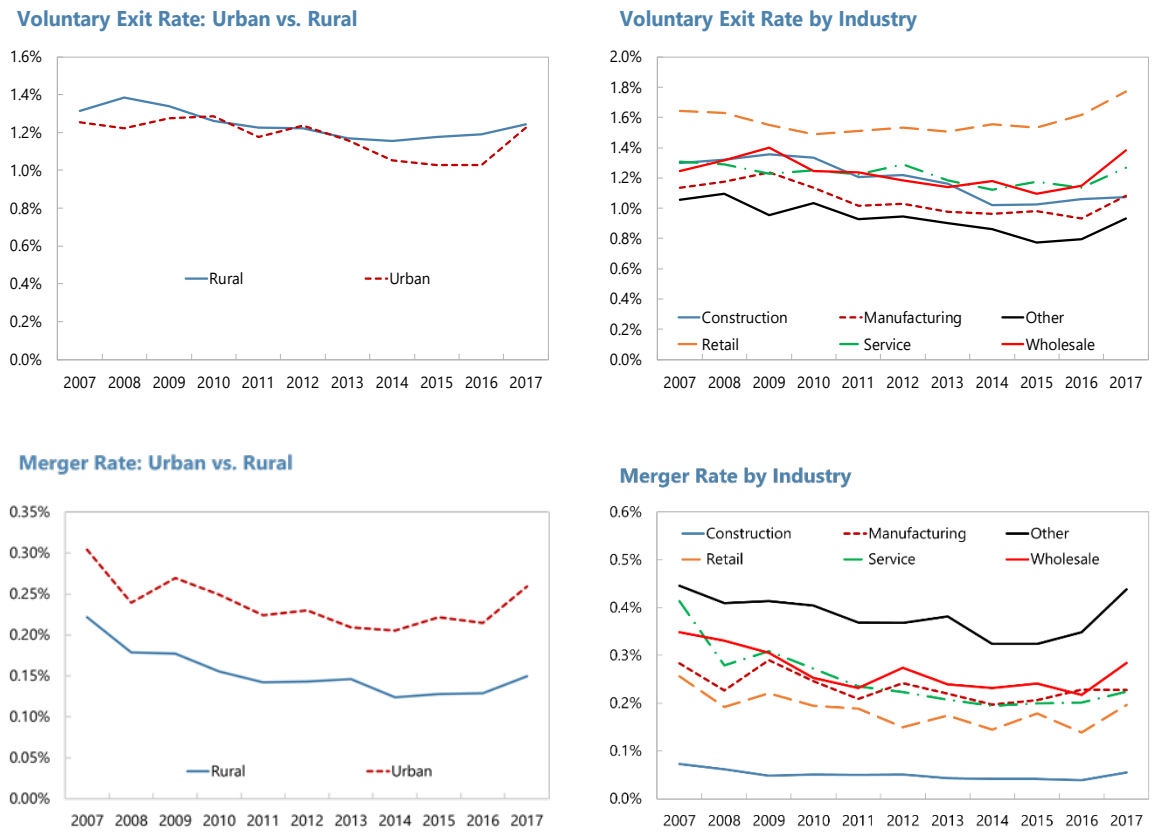
Source: Tokyo Shoko Research, LTD

Note: Each line represents firm's exit rates by exit type for a given year. X-axis represents years. Y-axis represents firm's exit rate in percent.

Chart 3 compares the changes in exit rates over time by region and industry by exit type. For bankruptcy, the share of firms that exited due to bankruptcy has declined steadily for all regions and all sectors. Bankruptcy rate is slightly higher for urban areas than for rural areas, but the difference is marginal.

Chart 3. Exit Types by Region and Industry





Source: Tokyo Shoko Research, LTD

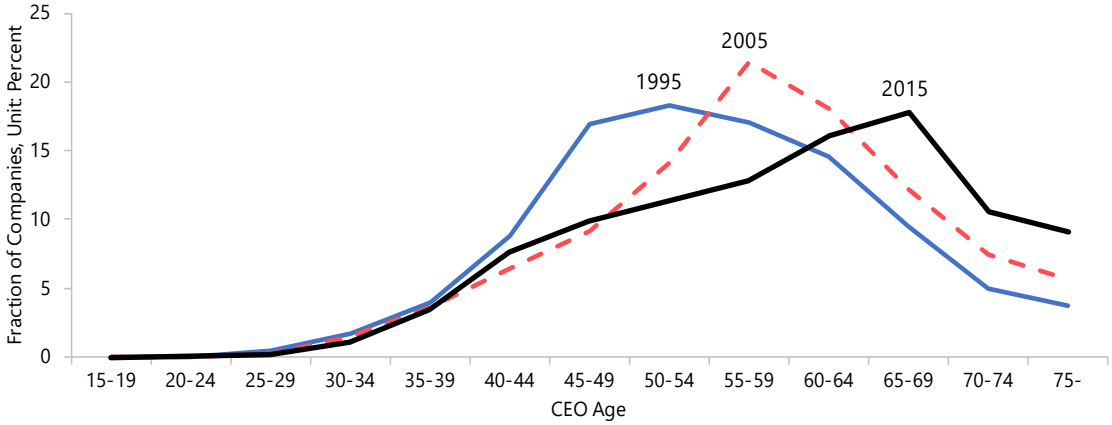
Note: For the left, each line represents exit rates (by type) by urban and rural area. For the right, each line represents exit rates (by type) by industry. For all charts, x-axis represents years and y-axis represents exit rates (by type) in percent.

On the other hand, the share of firms that exited due to voluntary exits and merger have increased in recent years for all regions and sectors. Firms in rural areas have equally high ratio of exiting voluntarily as those in urban areas. Comparing across sectors, firms in all sectors excluding construction industry had higher voluntary exits in 2017 compared to 2016. Firms in retail sectors have the highest ratio of voluntary exits, while firms in manufacturing sectors have relatively low rate. Unlike voluntary exits, we find that there is an important regional difference when firms exit through merging. Firms in urban areas have higher share of merging compared to those in rural areas. Firms in wholesale and retail sectors exhibited a higher ratio of exiting through merging in 2017 compared to 2016, while firms in construction sectors had a very low rate of merger.

3.2. CEO Age, Business Succession and Voluntary Exits

In this subsection, we analyze the patterns of voluntary exits and potential reasons for why we observe a recent upward trend in voluntary exits.

Chart 4. CEO Age Distribution for Japanese SMEs



Source: 2019 White Paper on Small and Medium Enterprises in Japan

Note: The figure displays the percentage of small and medium-sized companies with CEO age in each of the respective bins.

Managers in Japan are aging (Chart 4). The peak of the CEO age distribution for Japanese SMEs has shifted to the right during the last two decades. In 1995, the age group that had the largest share of CEOs was the age group between 50 to 54. In 2015, it was the age group between 65 to 69 that had the largest share of CEOs. The fraction of companies having CEOs over 65 years old in 2015 was 37 percent, which was nearly two times larger than the fraction of 18 percent in 1995.[10]

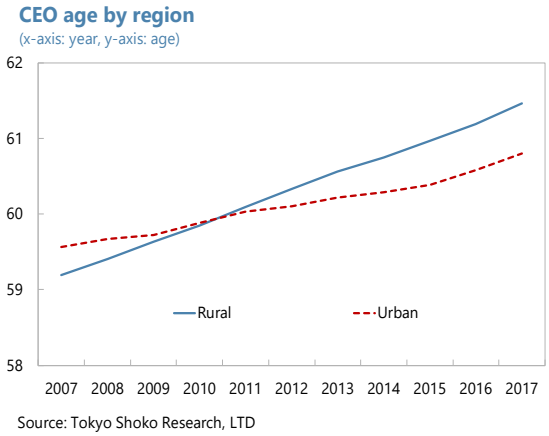
The SMEA (2017) reports that Japanese companies cited aging or aging-related challenges as key reasons for considering business closure. Nearly a third of medium-sized companies who participated in the survey reported 'cannot secure successor' as the second important reason for considering exits, followed by 'poor earnings'. Relatedly, about one in five companies (22.7 percent) reported 'getting old (physical strength/judgement declining)' as the reason for

[10] We obtain similar results to these when using the TSR data for 2015. The peak of the CEO age distribution is in the age group between 65 to 69.

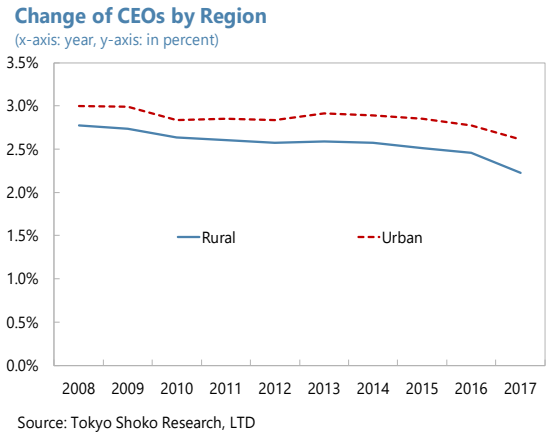
considering business closure. For small firms, nearly half of the respondent firms checked 'cannot secure successor' as the number one reason which would make firms consider business closure. In the TSR data, we confirm that business owners in Japan are aging in the sample of firms covered. Average age of CEO for the firms observed in the data is 61 years old in the 2017 data. The fraction of companies having CEOs who are over 65 was as high as 41 percent. There is little difference across industries in terms of the average age of CEOs, with construction sector having the youngest average age of 60 and wholesale sector having the oldest average age of 62 (Annex II).

We observe some regional differences in terms of the evolution of average age of business owners. Until 2010, average of CEOs was higher for urban areas compared to rural areas.[11] Since then, the order is reversed and in 2017, average age of business owners in rural areas is 61.5 years, while is 60.8 years for urban areas (Chart 5, left chart). This is somehow consistent with the fact that population is aging more rapidly in rural areas than in urban areas. In addition to the general demographic trends, we also find that firms in rural areas are less likely to change their business owners, compared to the firms in urban areas (Chart 5, right chart). For both urban and rural areas, Japanese firms show very low rate of changing their CEOs (2.2 percent for rural areas, 2.6 percent for urban areas in 2017). As the change of CEOs implies replacing older business owners with younger managers, average age of business owners is likely to be negatively correlated with the ratio of changing business owners.

Chart 5. CEO Age and Change of CEOs by Region



Source: Tokyo Shoko Research, LTD



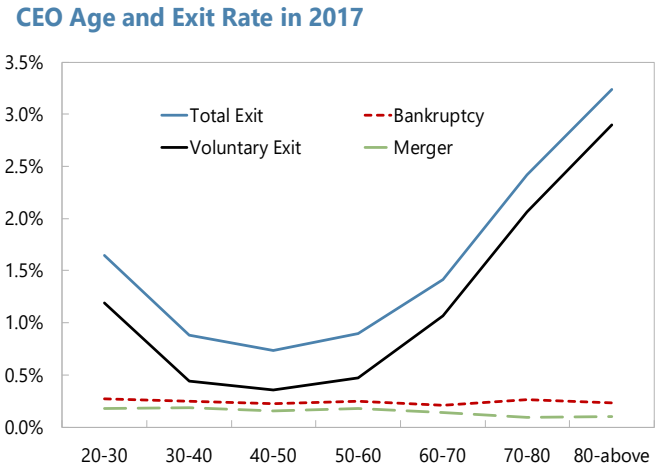
Source: Tokyo Shoko Research, LTD

[11] Throughout the paper, 'urban' areas include the following prefectures: Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka and Kyoto prefectures. All other prefectures are 'rural' in our paper.

Note: For the left chart, each line represents the average age of CEOs for each year for rural and urban areas. For the right chart, each line represents the percent of firms that changed CEOs by rural and urban area. For both charts, x-axis represents years.

Now, we assess how CEO age is related to firm exit patterns. Using the information on firm exit and the age of CEOs for each firm in the TSR data, we find a strong and positive correlation between the age of CEOs and voluntary exit rates, with voluntary exits reaching above 2 percent for CEOs aged between 70-80 and about 2.5 percent for CEOs aged above 80 years old. Interestingly, this positive correlation between exit rate and age of CEOs is observed only for voluntary exit, and not for other types of exits (bankruptcy and merger) (Chart 6).

Chart 6. Exit Rate by CEO Age

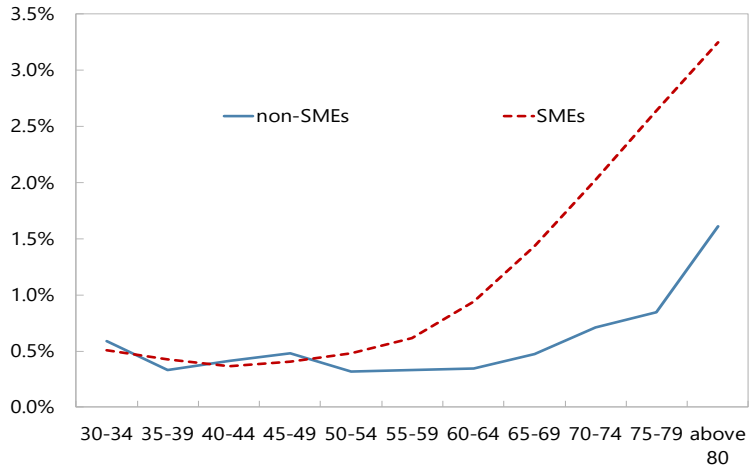


Source: Tokyo Shoko Research, LTD

Note: Each bin in the x-axis represents age group of CEOs. Y-axis represents firm exit rates by exit type for each age group (in percent). The data used is the 2017 sample of the TSR data.

Furthermore, we find that the relationship between CEO age and voluntary exit ratios is stronger for SMEs than non-SMEs (Chart 7). There does not exist a significant difference between voluntary exit rates for SMEs and those for non-SMEs until below 50 ages. However, voluntary exit rate rises more rapidly for SMEs compared to non-SMEs from the age of 50. And for each age group above 50, the positive correlation between voluntary exit rate and CEO age is higher for SMEs compared to non-SMEs. In other words, for the same age group, voluntary exit rates are higher for SMEs than for non-SMEs. For non-SMEs, voluntary exit rates rise mildly until above 75 ages and picks up fast after that.

Chart 7. CEO Age and Voluntary Exit Rate: SMEs vs. non-SMEs

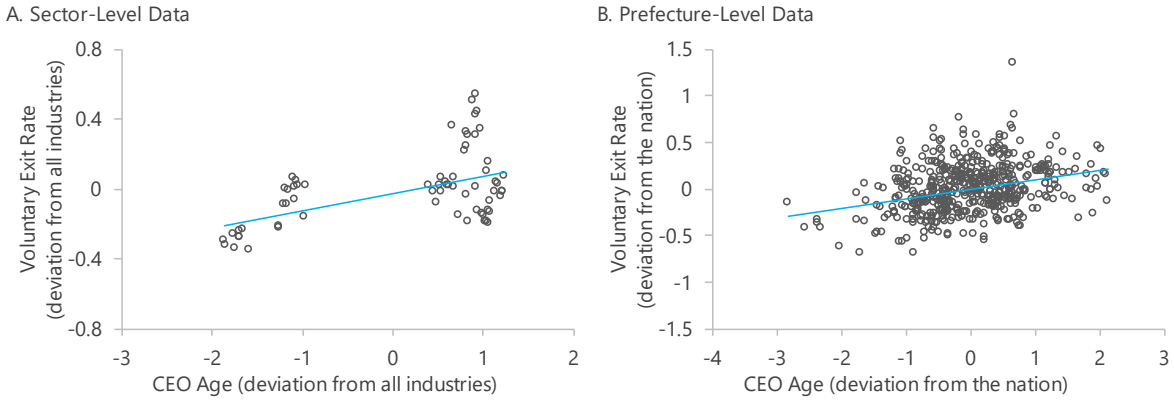


Source: Tokyo Shoko Research, LTD

Note: Each bin in the x-axis represents age group of CEOs. Each line represents voluntary exit rates by SMEs and non-SMEs. Y-axis is in percent. The data used is the 2017 sample of the TSR data.

High-correlations between CEO age and voluntary exit rates are also confirmed using sector-level data and prefecture-level data (Chart 8). First, sectoral-level correlation between CEO age and voluntary exit is positive (correlation: 0.52): a sector that has the average CEO age higher than that of all sectors tends to have higher-than-average voluntary exits. The second finding is the positive correlation at the prefecture-level (correlation: 0.31). Prefectures that have CEOs that are older compared to the average age across prefectures tend to exhibit higher voluntary exit rates than the average rate across Japan.

Chart 8. Voluntary Exit Rate and CEO Age, Sector-Level and Prefecture-Level Data, 2007-2017



Source: Tokyo Shoko Research, LTD

Note: For the left, each circle represents industry- and year-specific value. Six industries are considered: construction, manufacturing, wholesale, retail, service and others. Time horizon is from 2007 to 2017. X-axis represents the deviations of average CEO age of a sector from the average CEO age of all industries for a specific year. Y-axis plots the deviation of average voluntary exit rate of a sector from the average voluntary exit rate of all sectors for a specific year. For the right, each circle represents prefecture- and year-specific value. Time horizon is from 2007 to 2017. X-axis represents the deviations of average CEO age of a prefecture from the average CEO age of all prefectures for each year. Y-axis plots the deviation of average voluntary exit rate of a prefecture from the average voluntary exit rate of all prefectures for a specific year.

3.3. Declining bankruptcy rate and zombie firms

Here, we explore the implications of continued decline in bankruptcy rate. It could have two different underlying factors. First, a decline in bankruptcy rate could imply an improvement in the health of Japanese SMEs. If so, this would be reflected in the declining ratio of zombie firms, firms that are unable to cover debt servicing costs from current profits over an extended period. On the other hand, a decline in bankruptcy rate combined with an increase in the share of zombie firms implies deterioration in the cleansing mechanism of the market.[12]

We adopt three different methodologies of defining a zombie firm used in the literature: (1) Caballero, Hoshi, and Kashyap (2008, hereafter CHK); (2) Fukuda and Nakamura (2011, hereafter FN); and (3) Imai (2016).[13] CHK defines a zombie by creating a proxy for receiving subsidized credit, using estimates for reductions in interest payments. A firm is identified as a zombie firm if the actual interest payment is lower than the minimum required interest payment for a firm. On the other hand, FN adds additional two conditions: profitability and ever-greening. FN defines zombie firms as firms that fulfill the profitability criterion and meet at least one of the financial support criteria of interest payments (CHK) and evergreening. Finally, Imai (2016) follows the idea of FN, but uses a longer period to evaluate firm profitability. This helps to avoid the problems of misidentifying healthy firms as zombie firms if the healthy firms experience temporary profit

[12] Overly generous credit guarantee schemes provided to the SMEs has been cited as an important reason for low firm exit rates in Japan, creating inefficient allocation of resources and discouraging investment and job creation (Caballero, Hoshi, and Kashyap 2008, OECD 2017, and IMF 2017, 2018).

[13] Adalet McGowan, Andrews, and Millot (2017) defines a zombie firm as a firm whose interest coverage ratio (ICR) has been less than one for at least three consecutive years and if a firm is at least five years old. Banerjee and Hofmann (2018) adds another criterion based on a firm's growth potential by comparing Tobin's q and the median Tobin's q of the sector.

declines, and misidentifying zombie firms as healthy firms if the zombie firms have temporary profit increase. The minimum required interest payment for each firm is defined as follows:

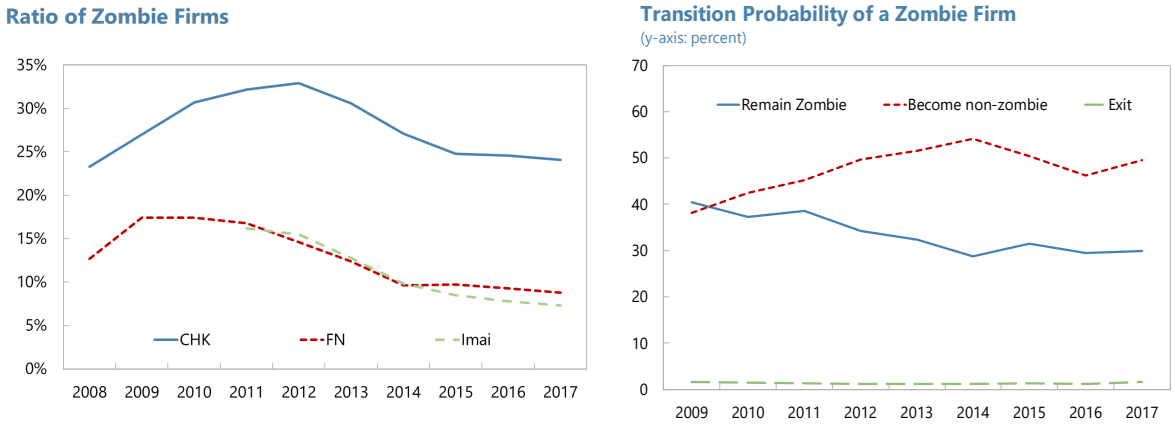
$$I_{i,t}^{*} = r_{t-1}^{short} * B_{i,t-1}^{short} + \left(\frac{1}{5} \sum_{j=1}^{5} r_{t-j}^{long} \right) * B_{i,t-1}^{long} + \min(r_{t-5}^{cb}, \dots, r_{t-1}^{cb}) * Bonds_{i,t-1}$$

where $I_{i,t}^{*}$ is the minimum required interest payment for firm *i* in year *t*, r_t^{short} is the short-term prime rate in year *t*, r_t^{long} is the long-term prime rate in year *t*, $\min(r_{t-5}^{cb}, \dots, r_{t-1}^{cb})$ is the minimum coupon rate observed on any convertible corporate bond issued in the last five years before year *t*. $B_{i,t}^{short}$ refers to short-term borrowing from banks for firm *i* at the end of year *t*, $B_{i,t}^{long}$ refers to long-term borrowing from banks for firm *i* at the end of year *t*, and $Bonds_{i,t}$ is total issued amount of corporate bonds for firm *i* at the end of year *t*. CHK defines a firm to be a zombie firm if $I_{i,t}^{*} > I_{i,t}$, where $I_{i,t}$ is actual interest paid by firm *i* in year *t*. FN defines a firm to be a zombie firm if $I_{i,t}^{*} > EBIT_{i,t}$ and $(B_{i,t} > B_{i,t-1}\ or\ I_{i,t} < I_{i,t}^{*})$. $EBIT_{i,t}$ denotes earnings before interest and taxes for firm *i* in year *t* and $B_{i,t}$ the amount of outstanding debt for firm *i* at the end of year *t*. Imai (2016) defines a firm to be a zombie firm if $\sum_{m=0}^{3}(EBIT_{i,t-m} - I_{i,t-m}^{*}) < 0$ and $(B_{i,t} > B_{i,t-1}\ or\ I_{i,t} < I_{i,t}^{*})$.

First, while the exact magnitude of the share of zombie firms depend on which definition we adopt, the share of zombie firms declined over the years (Chart 9, left figure). CHK zombie ratio peaked in 2012, suggesting the impact from decreasing interest rates since the Abenomics. FN zombie ratio peaked in 2009, suggesting that the ratio of zombie firms increased during the Global Financial Crisis. Given the limited sample period, Imai zombie ratio starts only in 2011, where we observe continued decline over the years. The share of zombie firms ranges from 5 percent (Imai) to 25 percent (CHK) for 2017. The share of zombie firms using CHK is nearly five times higher than those using FN and Imai, as CHK does not impose any filtering of zombie firms based on firm profitability. The CHK definition generates an upward bias during the low interest environment, as the CHK is more suitable in defining a zombie firm in the context of bank NPL issues and forbearance lending practices in 1990s. As a result, our preferred methodology is FN, as Imai's definition constrains the data coverage. This finding that the share of zombie firms has been declining in recent years supports the view that the health of Japanese SMEs, on average, has

improved.[14] Zombie firms who remain as a zombie in the next period has been declining over the years, stabilizing around 30 percent in 2017. On the other hand, more than half of zombie firms became non-zombie firms in the following period (Chart 9, right figure).

Chart 9. Share of Zombie Firms and Transition Probability



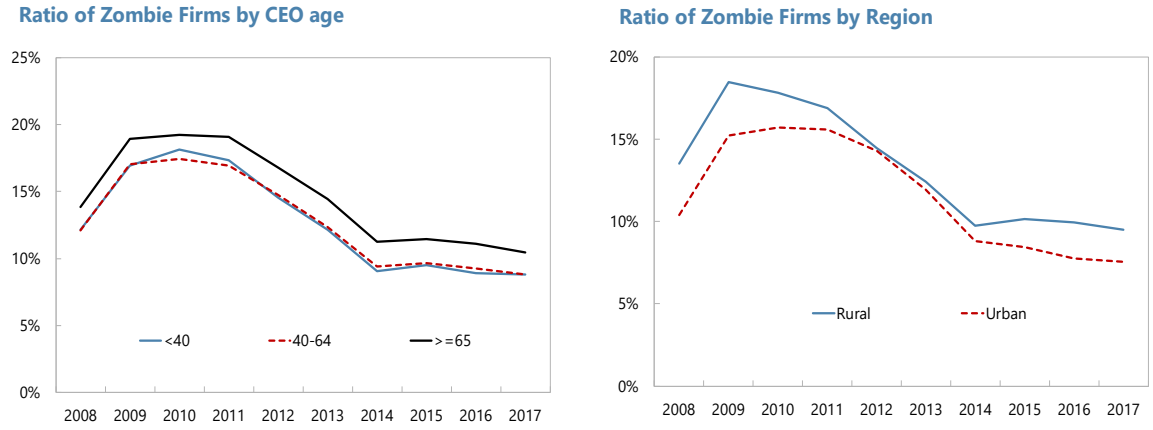
Source: Tokyo Shoko Research, LTD

Note: For the left chart, 'CHK' uses the zombie definition by Caballero, Hoshi, and Kashyap (2008), 'FN' uses the definition by Fukuda and Nakamura (2011), and 'Imai' uses the definition by Imai (2016). Y-axis refers to the ratio of zombie firms. For the right chart, y-axis refers to the transition probability at time t, conditional on the fact that a firm was a zombie firm at time t-1. For both charts, x-axis refers to the years.

Now, we turn to some characteristics of zombie firms. First, we find that firms with older CEOs have higher ratio of zombie firms (Chart 10, left chart). Studies show evidence that older CEOs invest less in productivity-enhancing investment as CEOs take less risks when they become older and such behavior leads to lower firm's productivity growth (Barker and Mueller 2002 and Campbell, Jeong, and Graffin 2019). Another feature that is unique to Japanese firms could be the sticky relationship between firms and between banks and firms (Hong, Ogura, and Saito 2019).

[14] Using firm-level data for 14 advanced economies, mostly covering European countries, Banerjee and Hofmann (2018) suggest that low interest rates drove up the share of zombie firms and resulted in low productivity. We do not find support for these findings for the Japanese firms.

Chart 10. Ratio of Zombie Firms Using FN: by CEO Age and Region



Source: Tokyo Shoko Research, LTD

Note: The definition of a zombie firm follows Fukuda and Nakamura (2011). X-axis refers to the years. The y-axis of the left chart shows the ratio of zombie firms by age group of CEOs at each year. The y-axis of the right chart is the ratio of zombie firms in rural and urban areas.

Second, the ratio of zombie firms in rural areas has been higher than those in urban areas. This could partly reflect the fact that aging is happening more rapidly in rural areas, due to overall declining in fertility rates combined with younger population leaving the rural areas to look for jobs and education.

3.4. Firm Network and Exit Patterns

Recent studies highlight the importance of inter-firm network as a shock propagation channel (Bernard, Moxnes, and Saito 2019 and Carvalho et al. 2017 for Japanese companies). As we will explore the propagation of a firm's exit to the exit of other firms in the network in the next section, it is important to understand these characteristics of the network of Japanese firms in the TSR data.

First, a firm in the TSR data has an average of 5 suppliers and consumers in their network. We observe that number of suppliers and consumers is relatively smaller for firms in rural areas than in urban areas (Table 2). For both urban and rural areas, the number of firms connected through networks is stable, implying that stability and persistence of inter-firm relationships in Japan.[15]

[15] The recent increase in the number of firms connected through networks is mainly due to the increase in sample coverage.

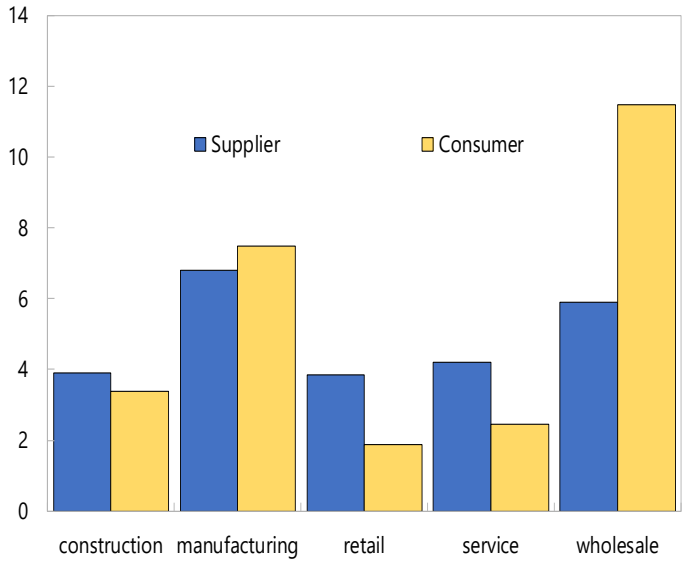
Number of suppliers is highest for manufacturing sector, while number of consumers is highest for wholesale sector (Chart 11).

Table 2. Average Number of Suppliers and Consumers

	Supplier		Consumer	
Year	Rural	Urban	Rural	Urban
2007	4.0	5.0	3.7	5.3
2008	4.0	5.1	3.7	5.4
2009	4.0	5.1	3.7	5.5
2010	4.0	5.2	3.7	5.6
2011	4.0	5.2	3.7	5.6
2012	3.9	5.2	3.6	5.6
2013	3.9	5.2	3.6	5.6
2014	3.9	5.3	3.6	5.7
2015	4.1	5.5	3.8	5.9
2016	4.1	5.5	3.8	5.8
2017	4.1	5.5	3.8	5.8

Source: Tokyo Shoko Research, LTD

Chart 11. Average Number of Suppliers and Consumers: by Industry



Source: Tokyo Shoko Research, LTD

Note: 2017 sample from the TSR data used. Y-axis denotes the average number of suppliers and consumers for each industry.

Geographical proximity also plays an important role in inter-firm networks. We look at the distance between suppliers and consumers. Average distance between connected firms in production network is 170 kilometers, but the median is much shorter 31 kilometers (Table 3). Distances between connected firms in rural areas are marginally shorter than in urban areas. For urban areas, distance to suppliers is 172 kilometers on average (30.5 kilometers median). For rural areas, distance to suppliers is 167 kilometers on average (30.9 kilometers median). This is also true for the distance to consumers. There are differences across sectors. Retail and wholesale sectors have the longest distance to suppliers but have relatively short distance to consumers. Manufacturing firms are the opposite, where the distances to suppliers are relatively short and the distances to consumers are the longest.[16]

Table 3. Distance to Firms in Production Network (in Kilometers)

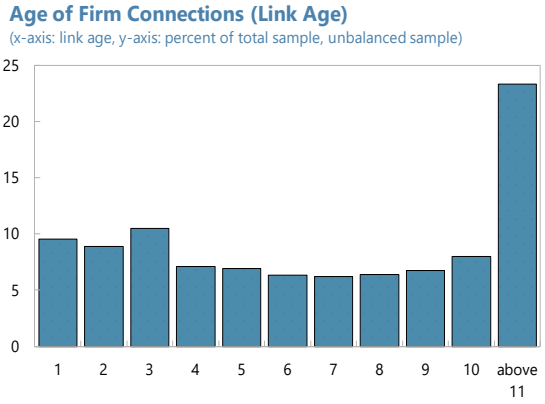
	Number of firms	Average	Median
All firms	4,312,317	169.9	30.6
	Distance to Suppliers		
Rural	2,178,937	167.7	30.9
Urban	2,133,380	172.1	30.5
Construction	1,196,599	115.5	16.6
Manufacturing	918,417	179.5	42.9
other	307,190	183.3	30.9
Retail	396,743	237.3	84.9
Service	825,113	138.8	17.7
Wholesale	668,255	246.1	103.9
	Distance to Consumers		
Rural	2,035,862	143.8	24.3
Urban	2,276,455	193.2	36.0
Construction	1,034,685	98.6	13.4
Manufacturing	1,010,021	237.1	95.1
other	295,253	179.7	25.5
Retail	193,633	124.0	22.7
Service	478,236	169.4	22.9
Wholesale	1,300,489	179.1	41.0

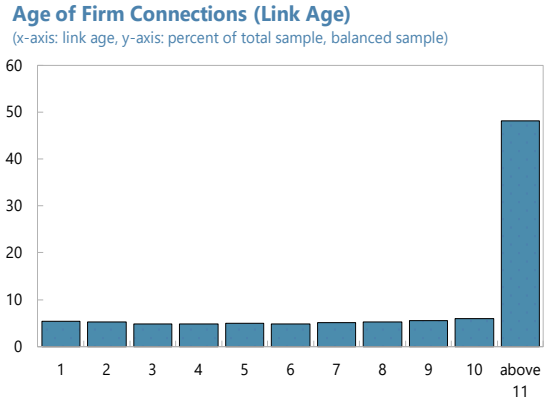
Source: Tokyo Shoko Research, LTD

[16] Unconditional mean of distance between connected firms may be driven by supply network structure of large wholesalers and manufacturing firms. Okubo, Ono, and Saito (2015) find that large wholesalers tend to locate closer to their manufacturing buyers and farther from their manufacturing sellers, ceteris paribus (https://www.rieti.go.jp/jp/publications/dp/14e059.pdf).

Finally, the average duration of inter-firm connections is high, confirming that firm networks are quite persistent. Using the entire sample (unbalanced panel) of firms in 2017, about a quarter of total firm networks was at least as old as 11 years old (the maximum number of years possible from the TSR data given the time coverage). For the balanced panel, we find that the ratio increases and that about a half of total firm networks is at least 11 years old (Chart 12).

Chart 12. Distribution of Link Age





Note: X-axis represents years of inter-firm relationship (link age). Y-axis shows the percent of inter-firm connections with certain link age. Left chart is based on an unbalanced sample. Right chart is based on a balanced sample. Both charts use the observations from 2017 in the TSR data.

4. Business Succession, Voluntary Exits and Spillovers

In this section, we conduct empirical analyses to assess the propagation impact of a firm's exit through inter-firm transaction network. First, we investigate how a firm's exit affects business activities for its partner companies. Second, we explore how a firm's exit affects the likelihood of an exit of its partner companies. Finally, we look into the determinants of each exit type and compare them across different exit types.

4.1. Impact of an exit of a firm on partner firms' business activities

We run an OLS regression to estimate the impact of a firm's exit on business activities for its partner firms. The regression specification is as follows:

$$Y_{i,r,s,t} = \alpha_s + \alpha_r + \alpha_t + \beta MEANEXIT^h_{i,t-1} + \gamma X_{i,r,s,t} + e_{i,r,s,t}.$$

$Y_{i,r,s,t}$ is a variable of interest for firm *i*, located in prefecture *r*, operating in industry *s* for year *t*, which could be sales growth, new supplier connections, and new consumer connections. $MEANEXIT_{i,t}^{h}$ is a measure of an exit rate of business connections of firm *i* for year *t*. It is defined as:

$$MEANEXIT_{i,t}^{h} = mean\left(Exit_{i,j,t}^{h}\right).$$

$Exit_{i,j,t}^{h}$ is an indicator function that equals one if a partner company *j* of firm *i* exits in year *t* and otherwise equals zero. The type of exit, *h*, can take three different forms: bankruptcy, merger, and voluntary exit. A partner company can be either a supplier or a consumer, and we take two cases separately. $X_{i,r,s,t}$ denotes a control variable. Variables include firm age, CEO age, number of consumer connections, number of supplier connections, number of employment (all in log terms so far), and a dummy variable for the change of CEO. Fixed-effects for industry (*s*), prefecture (*r*) and year (*t*) are included.

Table 4 shows the results. We find that an exit of a partner company due to bankruptcy or voluntary exit negatively affects sales growth in the following period. The magnitude varies across exit types. A sudden and disruptive bankruptcy has a larger negative impact on sales growth. A one-fifth increase in the variable of exit rate of business connections drops sales in the following period by 0.59 percent (=1/5*-0.0297*100) in the case of supplier bankruptcy and by 0.55 percent (=1/5*-0.0278*100) in the case of consumer bankruptcy. This increase corresponds to the case where one of five business connections for a company goes bankrupt. Compared to bankruptcy, voluntary exit leads to a softer decline in sales growth. A one-fifth increase in the variable of exit rate of business connections lowers sale in the following period by 0.26 percent (=1/5*-0.0133*100) for supplier voluntary exit and by 0.25 percent (=1/5*-0.0125*100) for consumer one. Companies are likely to be announced beforehand by its exiting partner and therefore could prepare for the exit. Interestingly, when a partner, whether it be supplier or consumer company, exits through merger, sales growth in the following period is positively affected. This could be due to various endogenous factors. For instance, firms that find partners to merge may be profitable firms to begin with. Also, given everything else equal, through merger, existing firms can benefit from an expansion in network of the ‘new’ partner.

An exit of a partner company also triggers building new connections, for all exit types. In fact, a clear pattern emerges that an exit of a supplier leads to finding new suppliers and not consumers.

Finally, we observe that sales growth and new network creation are negatively correlated with the age of CEO and firm age. Perhaps, relatedly, the change of CEOs (d_change_exe) is positively correlated with both 'lnindeg_new' and 'lnoutdeg_new,' suggesting that new CEOs who are likely to be younger than the CEO he/she replaced search for new connections.

Table 4. Growth of Sales, Network Creations when a Partner Company Exits

	(1)	(2)	(3)
VARIABLES	dlnsales	indeg_new	outdeg_new
lnage	-0.0220***	-0.305***	-0.253***
	(0.000369)	(0.00771)	(0.0109)
lnage_exe	-0.0467***	0.622***	0.285***
	(0.000964)	(0.0155)	(0.0155)
d_change_exe	-0.0104***	0.328***	0.227***
	(0.00105)	(0.0311)	(0.0322)
lnindeg	-0.00308***	1.453***	0.272***
	(0.000268)	(0.0186)	(0.00696)
lnoutdeg	0.00253***	0.127***	1.185***
	(0.000220)	(0.00794)	(0.0127)
lnemp	0.0146***	0.578***	0.348***
	(0.000208)	(0.00533)	(0.00449)
supplier bankruptcy (t-1)	-0.0297***	0.917***	0.00362
	(0.00727)	(0.0308)	(0.0358)
consumer bankruptcy (t-1)	-0.0278***	0.0454	0.668***
	(0.00630)	(0.0349)	(0.0269)
supplier merger (t-1)	0.00884**	0.569***	-0.0476**
	(0.00388)	(0.0206)	(0.0219)
consumer merger (t-1)	0.0351***	-0.0677	0.171***
	(0.00661)	(0.0672)	(0.0333)
supplier voluntary exit (t-1)	-0.0133**	0.444***	0.110***
	(0.00578)	(0.0254)	(0.0308)
consumer voluntary exit (t-1)	-0.0125**	0.268***	0.846***
	(0.00610)	(0.0334)	(0.0277)
Constant	0.277***	-3.796***	-1.774***
	(0.00494)	(0.0754)	(0.0613)
Observations	2,862,101	3,582,570	3,582,570
R-squared	0.025	0.110	0.094

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. 'lnage', 'lnage_exe', 'lnindeg', 'lnoutdeg' and 'lnemp' indicate age of firms, age of CEOs, number of inbound inter-firm connections (suppliers), number of outbound inter-firm connections (consumers) and total employment of the firm, respectively, all in natural logs. 'd_change_exe' is a dummy variable which takes value 1 if the firm changed CEOs for time t, and 0 otherwise. Left-hand side variables include 'dlnsales', 'lnindeg_new' and 'lnoutdeg_new', indicating sales growth, natural log of *new* inbound firm-connections

(suppliers) and *new* outbound firm-connections (consumers), respectively. Fixed-effects for industry, prefecture and year are included.

4.2. Impact of an exit of a firm on partner firms' exits

Now, we assess the spillover effects of an exit of a firm on its partner firms' exits through inter-firm transaction network. To do so, we use a probit regression to estimate the likelihood of an exit of its business connection when a firm exits. Specifically, we consider the following regression model:

$$Exit_{i,r,s,t} = \Phi\left(\alpha_s + \alpha_r + \alpha_t + \beta MEANEXIT^{h}_{i,t-1} + \gamma X_{i,r,s,t} + \varepsilon_{i,r,s,t}\right).$$

$Exit_{i,r,s,t}$ denotes an indicator function that equals one if firm *i*, located in prefecture *r*, operating in industry *s* exits in year *t* and equals zero otherwise. We also explore the effects of business connections exits on a firm exit through bankruptcy, voluntary exit, and merger to see if propagation characteristics differ by exit type. To this end, we run probit regressions with the dependent variable of $Exit_{i,r,s,t}$ for bankruptcy, with that for voluntary exit, and with that for merger. $MEANEXIT^{h}_{i,t-1}$ is a measure of an exit rate of business connections of firm *i*. Control variables, $X_{i,r,s,t}$, include firm age, CEO age, number of consumer connections, number of supplier connections, number of employment (all in log terms so far), sales growth, and a dummy variable for the change of CEO. Fixed-effects for industry (*s*), prefecture (*r*) and year (*t*) are included.

To begin with, we report results of overall exit across industries. Table 5 shows that across industries, a bankruptcy of a partner company, whether it be supplier or consumer company, increase the likelihood of a firm's exit. This is true for both manufacturing and non-manufacturing companies. Interestingly, voluntary exits of a supplier increase the likelihood of firm exit, for both manufacturing and non-manufacturing sectors, while voluntary exits of a consumer company do not have spillover effects. Finally, as a firm exiting through merger in reality does not disappear from the market, its exit does not have any impact on the exit probability of its partners. For both sectors, firms with older CEOs tend to have higher likelihood of exit.

Table 5. Manufacturing vs. Non-manufacturing

	(1)	(2)	(3)
VARIABLES		Exit Dummy	
Industries	ALL	Manufacturing	Non-Manufacturing
lnage	-0.0602***	-0.0657***	-0.0582***
	(0.00340)	(0.00720)	(0.00389)
lnage_exe	0.600***	0.589***	0.603***
	(0.0111)	(0.0232)	(0.0127)
d_change_exe	0.169***	0.156***	0.173***
	(0.0102)	(0.0216)	(0.0117)
lnindeg	0.0202***	0.0184***	0.0222***
	(0.00279)	(0.00665)	(0.00309)
lnoutdeg	-0.0466***	-0.0709***	-0.0400***
	(0.00249)	(0.00581)	(0.00278)
lnemp	-0.100***	-0.0934***	-0.101***
	(0.00212)	(0.00433)	(0.00246)
dlnsales	-0.266***	-0.378***	-0.246***
	(0.00537)	(0.0136)	(0.00590)
supplier bankruptcy (t-1)	0.362***	0.233*	0.404***
	(0.0553)	(0.120)	(0.0623)
consumer bankruptcy (t-1)	0.288***	0.316***	0.283***
	(0.0499)	(0.116)	(0.0554)
supplier merger (t-1)	-0.0128	-0.0508	-0.0128
	(0.0430)	(0.124)	(0.0462)
consumer merger (t-1)	0.0636	0.127	0.0392
	(0.0483)	(0.0941)	(0.0569)
supplier voluntary exit (t-1)	0.240***	0.309***	0.215***
	(0.0521)	(0.106)	(0.0603)
consumer voluntary exit (t-1)	0.0897*	0.158	0.0750
	(0.0545)	(0.118)	(0.0616)
Constant	-4.536***	-4.382***	-4.555***
	(0.0561)	(0.129)	(0.0616)
Observations	3,393,380	766,646	2,616,115

Note: Standard errors in parentheses.: *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed effects for industry, year and prefectures are included.

Table 6 shows results of overall exit for different sectors of non-manufacturing companies. Bankruptcy of a supplier company increases the exit of firms for retail, wholesale, and construction, while bankruptcy of a consumer company increases the likelihood of a partner company's exit for wholesaling and construction, but not for retailing. On the other hand, as for voluntary exits, a company's exit is affected differently across different sectors. For instance, a company in retail sector has a higher probability of exiting if its consumer company exits voluntarily. On the other hand, a company in wholesale sector has a higher chance of exiting if its supplier company exits voluntarily.

Table 6. Spillover from Partner Company Exit to Own Exit: Non-manufacturing Sectors

	(1)	(2)	(3)	(4)
VARIABLES		Exit Dummy		
Industries	Non-Manufacturing	Retail	Wholesale	Construction
lnage	-0.0582***	-0.0824***	-0.0625***	0.00217
	(0.00389)	(0.0127)	(0.00757)	(0.00672)
lnage_exe	0.603***	0.612***	0.646***	0.660***
	(0.0127)	(0.0464)	(0.0248)	(0.0197)
d_change_exe	0.173***	0.218***	0.177***	0.140***
	(0.0117)	(0.0453)	(0.0231)	(0.0202)
lnindeg	0.0222***	-0.0290**	-0.0402***	0.0603***
	(0.00309)	(0.0120)	(0.00645)	(0.00466)
lnoutdeg	-0.0400***	-0.0201**	0.00607	-0.0537***
	(0.00278)	(0.00989)	(0.00533)	(0.00480)
lnemp	-0.101***	-0.0515***	-0.110***	-0.153***
	(0.00246)	(0.00789)	(0.00500)	(0.00473)
dlnsales	-0.246***	-0.341***	-0.345***	-0.218***
	(0.00590)	(0.0310)	(0.0141)	(0.00834)
supplier bankruptcy (t-1)	0.404***	0.921***	0.355***	0.385***
	(0.0623)	(0.211)	(0.129)	(0.0906)
consumer bankruptcy (t-1)	0.283***	0.0567	0.286**	0.178**
	(0.0554)	(0.239)	(0.122)	(0.0764)
supplier merger (t-1)	-0.0128	0.163	-0.0329	-0.0545
	(0.0462)	(0.111)	(0.0939)	(0.0998)
consumer merger (t-1)	0.0392	0.366**	0.128	-0.0797
	(0.0569)	(0.171)	(0.114)	(0.104)
supplier voluntary exit (t-1)	0.215***	-0.0893	0.500***	0.139
	(0.0603)	(0.319)	(0.115)	(0.0855)
consumer voluntary exit (t-1)	0.0750	0.394**	-0.171	-0.0242
	(0.0616)	(0.188)	(0.128)	(0.0966)
Constant	-4.555***	-4.404***	-4.526***	-4.921***
	(0.0616)	(0.209)	(0.117)	(0.0858)
Observations	2,616,115	178,258	627,899	1,180,238

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed effects for industry, year and prefectures are included.

Table 7 shows a company's exit of various types affects the likelihood of a company's exit through bankruptcy, for manufacturing and non-manufacturing sector. First, we find that bankruptcy of companies in a firm's network affects the firm's own bankruptcy. This is true for both manufacturing and non-manufacturing firms. What is interesting is that voluntary exit of supplier firms in the network could also affect bankruptcy of a firm. This is true for non-manufacturing companies, as we find that a voluntary exit of a supplier company leads to a higher likelihood of bankruptcy.

Table 7. Spillover from Partner Company Exit to Own Bankruptcy: Manufacturing vs. Non-manufacturing

	(1)	(2)	(3)
VARIABLES	Exit from Bankruptcy		
Industries	All	Manufacturing	Non-Manufacturing
lnage	-0.0558***	-0.0806***	-0.0498***
	(0.00502)	(0.0104)	(0.00577)
lnage_exe	0.135***	0.190***	0.116***
	(0.0157)	(0.0327)	(0.0180)
d_change_exe	-0.102***	-0.117***	-0.0961***
	(0.0177)	(0.0378)	(0.0202)
lnindeg	0.0777***	-0.00226	0.0937***
	(0.00411)	(0.00986)	(0.00455)
lnoutdeg	0.00478	0.0543***	-0.00187
	(0.00367)	(0.00875)	(0.00408)
lnemp	-0.0805***	-0.0796***	-0.0774***
	(0.00324)	(0.00657)	(0.00376)
dlnsales	-0.189***	-0.267***	-0.175***
	(0.00817)	(0.0204)	(0.00901)
supplier bankruptcy (t-1)	0.587***	0.483***	0.612***
	(0.0701)	(0.149)	(0.0798)
consumer bankruptcy (t-1)	0.503***	0.551***	0.493***
	(0.0633)	(0.152)	(0.0699)
supplier merger (t-1)	-0.0454	-0.272	-0.0214
	(0.0685)	(0.209)	(0.0731)
consumer merger (t-1)	0.0504	0.100	0.0436
	(0.0744)	(0.150)	(0.0865)
supplier voluntary exit (t-1)	0.244***	0.0956	0.272***
	(0.0782)	(0.172)	(0.0886)
consumer voluntary exit (t-1)	0.0184	0.110	0.00889
	(0.0865)	(0.190)	(0.0972)
Constant	-3.443***	-3.590***	-3.407***
	(0.0862)	(0.225)	(0.0936)
Observations	3,393,380	766,646	2,616,115

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

Table 8 shows results obtained from performing the same regressions for different sectors of non-manufacturing companies. Bankruptcy of supplier increases the firm's chance of bankruptcy in a significant way for all types of non-manufacturing companies. The impact is highest for retail companies, and smallest for wholesale firms. On the other hand, bankruptcy of consumer increases the chance of a firm's bankruptcy for wholesale and construction sectors, but not for retail sector. However, we also find evidence that voluntary exits could also have propagation effects, as we find that voluntary exits of suppliers increase the likelihood of bankruptcy for wholesale and construction companies.

Table 8. Spillovers from Partner Company Exit to Own Bankruptcy: Non-manufacturing Sectors

	(1)	(2)	(3)	(4)
VARIABLES	Exit from Bankruptcy			
Industries	Non-Manufacturing	Retail	Wholesale	Construction
lnage	-0.0498***	-0.0294	-0.0606***	-0.0473***
	(0.00577)	(0.0212)	(0.0114)	(0.00911)
lnage_exe	0.116***	0.0720	0.210***	0.121***
	(0.0180)	(0.0730)	(0.0364)	(0.0261)
d_change_exe	-0.0961***	-0.0951	-0.149***	-0.0327
	(0.0202)	(0.0904)	(0.0441)	(0.0283)
lnindeg	0.0937***	0.0528***	0.0239**	0.136***
	(0.00455)	(0.0199)	(0.00993)	(0.00647)
lnoutdeg	-0.00187	0.000738	0.00563	0.00324
	(0.00408)	(0.0157)	(0.00809)	(0.00658)
lnemp	-0.0774***	-0.0605***	-0.0825***	-0.0597***
	(0.00376)	(0.0132)	(0.00759)	(0.00660)
dlnsales	-0.175***	-0.353***	-0.249***	-0.140***
	(0.00901)	(0.0465)	(0.0212)	(0.0126)
supplier bankruptcy (t-1)	0.612***	1.180***	0.492***	0.615***
	(0.0798)	(0.276)	(0.180)	(0.110)
consumer bankruptcy (t-1)	0.493***	-0.0153	0.451***	0.370***
	(0.0699)	(0.402)	(0.168)	(0.0943)
supplier merger (t-1)	-0.0214	-0.0358	-0.153	0.00429
	(0.0731)	(0.209)	(0.158)	(0.145)
consumer merger (t-1)	0.0436	0.0474	0.282*	-0.0763
	(0.0865)	(0.336)	(0.158)	(0.149)
supplier voluntary exit (t-1)	0.272***	-0.463	0.700***	0.221*
	(0.0886)	(0.664)	(0.156)	(0.122)
consumer voluntary exit (t-1)	0.00889	0.283	-0.208	0.0856
	(0.0972)	(0.316)	(0.207)	(0.132)
Constant	-3.407***	-2.907***	-3.481***	-3.344***
	(0.0936)	(0.324)	(0.177)	(0.113)
Observations	2,616,115	178,258	627,899	1,180,238

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

Table 9 uses voluntary exits as the dependent variable. It shows that an increase in supplier bankruptcy leads to a higher likelihood of voluntary exit, for non-manufacturing companies. Some degree of coordination of voluntary exits within a firm network is also observed: as the supplier's voluntary exit leads to a higher likelihood of a voluntary exit of a company, for both manufacturing and non-manufacturing companies. For non-manufacturing companies, the propagation of voluntary exits onto voluntary exit is observed for retail companies (consumers) and for wholesalers (supplier) (Table 10).

Table 9. Spillover from Partner Company Exit: Manufacturing vs. Non-manufacturing

	(1)	(2)	(3)
VARIABLES	Voluntary Exit		
Industries	All	Manufacturing	Non-Manufacturing
lnage	0.0472***	0.0819***	0.0378***
	(0.00498)	(0.0109)	(0.00565)
lnage_exe	1.004***	0.932***	1.031***
	(0.0162)	(0.0338)	(0.0186)
d_change_exe	0.154***	0.133***	0.162***
	(0.0170)	(0.0372)	(0.0192)
lnindeg	-0.0678***	-0.0684***	-0.0652***
	(0.00399)	(0.00942)	(0.00444)
lnoutdeg	-0.0910***	-0.126***	-0.0826***
	(0.00365)	(0.00837)	(0.00408)
lnemp	-0.257***	-0.232***	-0.266***
	(0.00320)	(0.00625)	(0.00375)
dlnsales	-0.277***	-0.405***	-0.255***
	(0.00655)	(0.0166)	(0.00720)
supplier bankruptcy (t-1)	0.145*	0.0136	0.189**
	(0.0781)	(0.171)	(0.0877)
consumer bankruptcy (t-1)	0.0991	0.172	0.0836
	(0.0694)	(0.154)	(0.0781)
supplier merger (t-1)	-0.0589	-0.0267	-0.0625
	(0.0569)	(0.158)	(0.0613)
consumer merger (t-1)	0.0168	0.156	-0.0464
	(0.0660)	(0.121)	(0.0800)
supplier voluntary exit (t-1)	0.210***	0.386***	0.147*
	(0.0653)	(0.126)	(0.0772)
consumer voluntary exit (t-1)	0.0734	0.141	0.0530
	(0.0688)	(0.145)	(0.0784)
Constant	-6.219***	-5.879***	-6.294***
	(0.0788)	(0.175)	(0.0873)
Observations	3,393,380	766,646	2,616,115

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

Table 10. Spillover from Partner Company Exit: Non-manufacturing Sectors

	(1)	(2)	(3)	(4)
VARIABLES	Voluntary Exit			
Industries	Non-Manufacturing	Retail	Wholesale	Construction
lnage	0.0378***	0.0162	0.0669***	0.0812***
	(0.00565)	(0.0179)	(0.0112)	(0.00935)
lnage_exe	1.031***	0.968***	1.064***	1.135***
	(0.0186)	(0.0646)	(0.0365)	(0.0286)
d_change_exe	0.162***	0.103	0.103**	0.196***
	(0.0192)	(0.0819)	(0.0419)	(0.0300)
lnindeg	-0.0652***	-0.106***	-0.0741***	-0.0630***
	(0.00444)	(0.0170)	(0.00901)	(0.00651)
lnoutdeg	-0.0826***	-0.0416***	-0.0590***	-0.0943***
	(0.00408)	(0.0152)	(0.00762)	(0.00661)
lnemp	-0.266***	-0.255***	-0.296***	-0.298***
	(0.00375)	(0.0131)	(0.00761)	(0.00648)
dlnsales	-0.255***	-0.318***	-0.346***	-0.237***
	(0.00720)	(0.0370)	(0.0168)	(0.0102)
supplier bankruptcy (t-1)	0.189**	0.679**	0.344**	0.0235
	(0.0877)	(0.269)	(0.166)	(0.136)
consumer bankruptcy (t-1)	0.0836	0.00566	0.121	0.00142
	(0.0781)	(0.308)	(0.162)	(0.109)
supplier merger (t-1)	-0.0625	0.0326	-0.121	-0.0542
	(0.0613)	(0.145)	(0.125)	(0.124)
consumer merger (t-1)	-0.0464	0.417*	-0.0234	-0.265*
	(0.0800)	(0.222)	(0.157)	(0.154)
supplier voluntary exit (t-1)	0.147*	-0.0229	0.370**	0.0274
	(0.0772)	(0.378)	(0.150)	(0.110)
consumer voluntary exit (t-1)	0.0530	0.510**	-0.171	-0.101
	(0.0784)	(0.220)	(0.159)	(0.127)
Constant	-6.294***	-5.929***	-6.324***	-6.868***
	(0.0873)	(0.292)	(0.168)	(0.124)
Observations	2,616,115	178,258	627,899	1,180,238

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1‘. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

Finally, Table 11 and Table 12 show the impact of exit of various types on the likelihood of a company’s exit through merger. Unlike bankruptcy or voluntary exit where a bankruptcy in some cases can lead to a higher likelihood of voluntary exit and vice versa, partner exit from bankruptcy or voluntary exit is not likely to increase the likelihood of merger. Instead, it is only when business partners exit through merger that a firm is likely to be merged as well. This fact holds for both supplier and consumer exit in nonmanufacturing (Table 11), suppliers exit in retail and wholesale, and consumers exit in construction (Table 12).

Table 11. Spillover from Partner Company Exit: Manufacturing vs. Non-manufacturing

	(1)	(2)	(1)
VARIABLES	Exit from Merger		
Industries	All	Manufacturing	Non-Manufacturing
lnage	-0.213***	-0.257***	-0.196***
	(0.00618)	(0.0123)	(0.00721)
lnage_exe	0.110***	0.100**	0.101***
	(0.0231)	(0.0485)	(0.0265)
d_change_exe	0.314***	0.284***	0.319***
	(0.0145)	(0.0300)	(0.0167)
lnindeg	0.00181	0.0565***	-0.00761
	(0.00559)	(0.0136)	(0.00622)
lnoutdeg	-0.0324***	-0.130***	-0.00894*
	(0.00466)	(0.0109)	(0.00521)
lnemp	0.146***	0.177***	0.136***
	(0.00396)	(0.00892)	(0.00446)
dlnsales	-0.145***	-0.163***	-0.139***
	(0.0128)	(0.0314)	(0.0142)
supplier bankruptcy (t-1)	-0.114	-0.123	-0.0930
	(0.166)	(0.345)	(0.189)
consumer bankruptcy (t-1)	-0.137	-0.339	-0.0778
	(0.159)	(0.395)	(0.174)
supplier merger (t-1)	0.192**	0.287	0.167*
	(0.0833)	(0.243)	(0.0902)
consumer merger (t-1)	0.178*	0.0602	0.211**
	(0.0925)	(0.200)	(0.105)
supplier voluntary exit (t-1)	0.112	0.117	0.129
	(0.134)	(0.292)	(0.151)
consumer voluntary exit (t-1)	0.171	0.178	0.172
	(0.124)	(0.275)	(0.140)
Constant	-3.237***	-3.048***	-3.238***
	(0.120)	(0.267)	(0.132)
Observations	3,393,380	766,646	2,616,115

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

Table 12. Spillover from Partner Company Exit: Non-manufacturing Sectors

	(1)	(2)	(3)	(4)
VARIABLES	Exit from Merger			
Industries	Non-Manufacturing	Retail	Wholesale	Construction
lnage	-0.196***	-0.236***	-0.234***	-0.178***
	(0.00721)	(0.0221)	(0.0128)	(0.0181)
lnage_exe	0.101***	0.0810	0.0615	0.126**
	(0.0265)	(0.0907)	(0.0471)	(0.0588)
d_change_exe	0.319***	0.329***	0.315***	0.301***
	(0.0167)	(0.0593)	(0.0303)	(0.0408)
lnindeg	-0.00761	-0.0926***	-0.115***	0.0790***
	(0.00622)	(0.0206)	(0.0119)	(0.0137)
lnoutdeg	-0.00894*	-0.00814	0.0884***	-0.102***
	(0.00521)	(0.0158)	(0.00990)	(0.0140)
lnemp	0.136***	0.213***	0.158***	0.170***
	(0.00446)	(0.0139)	(0.00913)	(0.0134)
dlnsales	-0.139***	-0.0851	-0.168***	-0.129***
	(0.0142)	(0.0699)	(0.0299)	(0.0286)
supplier bankruptcy (t-1)	-0.0930	-0.175	-0.699	0.245
	(0.189)	(0.740)	(0.444)	(0.325)
consumer bankruptcy (t-1)	-0.0778	0.428	0.229	-0.322
	(0.174)	(0.436)	(0.295)	(0.361)
supplier merger (t-1)	0.167*	0.591***	0.354**	-0.100
	(0.0902)	(0.183)	(0.161)	(0.363)
consumer merger (t-1)	0.211**	0.390	0.194	0.494**
	(0.105)	(0.294)	(0.238)	(0.208)
supplier voluntary exit (t-1)	0.129	-0.0421	-0.0347	0.413*
	(0.151)	(0.696)	(0.300)	(0.246)
consumer voluntary exit (t-1)	0.172	-0.509	0.0724	-0.213
	(0.140)	(0.695)	(0.287)	(0.380)
Constant	-3.238***	-2.981***	-2.838***	-3.817***
	(0.132)	(0.408)	(0.218)	(0.266)
Observations	2,616,115	178,258	627,899	1,180,238

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1‘. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

4.3. Determinants of Exit Types

Finally, we use the same probit regression for all industries to understand factors of each exit type. We make some interesting observations that some factors have different relationships in different types of exits (Table 13). For instance, merger and bankruptcy rate decreases with firm age, implying that younger firms are likely to go bankrupt or to be merged compared to older firms. However, for voluntary exits, the relationship is the opposite – older firms are more likely to exit

voluntarily. Also, a firm is less likely to go bankrupt if the firm changed the CEO, but the opposite is true for merger and voluntary exits. Having more firm-connections tend to decrease the probability of voluntary exits, indicating firms which are more connected and more necessary to society are less likely to exit. The same mechanism applies for merger if a firm has higher number of consumers, while having more suppliers lead to higher bankruptcy rates. There are some common determinants as well: for all types of exits, firms that are large, have stronger sales growth and have younger CEOs tend to have lower probability of exits.

Table 13. Determinants of Exits by Exit Type

VARIABLES	All Exit	Bankruptcy	Merger	Voluntary Exit
Firm Age	-0.0602***	-0.0558***	-0.213***	0.0472***
	(0.00340)	(0.00502)	(0.00618)	(0.00498)
CEO Age	0.600***	0.135***	0.110***	1.004***
	(0.0111)	(0.0157)	(0.0231)	(0.0162)
Change of CEO	0.169***	-0.102***	0.314***	0.154***
	(0.0102)	(0.0177)	(0.0145)	(0.0170)
Number of Suppliers	0.0202***	0.0777***	0.00181	-0.0678***
	(0.00279)	(0.00411)	(0.00559)	(0.00399)
Number of Consumers	-0.0466***	0.00478	-0.0324***	-0.0910***
	(0.00249)	(0.00367)	(0.00466)	(0.00365)
Employment	-0.100***	-0.0805***	0.146***	-0.257***
	(0.00212)	(0.00324)	(0.00396)	(0.00320)
Sales Growth	-0.266***	-0.189***	-0.145***	-0.277***
	(0.00537)	(0.00817)	(0.0128)	(0.00655)
Supplier Bankruptcy (t-1)	0.362***	0.587***	-0.114	0.145*
	(0.0553)	(0.0701)	(0.166)	(0.0781)
Consumer Bankruptcy (t-1)	0.288***	0.503***	-0.137	0.0991
	(0.0499)	(0.0633)	(0.159)	(0.0694)
Supplier Merger (t-1)	-0.0128	-0.0454	0.192**	-0.0589
	(0.0430)	(0.0685)	(0.0833)	(0.0569)
Consumer Merger (t-1)	0.0636	0.0504	0.178*	0.0168
	(0.0483)	(0.0744)	(0.0925)	(0.0660)
Supplier Voluntary Exit (t-1)	0.240***	0.244***	0.112	0.210***
	(0.0521)	(0.0782)	(0.134)	(0.0653)
Consumer Voluntary Exit (t-1)	0.0897*	0.0184	0.171	0.0734
	(0.0545)	(0.0865)	(0.124)	(0.0688)
Constant	-4.536***	-3.443***	-3.237***	-6.219***
	(0.0561)	(0.0862)	(0.120)	(0.0788)
Fixed-Effects	Y	Y	Y	Y
Observations	3,393,380	3,393,380	3,393,380	3,393,380

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See note in Table 4 for detailed description of the variables. Fixed-effects for industry, prefecture and year are included.

5. Policy implications

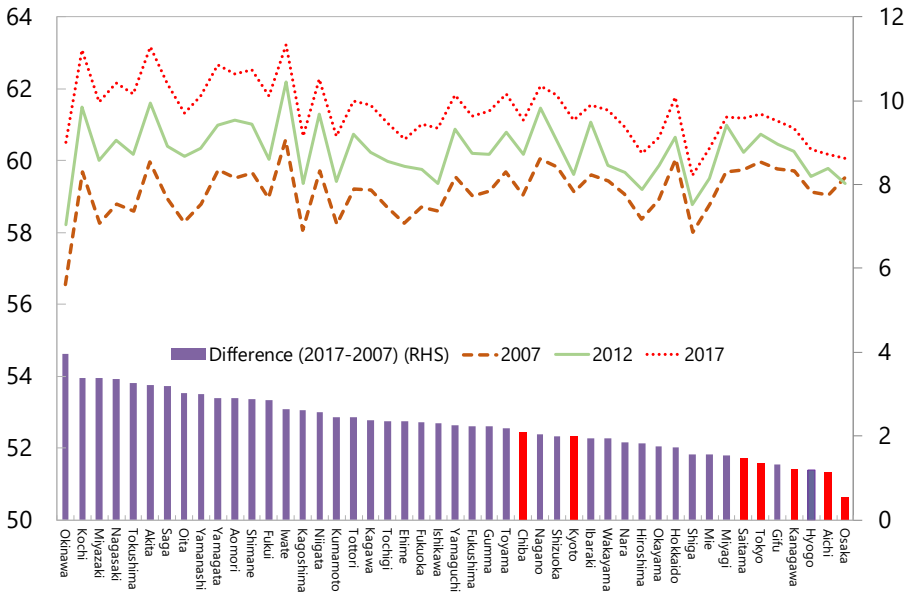
In this section, we briefly discuss the current policies by the Japanese government to address the issue of business succession and provide policy suggestions. In 2017, the Small and Medium Enterprise Agency formulated a 'Five-Year Plan for Business Succession,' to support business owners and SMEs to pass over their businesses to next generation CEOs. For business owners who have already identified business successors, the support has been mostly through tax measures, either deduction of tax rates or deferral of taxes. For instance, for the FY2018 and FY2019 tax reforms, the government introduced a system of 100 percent deferral of payment of inheritance tax and gift tax concerning the succession of land, buildings, machinery and equipment. For business owners who have not identified business successors, the government's support to find the right successor for retiring business owners has increased. This includes: (i) increasing awareness of the importance of business succession by sending financial institutions and professional experts to business owners, (ii) establishment of public centers for supporting business succession, (iii) establishment of special measures for SMEs which are funded by the business succession fund of the Organization for Small and Medium Enterprises and Regional Innovations (FY2019 tax reform), and (iv) reduction or exempt of registration license tax for M&A and real estate acquisition tax to support business succession to non-family members (FY2018 tax reform).[17] In December 2019, the Ministry of Economy, Trade and Industry published a package of policy-related measures to enlarge business successions from aged business owners to those who are not their relatives or employees working at their companies. Examples include the permission of access to information held by public centers for supporting business succession by private financial institutions and M&A companies, enhancement of cooperation between these centers and regional financial institutions to link business owners to potential new owners, and raising subsidies for business succession. The government aims 600,000 business owners can turn over their businesses to new owners in the coming decade through these measures.

Our analysis suggests that a greater support for firms' succession challenges in rural areas is essential. We find that voluntary exits of firms are correlated with age of CEOs and inter-firm connections. Firms in rural areas have more rapidly aging CEOs and less inter-firm connections

[17] The Small and Medium Enterprise Agency (2017, 2018, 2019) discuss motivations behind these measures introduced and plans going forward.

than those in urban areas. First, aging of CEOs is happening at a more rapid pace in rural areas compared to urban areas. Chart 13 compares the average age of CEOs by prefecture, comparing 2007, 2012 and 2017. CEOs are aging in all parts of Japan, as we see the upward shifts of lines from 2007 to 2017 for all prefectures. In 2017, prefectures with the oldest CEOs are Iwate, Kochi and Akita, where the average of age of CEOs exceed 63 years old of age. Prefectures with the youngest CEOs as of 2017 are Shiga, Osaka and Aichi prefectures where the average of age of CEOs is around 60 years old.[18] Another interesting observation from the chart is that CEOs in rural prefectures are aging faster than those in urban areas. The purple and red bars indicate the difference of average age of CEOs by prefecture, taking the difference between 2007 and 2017. Okinawa prefecture shows the largest difference and Osaka and Aichi prefectures show the smallest difference. Red bars indicate urban areas. We observe that urban areas are aging less rapidly than rural areas, in terms of the age of CEOs.

Chart 13. CEO Age by Prefectures (2007 vs. 2012 vs. 2017)

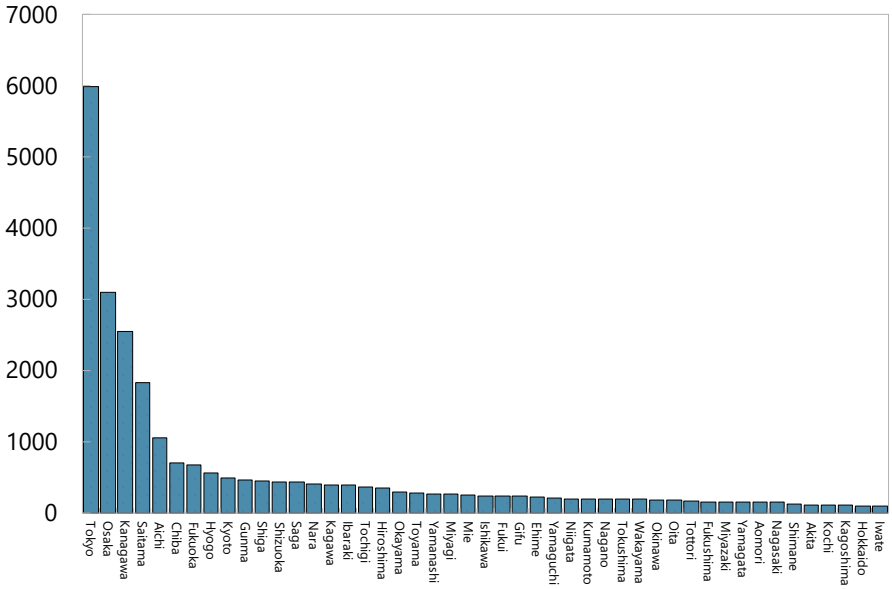


Note: Highlighted red bars indicate regions defined as 'urban' area in our analysis. 'Urban' areas cover the following prefectures: Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, and Kyoto. All other prefectures are defined as 'rural.' Left-hand axis represents the average age of CEOs. Right-hand axis represents the difference of the average age of CEOs in 2007 and 2017.

[18] Average age of CEOs in Tokyo is about 61 years old, which is about the median of all the prefectures in Japan.

Second, firms are much less densely populated in rural areas. Using the Grid Square Statistics from the Statistics Bureau of Japan that defines the whole area of Japan into small region using the latitude and longitude information, we define 'density of firms' as the total number of firms in ten square kilometers.[19] We find that the average number of firms in ten square kilometers in urban areas is about six times those in rural areas. For 2017, there are on average 1,343 firms in ten square kilometer in urban areas, but only 205 firms in rural areas. Furthermore, among urban areas, it is Tokyo and Osaka cities that exhibit the extreme concentration of firms, with Tokyo having close to 6,000 firms and Osaka close to 3,000 firms per ten square kilometers (Chart 14). About 40 out of 47 prefectures of Japan aside from the large metropolitan areas, the average number of firms per ten square kilometers is less than 500. This implies the difficulties in finding alternative partners to replace or to start new relationships in rural areas. That is, if a firm loses business partner(s) in the same production network, whether it be due to bankruptcy or voluntary exits, it is more difficult to find alternative business partners. This is due to the importance of geographical proximity in inter-firm network formation for Japanese firms, as shown in section 3.4.

Chart 14. Prefecture-Level Firm Density in 2017



Source: Tokyo Shoko Research, LTD

Note: Y-axis denotes the average number of firms per ten square kilometers by prefecture in 2017.

[19] We use the second digit mesh data. https://www.stat.go.jp/english/data/mesh/01.html

Finally, institutions or mechanisms that can reduce search frictions in matching retiring CEOs and business successors could reduce welfare losses from voluntary exits of potentially productive and profitable firms. Raising awareness of the importance of finding business successors and encouraging early preparation could also increase the likelihood of successful matching, although search costs should still be reduced to ensure efficient matching.

6. Conclusion

In this paper, we documented the changing exit patterns of Japanese firms, highlighting the recent increase of voluntary exits as old CEOs were not able to identify their business successors. Lower bankruptcy rates and the share of zombie firms suggests that health of Japanese firms, on average, has improved. However, an increase in voluntary exits due to business succession issues raises concerns. This can be amplified through a propagation through inter-firm supply chain network, as inter-firm relationship among Japanese firms tend to be persistent. We show empirically that this is the case, where firm exits, including voluntary exits, increase the probability of exits of other firms that are connected through firm network. As aging trend continues in Japan, adverse effects that arise from failing to identify business successors will only exacerbate going forward.

Policies to support business succession such as raising awareness of the importance of the issue, incentivizing non-family succession, and helping to improve matching between firms and potential successors are in the right direction. Our analysis further shows that more focus should be to regional firms, as regional firms are more likely to face these issues.

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Annex I. Summary Statistics

year	Total Number of Firms	non-SME	SME
2007	1,034,221	32,124	1,002,097
2008	1,055,557	36,854	1,018,703
2009	1,104,151	53,577	1,050,574
2010	1,158,362	70,153	1,088,209
2011	1,192,175	82,027	1,110,148
2012	1,240,063	92,951	1,147,112
2013	1,271,667	90,256	1,181,411
2014	1,264,155	88,684	1,175,471
2015	1,256,867	94,781	1,162,086
2016	1,281,440	100,869	1,180,571
2017	1,292,421	103,800	1,188,621

Source: Tokyo Shoko Research, LTD.

Note: Footnote 7 for the definition of an SME adopted in our analysis.

Annex II. Average Age of CEOs

		Region		Industry					
Year	Total	Rural	Urban	Construction	Manufacturing	Retail	Services	Wholesale	Other
2007	59.4	59.2	59.6	58.4	60.4	60.0	59.8	60.2	58.1
2008	59.5	59.4	59.7	58.5	60.6	60.4	60.0	60.5	58.3
2009	59.7	59.6	59.7	58.6	60.8	60.5	60.2	60.7	58.1
2010	59.9	59.8	59.9	58.8	60.9	60.7	60.4	61.0	58.2
2011	60.1	60.1	60.0	59.0	61.1	60.9	60.6	61.2	58.4
2012	60.2	60.3	60.1	59.1	61.3	61.1	60.8	61.4	58.5
2013	60.4	60.6	60.2	59.2	61.4	61.4	61.0	61.6	58.6
2014	60.6	60.7	60.3	59.3	61.5	61.5	61.2	61.8	58.9
2015	60.7	61.0	60.4	59.5	61.7	61.6	61.4	61.9	59.0
2016	60.9	61.2	60.6	59.8	61.8	61.8	61.6	62.1	59.1
2017	61.2	61.5	60.8	60.2	61.9	62.1	61.8	62.3	59.3

Source: Tokyo Shoko Research, LTD.