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Did the COVID-19 pandemic create more zombie firms in Japan?[1]

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Abstract

The COVID-19 pandemic constituted a massive shock to the Japanese economy, as in other countries, posing a significant threat to the business continuity of firms. Bankruptcy rates remain low, partly thanks to large government support, but it is unclear whether the pandemic worsened business dynamism and generated more zombie firms in Japan. In this paper, using firm-level balance sheet and exit information, we find that firm exit rates declined in general, including firms with weak balance sheets, suggesting that the cleansing mechanism, whereby a less productive firm exits to allow for a more productive firm to enter, weakened during the pandemic. Overall firm borrowing also increased during the pandemic, with particular increases in long-term borrowing. The share of zombie firms rose especially in the manufacturing sector.

Keywords: COVID-19, Zombie Firms, Corporate Balance Sheet, Government Support
JEL classification: D22, G33, L10, L14, R11

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1. Introduction

The COVID-19 pandemic constituted one of the largest economic shocks that countries faced since the World War II. Due to the outbreaks, the Japanese governments introduced several rounds of state of emergency measures including travel bans and physical distancing interventions. These timely and large supports saved lives but came at a cost of severe economic shock by constraining economic activities. Firms, especially small and medium-sized firms in contact-intensive sectors, were hit the hardest (Gourinchas et al. 2020, IMF 2022). Studies show that firm exits could have increased as much as 20 percent compared to the pre-pandemic levels without any government interventions (Miyakawa et al. 2021), with the supply chain amplifying the shock even more through a cascade of bankruptcies (Inoue and Todo, 2020).

The initial policy response by the Japanese government was swift and unprecedented in terms of size, with one of the largest fiscal support measures introduced in the world (IMF, 2022). Government interventions included spending (so-called "above-the-line" measures) on procurement, cash handouts, expansion of worker subsidies and "below-the-line" measures including large credit guarantees programs. Credit guarantee measures provide concessional loans and guarantees to affected firms though the public and private financial institutions, offering fully guaranteed loans.[1] While these measures were appropriate and timely and clearly were effective in saving firms as demonstrated by low bankruptcy rates as we will document in the following sections, concerns remain regarding the potential 'side-effects.' A prime example would be the loans and guarantees, if overly extended and overly generous even to firms that have insolvency issues, would contribute to zombie firms and dampen investment and productivity in the years ahead (Caballero et al. 2008).

As the economy starts to recover from the pandemic, it is important to assess the footprint the pandemic has left on Japanese firms. To this end, we ask the following two questions in this paper. The first is a backward-looking question on how the COVID-19 pandemic affected firm exits and how firms adjusted to the shock. The second question is a forward-looking one on how

[1] Ando et al. (2020) for more information on fiscal response by the Japanese government in the first six months of the pandemic.

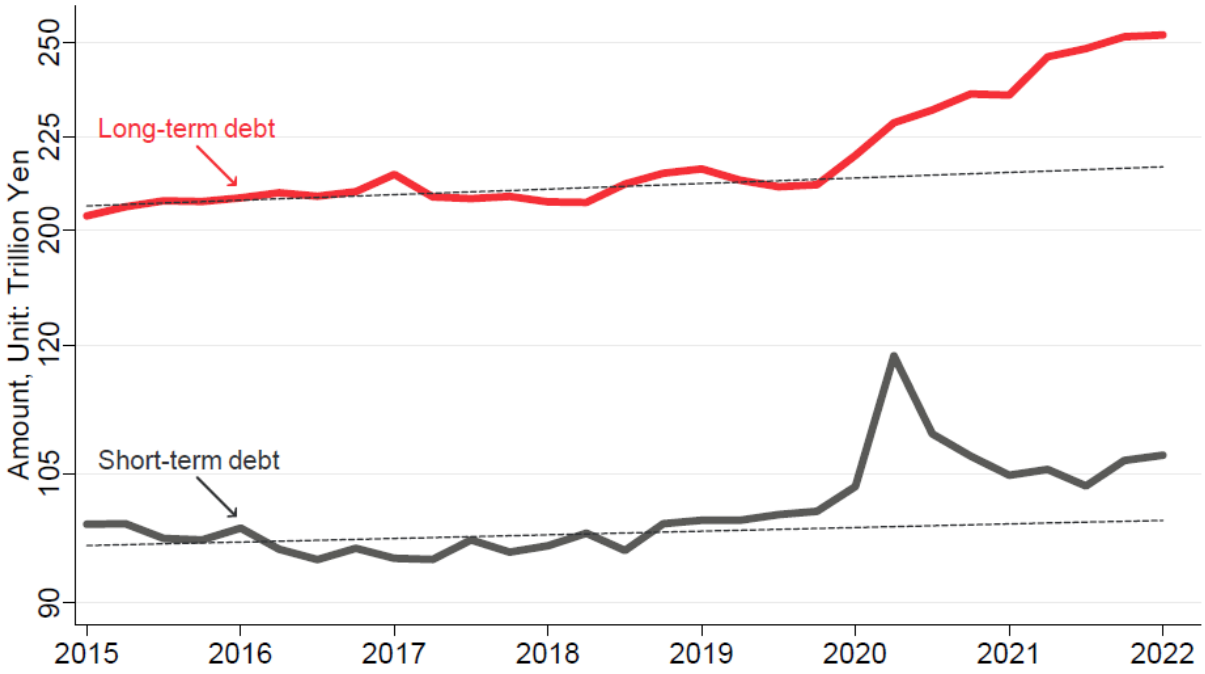
corporate balance sheet has been affected during the pandemic, especially in the context of zombie firms and what it implies for future investment and productivity.

In this paper, we draw upon a detailed firm-level dataset from Tokyo Shoko Research (TSR), covering around 1 million firms each year. This dataset provides rich information regarding the type of firm exits by distinguishing bankruptcy, voluntary exit or merger exit as well as firm characteristics. This information is available up to September 2021. In addition, for a subset of firms in the dataset, corporate balance sheet information on assets and liabilities are available covering up to December 2020.[2] In both datasets, while the end of fiscal year of the information differs depending on firms, the several months during the COVID-19 pandemic is covered, enabling us to examine the impact of COVID-19 on Japanese firm health, firm exits and how firms responded to the pandemic.

At the aggregate level, total corporate borrowing increased since 2020 (Figure 1). There is an interesting pattern for short-term corporate borrowing, as there is a sharp yet short-lived increase in the early phase of the pandemic in 2020. On the other hand, long-term debt has increased more steadily since 2020 compared to trend.

[2] Firm information, such as number of employees and sales, are collected by TSR and the timing of dataset provided is at the end of September for each year, from 2007 to 2021. The end of fiscal year for each firm differs and the timing of survey by TSR also differs. So, we have to restrict samples or control the timing to see the effect. Firm exit information is from October 2007 to September 2021. Exit rate of 2020, for example, is calculated number of firms exiting from October 2020 to September 2021 divided by number of total firms at the end of September 2020. On the other hand, the timing of corporate balance sheet information is more organized, i.e., the end of fiscal year is from January to December 2020 for the data 2020.

Figure 1. Corporate Borrowing: Short-Term Debt vs. Long-Term Debt



Source: Corporate Financial Statement, Ministry of Finance, Japan

Looking at the firm-level analysis, we first document firm exit patterns during the normal times (pre-pandemic) and during the pandemic and examine how firm characteristics affect a firm exit differently in different times. Unlike most studies, we distinguish firms' exit types, as not accounting for the type of firm exit misses out an important piece of information necessary to understand the lifecycle of firms in Japan (Hong et al., 2020). While there is a small number of firms that exit due to bankruptcy, most firm exits are voluntary exits (where owners decide to discontinue the business) (Hong et al., 2020). As we explain in greater details below, firm characteristics such as the size of firms, productivity and the age of owners, play an important role in determining how firms exit. Furthermore, we see that the cleansing mechanism weakened during the pandemic, as the negative correlation between firm's health and firm exit rate weakened compared to pre-pandemic years.

As for the forward-looking question, using firm-level balance sheet information, we examine firms' indebtedness and identify 'zombie' firms using a commonly used definition in the literature. We observe an uptick in the economy-wide zombification, with the share of zombie firms (or financially weak firms) considerably increased in the manufacturing sector and certain

service sectors compared to pre-pandemic trend. We also find that cleansing mechanism, which had been stronger for zombie firms compared to non-zombie firms in normal times, have further strengthened during the pandemic. This has made relatively-in-good-shape zombie firms have more chance to remain in business, resulting in lower exit ratios of zombie firms in 2020.

Our paper contributes to two strands of research literature relating to the corporate sector. First is the burgeoning literature on the impact of COVID-19 on corporate balance sheet. To name a few, Gourinchas et al. (2020, 2021) estimates the impact of COVID-19 on SME bankruptcies using a cross-country firm-level database. Bloom et al. (2021) documents the potential impact the pandemic would have on firm productivity. Our paper separates from these previous studies by using the realized outcomes during the several months of COVID-19 instead of using simulations based on pre-pandemic firm-level database. Second, our paper also contributes to the relatively under-researched area of firm exits by exit type with the exception of Hong et al. (2021). Previous studies have focused on distressed firms and how different types of exits (bankruptcy, voluntary liquidation and M&A) are suitable for firm depending on its characteristics. Harhoff et al. (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. Doi (1999) studies the determinants of firm exit focusing on the Japanese manufacturing firms from 1981 to 1989. 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.

Our paper is organized as follows. Section 2 describes the dataset that we use for the analysis. Section 3 documents how firm exit patterns were affected during the pandemic shock, by differentiating types of exits. We also ask whether the pandemic shock affected the cleansing mechanism. Section 4 examines the changes in corporate indebtedness and zombie firms during the pandemic. Section 5 concludes with policy implications.

2. Data Description

For our analysis, we draw upon the data set provided by Tokyo Shoko Research, LTD (TSR, hereafter). This is a rich longitudinal firm-level data for both listed and unlisted Japanese firms. There are two subsets of the TSR datasets that we use. The first one is a dataset of more than one

million firms with firm exit information and other basic information that will be explained at a greater detail in the following paragraph. The latest point of this dataset is 2020 for firm basic information and 2021 for firm exit information. The second data set is the annual balance sheet information for a subset of firms covered in the first dataset and the latest point of this data is 2020. For instance, the latest dataset covers the balance sheet of about 390,000 firms. The end of fiscal year differs depending on each firm. The first dataset is provided at the end of September and the information is collected before the time point. Then, in order to calculate the exit rate for 2020 dataset, we use the number of firms exited from October 2020 to September 2021. On the other hand, for the second dataset, the dataset of 2020 includes information with the end of fiscal year from January 2020 to December 2020. Both datasets include the crucial months of the COVID-19 outbreak and their impact on firm exits and firm balance sheets.

Firm information included in the first dataset are the basic information for each firm, including industry classification (Japanese Standard Industrial Classification 4-digit), address of the firm location, number of employees, total sales amount, the year of establishment, CEO's name and his/her birth date and credit score estimated by TSR.[3] About 91 percent of total firms are small and medium-sized enterprises (SMEs) in the 2017 dataset.[4] Importantly, the data set contains monthly information on firm exits. For the firms that exited, the TSR provides information how a firm exited, i.e. type of firm exits, which can be categorized into three groups: *tosan* (bankruptcy), *gappei* (merger), and voluntary exit.[5] For the second dataset, corporate balance sheet information contains

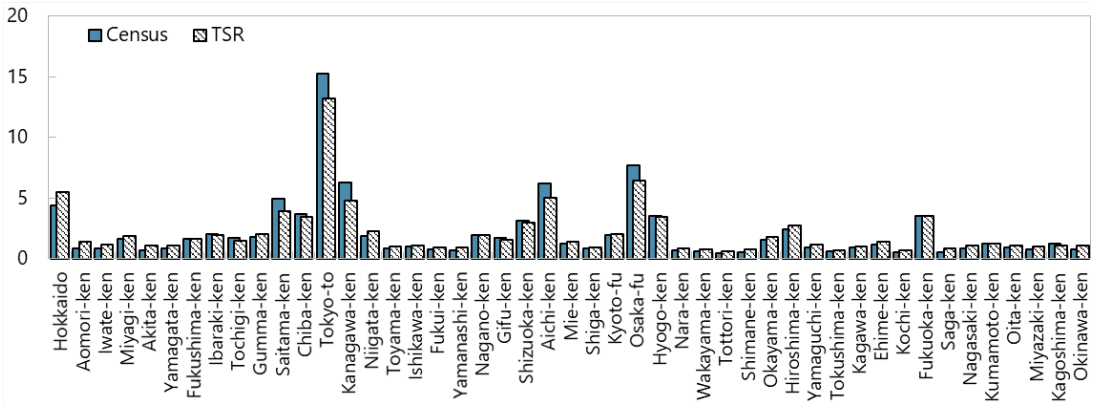
[3] See Carvalho et al. (2017) and Bernard, Moxnes, and Saito (2019) for more details on TSR data.

[4] 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 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. However, due to availability of dataset, we only use information of the number of employees as follows. 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.

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

a detailed breakdown of assets (i.e. tangible, intangible, current) and liabilities (i.e. bonds, short-term debt, long-term debt).

Figure 2. Comparison of Geographical Distribution: Census Data vs. TSR data



Sources: Statistics Bureau of Japan, 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.

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 comparing the distributions of firms by prefecture and by firm size using both the TSR data and the Census data. Figure 2 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 Statistics Bureau of Japan. The percentage figures based on the TSR dataset are close to the ones based on the Census survey for most of prefectures.[6] Table 1 shows the comparison of the distributions of firms by firm size using the Census survey and the TSR dataset. The distribution of firm sizes using the TSR data closely resembles that using the Census data. The largest gaps are found for micro-enterprises where the number of employees per firm is less than 5 persons. However, if we adopt an alternative grouping of these firms (for instance, less than 10 employees), the gap between the two datasets decreases.

[6] Exceptions include Tokyo, Kanagawa, Osaka, Aichi, and Hokkaido, where there exist small differences ranging from 1 to 2 percentage points between them.

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: Statistics Bureau of Japan, 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. Firm Exit Patterns in Japan: Normal times vs COVID-19

In this section, we document firm exit patterns, the cleansing mechanism, and how firm characteristics are correlated with firm exit rates by exit types, comparing the times before COVID and during COVID.

3.1. Firm Exit Patterns over Time

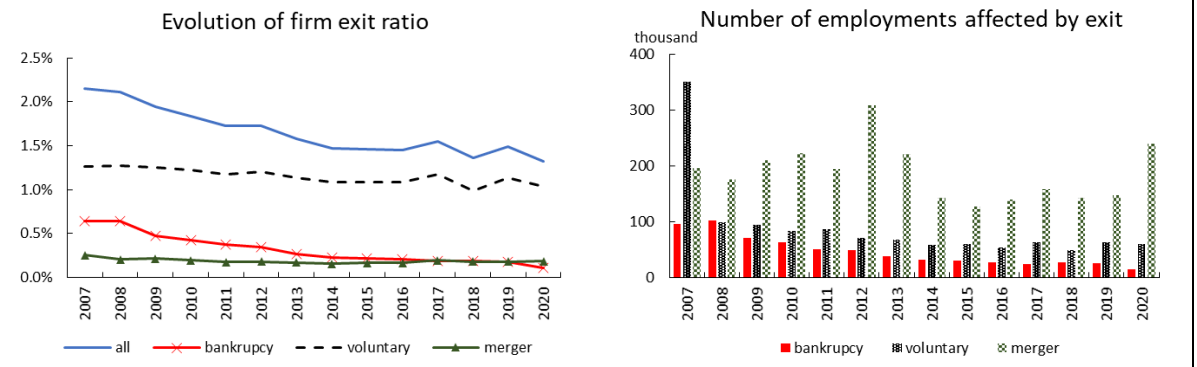
The overall firm exit rate in Japan is very low at below 2 percent and has been on a downward trend (Figure 3, left panel). This is much lower compared to other advanced countries, such as the United States (10 percent) and European countries (7 percent on average), suggesting that business dynamism is quite dormant in Japan.[7] The majority of firm exits in Japan are voluntary exits where the owners of firms decide to discontinue their businesses even when they are not forced to close their businesses for financial reasons. The relatively high share of voluntary exits in Japan is correlated with the aging of owners, where old owners cannot secure business successors (Hong et al., 2020). Bankruptcy rates, on the other hand, have been on the downward trend and remain very low (below 0.6 percent) since the late 2000s and remained so throughout the pandemic. Firm exits through mergers are at very low levels, at around 0.2 percent. In terms of the effects on the labor market, mergers explain the largest share, compared to other exit types (Figure 3, right panel).[8] In 2020, the total number of employees affected by mergers are more than quadruple the total number of employees affected by voluntary exits, implying that voluntary exits are likely for small firms and mergers are for large firms, consistent with the

[7] Source: Bureau of Labor Statistics for the US, OECD and Eurostat for the European countries

[8] The deviation in the total number of employees affected by voluntary exit in 2007 is caused by one big firm.

findings Hong et al. (2020). Bankruptcies are shown to have the smallest impact on employment among all exit types.

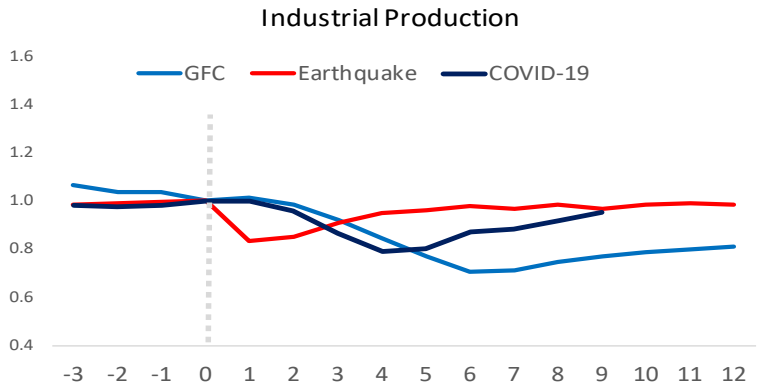
Figure 3. Firm Exit Rates and Total Number of Employees Affected by Exit Type



Sources: Tokyo Shoko Research, LTD and authors' calculations.

During the period covered by the data, we had several economic shocks in addition to COVID-19 pandemic. In particular, we had another two major economic events associated with significant economic downturns in Japan: the Lehman Shock (or the Global Financial Crisis), and the 2011 Tohoku earthquake. Figure 4 compares the aggregate output across the three episodes using the monthly index of industrial production before and after each shock. The index of industrial production is a commonly used indicator collected by the Ministry of Economy, Trade and Industry (METI) based on a survey of production of (relatively large) manufacturing establishments. We see a decrease in production and recovery in each episode, albeit of varying shapes. Compared to the output contraction during the earthquake, the impact of COVID-19 on output was more delayed. The economic contraction was largest and most persistent for the GFC. Taking the low firm exits in Figure 3 and a large drop in output from Figure 4, we can infer that Japanese firms respond to economic shocks predominantly through intensive margin adjustment (production/output) rather than extensive margin adjustment (exits).

Figure 4. Index of Industrial Production: GFC vs. Tohoku Earthquake vs. COVID-19



Footnote: X-axis represents the number of months before and after the time of the major event. Time t=1 denotes the month when the major event broke out and refers to September 2008, March 2011 and February 2020 for the GFC, the Tohoku Earthquake and the COVID-19, respectively. Y-axis represents the Index of Industrial Production (IIP) for each month, normalized by IIP at time t=0.

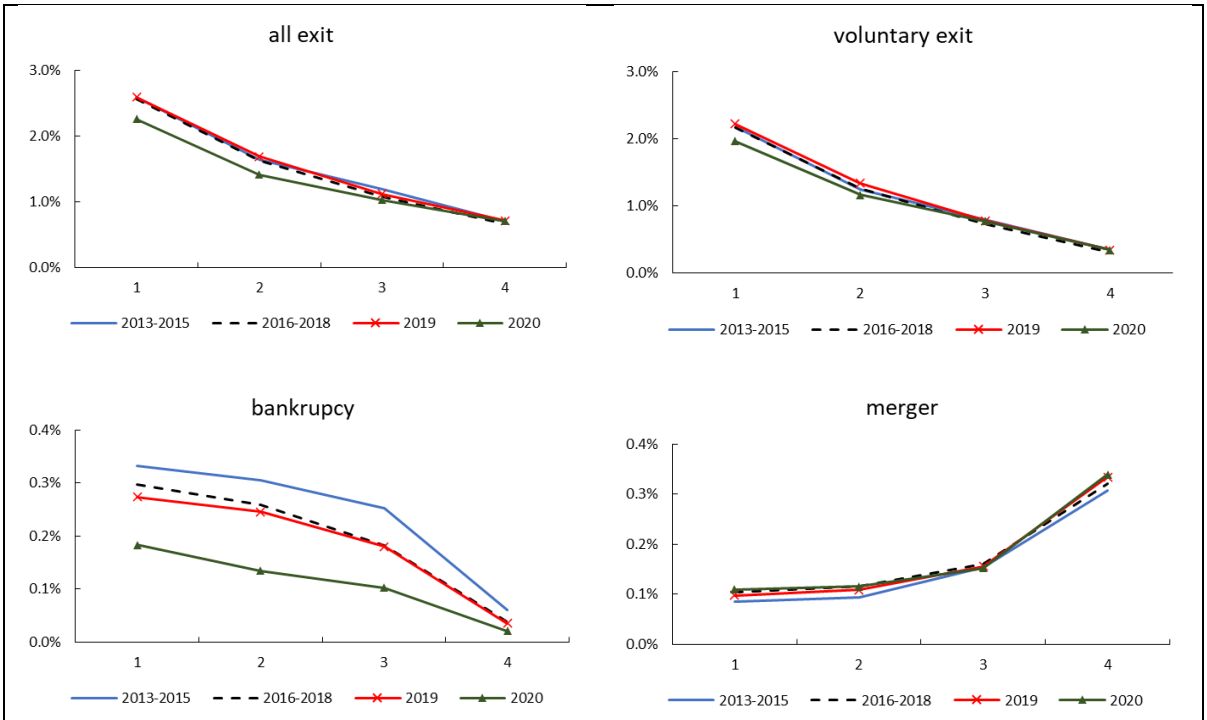
3.2. Firm Exit Patterns and Cleansing Effects

How did the pandemic shock affect the cleansing mechanism? The cleansing mechanism is the key argument for large economic shocks, which may contribute to an improvement of aggregate productivity by letting weaker firms exit (Foster et al., 2014). To answer this question, we first focus on credit score measure (hereafter, "score") constructed by TSR to see firm healthiness and compare its correlations with firm exit rate before and during the pandemic.[9] Figure 5 shows overall exit rate, voluntary exit rate, exit rate due to bankruptcy and exit rate due to merger by credit score quantiles. We average exit rates of three years from 2013 to 2015 (the solid blue line) and those from 2016 to 2018 (the dot black line) to show pre-pandemic values, and two exit rates of single year, 2019 (the x-mark red line) and 2020 (the triangular mark green line). X-axis denotes bins separated by quantiles of a firm's score. The thresholds for the first, second and third quantiles are 43, 46 and 50 respectively and these thresholds are stable across different years. Here, as mentioned before, timing of exit for the year *y* is from October of year *y* to September of the year *y+1* since the timing of firm information dataset is the end of September. For example, exit rate of 2020 is calculated by the number of firms exited from October 2020 to September 2021 divided by the number of firms at the end of September 2020. As for the exit

[9] TSR 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.

rate of 2019, we capture firm exit from October 2019 to September 2020 which includes pre-pandemic period and the effect of pandemic might appear smaller than as it is.

Figure 5. Correlation of firm exit rate with firm healthiness



Source: Tokyo Shoko Research, LTD and authors' calculations.
Note: Firms are categorized in quantiles based on the score measure. Bin 1 represents firms in the lowest quartile of each variable. Firms are healthier with higher scores.

As we saw in Figure 3, the majority of firm exit in Japan is voluntary exit, driving the trend of overall exit. Healthier firms with higher scores exhibit lower voluntary exit rates shown as a downward slope in the figure. The slope didn't change in 2019 but becomes gentler in 2020, with a decrease in the voluntary exit rates for firms with score below the 25th percentile. Meanwhile, bankruptcy rates have declined over time. The decline was significantly larger for all level of score in 2020 during the pandemic, but particularly for lower score bins. This implies a considerably decrease (in relative terms) in bankruptcy rates of firms during the pandemic, especially for less healthy firms. On the other hand, exit rate due to merger has positive correlation and it increases slightly during the pandemic. Overall, if we can infer the degree of cleansing mechanism based on simple visual correlations between firm exits and firm

healthiness, the pandemic weakened the cleansing mechanism dramatically for firms exiting through bankruptcy and, to a lesser extent, through voluntary exit during the pandemic.

We conduct a simple regression analysis to make this point. Table 2 shows the OLS fixed-effect regression testing the correlation between firm exit rate and firm characteristics from 2013 to 2020, using the score, firm size, labor productivity, sales growth, and the age of owners. For each regression, we introduce a single term of each firm characteristic and a cross-term that interacts the firm characteristic with a dummy variable, "d_COVID", that takes value 1 for the year of 2019 and 2020 and value 0 otherwise. [10] First, Panel A shows the correlation of exit rates with firm healthiness measured by credit score. Controlling for industry-fixed effects at two digits, prefecture and year, we see a negative coefficient for the score and a positive coefficient for the cross term between the score measure and the COVID dummy for all exit types except for merger. Both coefficients are statistically significant. This finding is consistent with the properties observed in Figure 5 and supports the argument that the cleansing mechanism weakened during the pandemic, as compared to pre-COVID period, firm exits are less associated with firm health during COVID. In other words, the positive sign of the cross terms means that unhealthy firms which exited more than healthy firms in normal time tend to exit less during COVID. As for exit by merger, healthy firms tend to exit more and such effect is strengthened during COVID and total exit rate by merger slightly increased during COVID, as we see in Figure 5.

Panels B, C, D and E in Table 2 show the correlations with other firm characteristics, such as, firm size by number of employees, firm productivity by sales per employee, firm performance by sales growth, and CEO age, respectively. We see that smaller firms, less productive firms, firms with lower growth and firms with older CEOs tend to exit more in total. For most of the regressions, the cross-terms show the opposite sign, implying firm characteristics matter less during COVID, except for CEO age. Since the total exit rate decreases during COVID, the fact that the sign changes for the cross-terms compared to the stand-alone terms suggests that exit probability of small firms, low productive firms, low growth firms during COVID has declined compared to in normal time. The results corroborate the finding of Panel A of a weakened

[10] As mentioned earlier that 2019 data partially included a pre-pandemic period, we conduct a robustness check by using separate dummies for 2019 and 2020 instead of the combined d_COVID dummy. The results are presented in Appendix Table 1. We find that in most of the cases, the effect is stronger in 2020, which is consistent with the effect observed in Figure 5.

cleansing mechanism, especially where less productive firms and firms with lower growth find it easier to remain in the market than in normal times.

The results of the CEO age (Panel E) behave somewhat differently from other characteristics, as the correlation before the pandemic was strengthened, not weakened, during COVID, suggested by the same sign of coefficients for both stand-alone terms and cross terms. More specifically, the positive coefficients of the stand-alone terms for all exits, bankruptcy and voluntary exits imply that older CEOs are likely to exit voluntarily or through bankruptcy even during normal times, consistent with the previous findings in Hong et al. (2020). The positive coefficients for the cross-terms shows that this tendency strengthened during COVID.

The results in Table 2 show that the correlations of merger exits are different from those for other types of exits. For instance, we observed that healthy firms exit more by merger in Panel A. In Panels B, C, D and E, we see that big firms, high productive firms, and firms with younger CEOs tend to exit more in normal times from the coefficient of single term. Meanwhile, firms with low sales growth are more likely to exit through merger, similar to other types of exit. It is possible that acquirers perceive these firms to have a higher growth potential as long as these firms are healthy and productive. The cross terms have the same signs with the stand-alone coefficients, except for CEO age (Panel E) and are insignificant for productivity (Panel C). This shows that firm characteristics such as healthiness, firm size, and performance mattered more for mergers during COVID, while firms with older CEO who exit less by merger in normal times exited more during COVID. While most of the findings are intuitive, the positive correlation between labor productivity and bankruptcy is surprising, and more work is needed to understand this finding.

Table 3 shows the regression analysis for the subgroup of industry, location, and firm size to examine if the cleansing mechanism of less healthy firms exit and the impact of COVID differed based on these characteristics. Specifically, we compare the results between the manufacturing sector versus the non-manufacturing sector, the core regions (urban areas) versus the periphery regions (rural areas), and SME versus non-SME.[11] The results confirm similar properties for exit for all, bankruptcy and voluntary exits, i.e. firms with lower scores tend to exit in normal time

[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.

and such tendency was weakened during COVID. The exception is the insignificant cross terms for exit in total and bankruptcy for manufacturing sector, suggesting cleansing mechanism among manufacturing firms was not weakened during the pandemic. For exit by merger, the general finding of healthier firms exit through merger holds in all cases, with COVID-19 seems to have strengthened this exit type among healthier firms in nonmanufacturing sector, periphery regions, and non-SMEs firms.

Our findings contribute to a growing literature documenting patterns of bankruptcies and firms closures during the pandemic. We find a weakening cleansing mechanism during COVID-19—lower exit rates with less healthy firms continue to remain active—in line with the findings of recent studies documenting lower exit rates and suggesting an important role of the government support for this phenomenon (Banerjee et al., 2021; Orlando and Rodano, 2022; Nguyen et al., 2022). Moreover, we discover the different patterns of exit types: while exit rates and cleansing mechanism by bankruptcy and voluntary exit have declined during the pandemic, exit by merger was actually strengthened. A very preliminary explanation could be firms exiting by merger had their business relatively in a good shape to receive support from the government, but at the same time they also faced difficulties during COVID and thus more likely to consider M&A deals. However, more rigorous analysis is warranted to understand the background behind this phenomenon.

Table 2. Regression of Firm Exit Rate on Firm Characteristics

Panel A: firm healthiness by score

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
score	-0.00131***	-0.000197***	-0.00125***	0.000133***
	(7.60e-06)	(2.79e-06)	(6.58e-06)	(2.65e-06)
d_COVID_score	0.000146***	5.14e-05***	7.77e-05***	1.73e-05***
	(1.45e-05)	(5.32e-06)	(1.26e-05)	(5.06e-06)
Fixed-Effects	Y	Y	Y	Y
Observations	10,244,978	10,244,978	10,244,978	10,244,978

Panel B: firm size by the number of employees

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
lnemp	-0.00486***	-7.66e-05***	-0.00572***	0.000940***
	(3.66e-05)	(1.39e-05)	(3.15e-05)	(1.27e-05)
d_COVID_lnemp	0.000513***	-5.79e-05**	0.000427***	0.000145***
	(6.72e-05)	(2.55e-05)	(5.78e-05)	(2.33e-05)
Fixed-Effects	Y	Y	Y	Y
Observations	9,707,705	9,707,705	9,707,705	9,707,705

Panel C: productivity by sales per employee

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
lnlp	-0.00621***	0.000200***	-0.00697***	0.000556***
	(4.08e-05)	(1.59e-05)	(3.51e-05)	(1.38e-05)
d_COVID_lnlp	0.000154**	-0.000161***	0.000301***	1.37e-05
	(7.44e-05)	(2.89e-05)	(6.40e-05)	(2.51e-05)
Fixed-Effects	Y	Y	Y	Y
Observations	9,529,472	9,529,472	9,529,472	9,529,472

Panel D: firm performance by sales growth

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
lngrowth_sales	-0.0106***	-0.000893***	-0.00962***	-7.98e-05**
	(0.000119)	(4.57e-05)	(0.000102)	(3.99e-05)
d_COVID_lngrowth_sales	0.00129***	0.000410***	0.00103***	-0.000149*
	(0.000238)	(9.14e-05)	(0.000205)	(7.99e-05)
Fixed-Effects	Y	Y	Y	Y
Observations	9,305,221	9,305,221	9,305,221	9,305,221

Panel E: CEO age

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
age_exe	0.000541***	7.02e-06***	0.000556***	-2.23e-05***
	(4.34e-06)	(1.75e-06)	(3.73e-06)	(1.43e-06)
d_COVID_age_exe	5.31e-05***	6.56e-06*	3.93e-05***	7.24e-06**
	(8.81e-06)	(3.55e-06)	(7.56e-06)	(2.89e-06)
Fixed-Effects	Y	Y	Y	Y
Observations	7,209,082	7,209,082	7,209,082	7,209,082

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

Table 3. Regression of Firm Exit Rate on Firm healthiness for subsamples

Panel A: All Exit

VARIABLES	Exit Dummy					
	MANU	NONMANU	CORE	PERIPHERY	SME	NONSME
score	-0.00133***	-0.00131***	-0.00128***	-0.00134***	-0.00140***	-0.00122***
	(2.05e-05)	(8.20e-06)	(1.18e-05)	(9.98e-06)	(8.24e-06)	(2.29e-05)
d_COVID_score	2.70e-05	0.000162***	0.000119***	0.000166***	0.000142***	0.000278***
	(4.06e-05)	(1.56e-05)	(2.25e-05)	(1.90e-05)	(1.58e-05)	(3.87e-05)
Fixed-Effects	Y	Y	Y	Y	Y	Y
Observations	1,235,919	9,009,059	4,352,470	5,892,507	9,459,769	785,208

Panel B: Bankruptcy

VARIABLES	Bankruptcy					
	MANU	NONMANU	CORE	PERIPHERY	SME	NONSME
score	-0.000318***	-0.000178***	-0.000198***	-0.000197***	-0.000207***	-0.000116***
	(9.37e-06)	(2.89e-06)	(4.62e-06)	(3.45e-06)	(3.11e-06)	(4.29e-06)
d_COVID_score	7.74e-05***	4.87e-05***	5.06e-05***	5.16e-05***	5.20e-05***	3.56e-05***
	(1.86e-05)	(5.49e-06)	(8.82e-06)	(6.57e-06)	(5.98e-06)	(7.24e-06)
Fixed-Effects	Y	Y	Y	Y	Y	Y
Observations	1,235,919	9,009,059	4,352,470	5,892,507	9,459,769	785,208

Panel C: Voluntary Exit

VARIABLES	Voluntary Exit					
	MANU	NONMANU	CORE	PERIPHERY	SME	NONSME
score	-0.00118***	-0.00126***	-0.00126***	-0.00125***	-0.00132***	-0.00102***
	(1.65e-05)	(7.17e-06)	(9.83e-06)	(8.87e-06)	(7.15e-06)	(1.93e-05)
d_COVID_score	-2.03e-05	8.86e-05***	6.79e-05***	8.49e-05***	7.93e-05***	0.000162***
	(3.27e-05)	(1.36e-05)	(1.88e-05)	(1.69e-05)	(1.37e-05)	(3.25e-05)
Fixed-Effects	Y	Y	Y	Y	Y	Y
Observations	1,235,919	9,009,059	4,352,470	5,892,507	9,459,769	785,208

Panel D: Exit by Merger

VARIABLES	Merger					
	MANU	NONMANU	CORE	PERIPHERY	SME	NONSME
score	0.000162***	0.000128***	0.000176***	9.84e-05***	0.000126***	-9.04e-05***
	(7.96e-06)	(2.81e-06)	(4.63e-06)	(3.10e-06)	(2.73e-06)	(1.18e-05)
d_COVID_score	-3.00e-05*	2.45e-05***	4.21e-07	2.97e-05***	1.03e-05**	8.05e-05***
	(1.58e-05)	(5.35e-06)	(8.83e-06)	(5.91e-06)	(5.24e-06)	(1.99e-05)
Fixed-Effects	Y	Y	Y	Y	Y	Y
Observations	1,235,919	9,009,059	4,352,470	5,892,507	9,459,769	785,208

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

4. Corporate health during COVID-19: a glance at zombification situation

As cleansing mechanism weakened during the pandemic, concerns of an increase in zombie firms, mainly due to government support during COVID-19, are gradually raised. Previous studies show that generous government support to continue to lend to financially vulnerable firms have resulted in insolvent and zombie firms, detrimental to aggregate investment, employment and productivity. During the COVID-19 pandemic, these concerns again arose that too generous support would lead to the zombification of firms by providing lifelines to financially weak firms (Barnes et al. (2021)). However, utilizing a large sample of SMEs located in 14 European countries, Demmou and Franco (2021) challenges this idea, indicating that only a small share of firms (4-8 percent) receiving support during COVID could be classified as insolvent. In this section, we contribute to the literature by documenting the share of insolvent firms across firm size and industry over time in Japan to better understand the overall impact of the COVID-19 pandemic and related government measures on corporate health.

Different methodologies have been introduced in the literature to define a 'zombie firm,'—insolvent firms whose balance sheets are too weak to pay up its debt. [12] Here, we compare three different methodologies used in the literature particularly relevant to Japanese firms: (1) Caballero, Hoshi, and Kashyap (2008, hereafter CHK); (2) Fukuda and Nakamura (2011, hereafter FN); and (3) Imai (2016). 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, indicating firms receiving subsidized credit as a zombie. On the other hand, FN consider profitability into the CHK definition by adding 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 ever-greening. 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] Adalet et al (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* from the Bank of Japan,[13] $\min(r_{t-5}^{cb}, \dots, r_{t-1}^{cb})$ 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 the actual interest payment is lower than the minimum required interest payment for a firm, i.e. $I_{i,t}^{*} > I_{i,t}$, where $I_{i,t}$ is actual interest paid by firm *i* in year *t*. FN defines a firm to be a zombie firm if its profitability could not cover the minimum required interest payment $EBIT_{i,t} < I_{i,t}^{*}$ and the firm meets at least one of the financial support criteria of interest payments (CHK) and ever-greening, i.e. higher borrowing and total debt larger than a fifth of total asset ($B_{i,t} > B_{i,t-1}\ and\ D_{i,t-1} > 0.2A_{i,t-1}$). $EBIT_{i,t}$ denotes earnings before interest and taxes for firm *i* in year *t*; $B_{i,t}$, $D_{i,t}$, and $A_{i,t}$ are the amount of bank borrowing, outstanding debt, and total assets of firm *i* at the end of year *t*. Finally, Imai (2016) defines a firm to be a zombie firm if a firm violates the profitability criterion for at least 4 continuous years, i.e. $\sum_{m=0}^{3}\left(EBIT_{i,t-m} - I_{i,t-m}^{*}\right) < 0$ and ($B_{i,t} > B_{i,t-1}\ or\ I_{i,t} < I_{i,t}^{*}$).

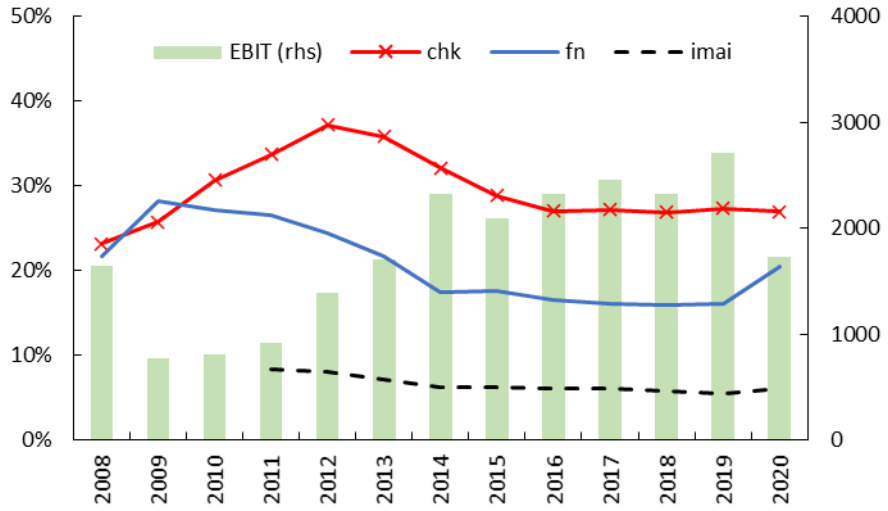
4.1. Transition of zombie in Japan in recent years

[13] Source : https://www.boj.or.jp/en/statistics/dl/loan/prime/prime.htm/

The result of zombie calculations is presented in Figure 6. Prior to the pandemic, we observe a declining trend after peaking at the Global Financial Crisis, attributable to various factors, including a decline in market rates since the Abenomics and corporate restructuring efforts. However, the share of zombie firms in 2020 is essentially flat for the CHK and Imai methods, but sharply increased for the FN method. The difference mainly reflects a steep decline in earnings of Japanese companies in 2020 due to the pandemic, which is taken into account in FN method but not the other two.

Given the limited sample period, Imai zombie ratio starts only in 2011, where we observe a continued decline over the years since the first observation. As CHK does not impose any filtering based on firm profitability, the share of zombie firms using CHK is much higher than those using FN and Imai. As a result, 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 non-performing loan issues and forbearance lending practices in 1990s. Our preferred methodology is FN, as Imai's definition puts more constrain on data coverage than the FN measure. Thus, all analysis of this paper onward relating to zombie firms will utilize the FN methodology for zombie definition.

Figure 6. Share of zombie firms using different methodologies



Source: Tokyo Shoko Research, LTD and authors' calculations.
Note: 'CHK' uses the zombie definition by Caballero, Hoshi, and Kashyap (2008), 'FN' uses the definition by Fukuda and Nakamura (2011) and Nakamura and Fukuda (2013), and 'Imai' uses the definition by Imai (2016). EBIT refers to median of earning before interest and tax. Y-axis refers to the ratio of zombie firms and x-axis refers to the years.

We look further to industry disaggregated data to see the zombie development among different industries. Figure 7 shows the difference of zombie ratio by manufacturing sector and non-manfacturing sector and by SME and non-SME. We see that the share of zombie firms sharply increased during COVID for both small and large firms in manufacturing sector (left chart) while only withnessed an uptick for non-manufacturing firms (right chart). Interestingly, SMEs in general have higher ratio of zombies compared to non-SMEs in manufacturing and in non-manufacturing and the differences in zombie ratio by firm size is also larger in non-manufacturing. The findings are consistent with Goto and Wilbur (2019), who also found a higher zombie ratio for manufacturing and smaller firms.

Note that there is a significant divergence across sectors in terms of economic impact from the pandemic even within the non-manufacturing sector[14].

Figure 7. Share of zombie firms: manufacturing vs. non-manufacturing and SME vs non-SME

Source: Tokyo Shoko Research, LTD and authors' calculations.

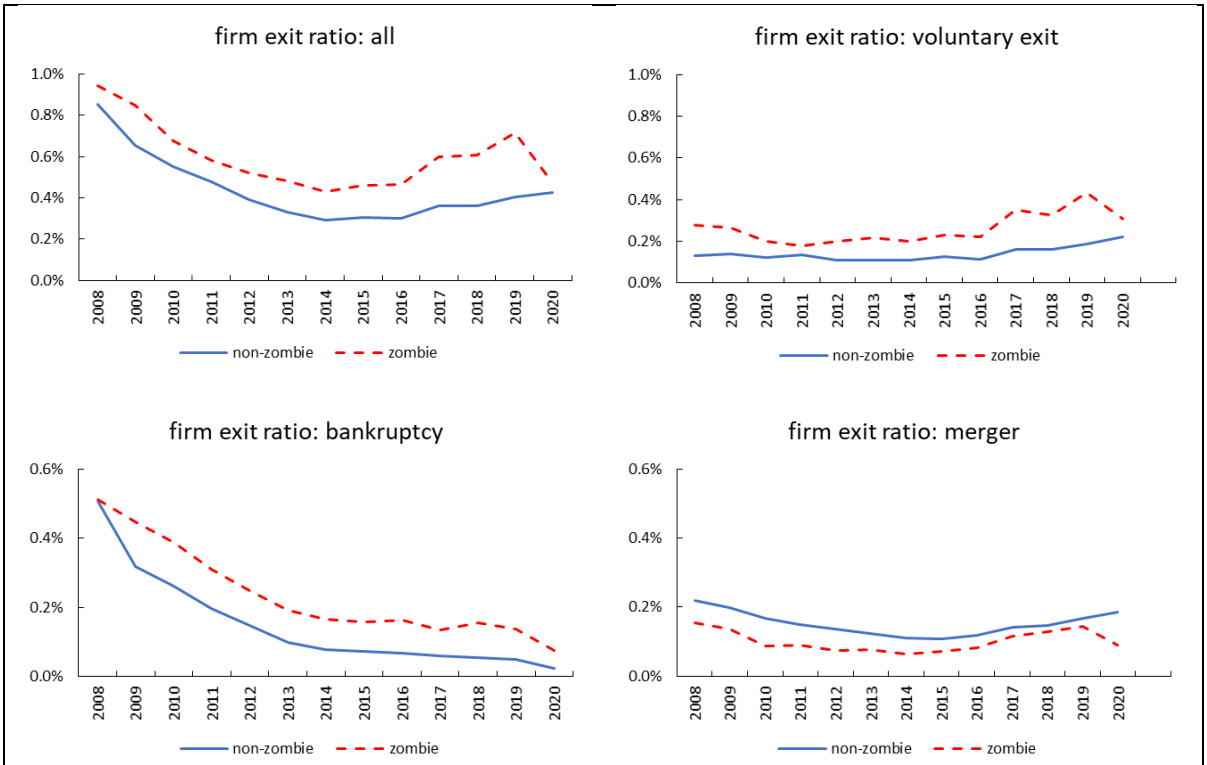
Note: The definition of a zombie firm follows Fukuda and Nakamura (2011) and Nakamura and Fukuda (2013). X-axis refers to the years. The y-axis of the left chart shows the ratio of zombie firms by manufacturing and non-manufacturing sectors.

[14] Most affected industries in non-manufacturing sectors are contact-intensive sectors, namely, 'accommodation, eating and drinking,' 'retail,' 'transportation,' and 'wholesale,' and we see the largest increases in the share of zombie firms if we compare the year 2020 with the preceeding 3 years.

4.2. Market exit of zombies

The increase in zombie ratio intrigued a question on the dynamism of zombification and firm exit during COVID where government support could potential help them remain floating without exit. We examine the exit ratio of zombie firms and non-zombie firms over time and present the result in Figure 8. We see that exit ratio of zombie firms is higher than non-zombie firms in all exit type, except for merger. The results are intuitive as insolvent firms should exit from the market, either by bankruptcy or voluntary exit, while healthy firms will likely exit by M&A. Prior to the pandemic, the exit ratio of zombie firms had been increasing and such tendency is caused by voluntary exit. However, this tendency was reserved during COVID, where we observe a decrease in exit ratio for zombie firms in 2020 for all exit types. On the other hand, exit ratios of non-zombie firms has held up even during COVID (with a declining trend of bankruptcy an exception).

Figure 8. Firm Exit Ratio: Zombie Firms vs. Non-Zombie Firms



Source: TSR and author's calculations.

Econometric analysis also suggests that the hypothesis of lower exit ratio among zombie firms during COVID was statistically significant, except for voluntary exit. We test whether zombie firms have exit less during the pandemic by conducting a simple OLS fixed-effect regression of an exit dummy explained by the zombie dummy and its interaction with the COVID dummy, which takes value 1 in 2019 and 2020 and 0 otherwise, controlling for location, industry, and year fixed effects. The results are shown in Table 4, column (1)-(4). Zombie firms are found to be more likely to exit, except for merger, as the zombie dummy *d_fn* takes positive value in all columns (1)-(3). This exit likelihood of zombie firms is also found to have declined during COVID for bankruptcy and merger, but not for voluntary exit.

As a robustness check, we break the COVID dummy into two separate dummies of d_2019 and d_2020 for year 2019 and 2020, as combining two years might possibly create misleading aggregate effects. The results of this exercise are presented in Table 4, column (5)-(8). As expected, 2020 is the main year where we see a major difference in exit pattern of zombie firms verus healthy firms. The exit likelihood of zombie firms has significantly decreased in 2020 for all exit types, bankruptcy and merger compared to healthy firms, in line with the results suggested by Figure 8. However, the decline in exit likelihood among zombie firms for voluntary exit was again confirmed to be statistically insignificant in 2020, contradicting with what suggested in Figure 8 upper right panel. Rather than that, exit probability is suggested to have significantly increased in 2019 for voluntary exit, leading to an increase in exit probability of all type exit in the same year, which is partially caused by increasing trend of the exit likelihood of zombie firms before COVID.

Table 4: Regression of firm exit dummy on zombie status

	Exit Dummy							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	All	Bankruptcy	Voluntary	Merger	All	Bankruptcy	Voluntary	Merger
d_fn	0.00202***	0.000861***	0.00144***	-0.000283***	0.00202***	0.000861***	0.00144***	-0.000283***
	(0.000119)	(5.45e-05)	(8.01e-05)	(6.96e-05)	(0.000119)	(5.45e-05)	(8.01e-05)	(6.96e-05)
d_COVID_zombie	-0.000213	-0.000241**	0.000368**	-0.000340**				
	(0.000247)	(0.000113)	(0.000166)	(0.000144)				
d_2019_zombie					0.00129***	-3.35e-05	0.00119***	0.000126
					(0.000342)	(0.000156)	(0.000230)	(0.000200)
d_2020_zombie					-0.00148***	-0.000416***	-0.000328	-0.000733***
					(0.000317)	(0.000145)	(0.000213)	(0.000185)
Constant	0.00341***	0.000641***	0.00143***	0.00135***	0.00342***	0.000641***	0.00143***	0.00135***
	(4.37e-05)	(2.00e-05)	(2.94e-05)	(2.55e-05)	(4.37e-05)	(2.00e-05)	(2.94e-05)	(2.55e-05)
Fixed-Effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,393,634	2,393,634	2,393,634	2,393,634	2,393,634	2,393,634	2,393,634	2,393,634
R-squared	0.001	0.000	0.001	0.002	0.001	0.000	0.001	0.002

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

4.3. Market cleansing mechanism of zombies

In this sub-section, we further investigate the cleansing mechanism among zombie firms and the potential differences between zombies and non-zombies by conducting a simple OLS fixed-effect regression using the *score* information in our data. A caveat of this exercise is that not all firms in the TSR dataset have balance sheet information available, which is necessary for the zombie definitions, leading to a decrease in observations and consequentially a much smaller dataset of zombie-nonzombie firms compared to the full TSR dataset in Section 3. We first replicate the regression in Table 2 to examine the cleansing mechanism for a sample of firms with balance sheet information, thus, eligible for zombie firms analysis (Table 5). The implications for cleansing mechanism remain broadly the same as in Table 2 when applying to the subsample, except for voluntary exits – in a larger sample used to produced Table 2, the cleansing mechanism for voluntary exits weakened during the pandemic, while in a smaller sample used to produced Table 5, the cleansing mechanism is shown to have strengthened during the pandemic. A large reduction in the sample size with limited availability of balance sheet information allows for many possibilities to explain this change in the pattern. One possibility is that the availability of balance sheet information is mostly available for large firms, which might have lower exit probability than smaller firms. For instance, the exit rate of voluntary exits for the matched sample decreases dramatically from about 1 percent on average from the original

sample to 0.1 percent, indicating a large amount of firms who exited voluntarily did not have balance sheet information and therefore were exluded from the sub-sample.

Table 5. Regression of firm exit rate on firm healthiness: Firms with balance sheet information

	Exit dummy			
	(1)	(2)	(3)	(4)
VARIABLES	All	Bankruptcy	Voluntary	Merger
score	-0.000238***	-0.000129***	-0.000167***	5.80e-05***
	(6.78e-06)	(3.05e-06)	(4.60e-06)	(3.96e-06)
d_COVID_score	1.18e-05	3.83e-05***	-6.05e-05***	3.40e-05***
	(1.28e-05)	(5.77e-06)	(8.70e-06)	(7.49e-06)
Constant	0.0153***	0.00662***	0.0106***	-0.00196***
	(0.000296)	(0.000133)	(0.000201)	(0.000173)
Fixed-Effects	Y	Y	Y	Y
Observations	2,877,971	2,877,971	2,877,971	2,877,971
R-squared	0.001	0.001	0.001	0.002

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

Putting in mind the possible difference of utilizing a subsample instead of the full sample due to data availability, Table 6 shows the regression results of firm healthiness, proxied by the variable 'score', on firm exit ratio for different groups of zombie and non-zombie firms during COVID. We first confirm that the coefficients of *score* take negative value for all cases as expected (coefficients of merger take positive value as expected), intituively indicating that healthier firms are less likely to exit. This finding holds for both zombie and non-zombie groups. Second, in Table 2, we saw that cleansing mechanism weakened during COVID for exit in total, voluntary exit and bankruptcy. However, with the subsample of balance sheet information, bankruptcy exit is the only one to show opposite coefficients of *score* and *d_COVID_score* for both zombie and non-zombie firms. This suggests that the cleansing mechanism weakened during the pandemic for bankruptcy exit, but was instead strengthened for voluntary exit and merger. Meanwhile, *score* seems not playing a role in exit by merger for zombie firms. In short, during COVID, cleansing machenism is found to be weakened for bankruptcy, while strengthened for voluntary exit for both zombie and non-zombie firms. The main difference between the two groups comes from merger, where mechanism was strengthened during COVID but the 'healthiness' seems not matter for zombie if exit through merger.

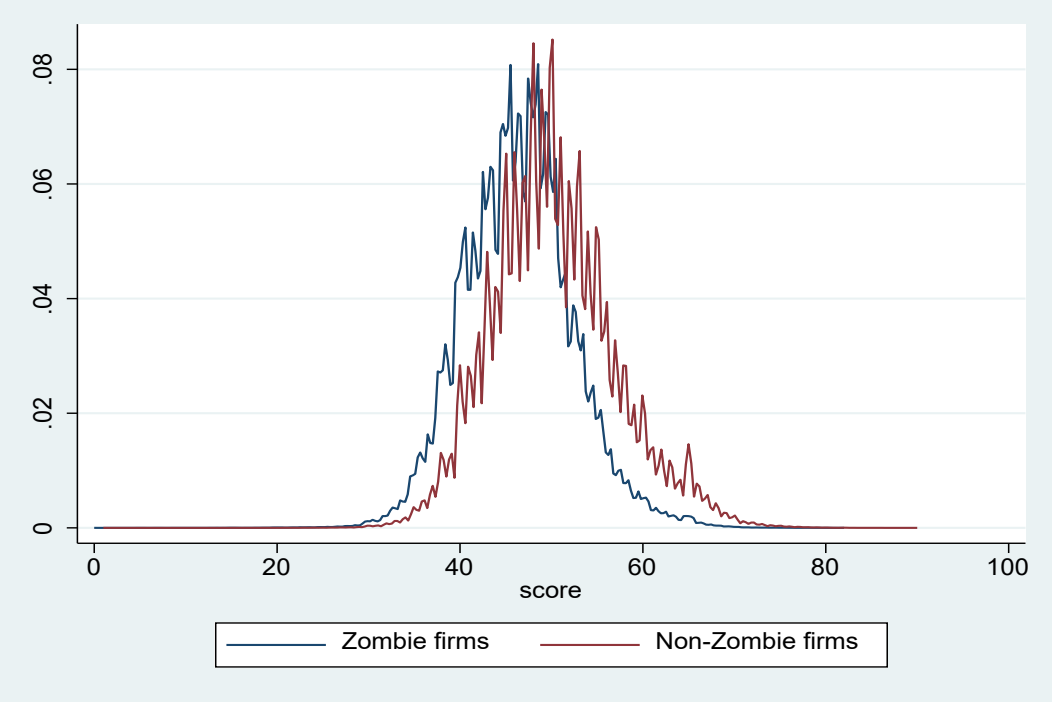
Table 6. Regresion of firm exit ratio on firm healthiness for by zombie status

	Exit dummy for Zombie				Exit dummy for Non-Zombie			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	All	Bankruptcy	Voluntary	Merger	All	Bankruptcy	Voluntary	Merger
score	-0.000551***	-0.000262***	-0.000294***	4.57e-06	-0.000179***	-0.000114***	-0.000123***	5.71e-05***
	(2.36e-05)	(1.26e-05)	(1.73e-05)	(1.01e-05)	(7.74e-06)	(3.31e-06)	(5.05e-06)	(4.86e-06)
d_COVID_score	-9.98e-05**	6.55e-05***	-0.000172***	6.34e-06	7.34e-06	4.42e-05***	-7.02e-05***	3.33e-05***
	(4.47e-05)	(2.39e-05)	(3.28e-05)	(1.91e-05)	(1.50e-05)	(6.40e-06)	(9.77e-06)	(9.40e-06)
Constant	0.0317***	0.0129***	0.0182***	0.000661	0.0123***	0.00581***	0.00841***	-0.00187***
	(0.000980)	(0.000524)	(0.000718)	(0.000418)	(0.000348)	(0.000149)	(0.000227)	(0.000219)
Fixed-Effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	423,516	423,516	423,516	423,516	1,969,436	1,969,436	1,969,436	1,969,436
R-squared	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.002

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

As we want to investigate the possible difference of cleansing mechanism between zombie and non-zombie firms, it is essential to include both score, zombie dummy and their interactions in one regression for statistical tests. We acknowledge the concerns of possible existence of correlation between score and zombie status, i.e. firms with lower score is likely to be a zombie. However, this possiblity is likely marginal in our data sample. Figure 9 plots the kdensity distribution of *score* by zombie status. While zombie group do not have firms having extremely high score of over 90, the distribution of score for this group is not skewed leftward but in fact similar to the normal distribution of non-zombie firms, except for a lower average level. The correlation of score and zombie dummy is also low at 0.23. Therefore, we decide to include all score, zombie dummy, their interactions with each other and with COVID dummy to statistically test a possible difference of cleansing mechanism between the two groups. The result of this exercise is presented in Table 7.

Figure 9: Distribution of score by zombie status



Source: TSR and authors' calculations.

Table 7: Regresion of firm exit ratio on firm healthiness and zombie status

	Exit dummy			
	(1)	(2)	(3)	(4)
VARIABLES	All	Bankruptcy	Voluntary	Merger
score	-0.000184***	-0.000119***	-0.000124***	5.86e-05***
	(7.97e-06)	(3.63e-06)	(5.36e-06)	(4.66e-06)
d_COVID_score	9.15e-06	4.52e-05***	-6.97e-05***	3.36e-05***
	(1.56e-05)	(7.12e-06)	(1.05e-05)	(9.14e-06)
zombie	0.0167***	0.00552***	0.00872***	0.00245***
	(0.000936)	(0.000427)	(0.000630)	(0.000548)
d_COVID_zombie	0.00507***	-0.000887	0.00481***	0.00114
	(0.00194)	(0.000886)	(0.00131)	(0.00114)
d_score_zombie	-0.000330***	-0.000109***	-0.000166***	-5.51e-05***
	(1.99e-05)	(9.07e-06)	(1.34e-05)	(1.16e-05)
d_COVID_score_zombie	-0.000113***	1.73e-05	-0.000103***	-2.79e-05
	(4.11e-05)	(1.87e-05)	(2.76e-05)	(2.40e-05)
Constant	0.0125***	0.00606***	0.00842***	-0.00196***
	(0.000357)	(0.000163)	(0.000241)	(0.000209)
Fixed-Effects	Y	Y	Y	Y
Observations	2,392,953	2,392,953	2,392,953	2,392,953
R-squared	0.002	0.001	0.002	0.002

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year. The data sample covers the 2013-2020 period.

First, the coefficients for score and d_COVID_score in Table 7 are consistent with the results of the non-zombie group in Table 6 since zombie measure is zero (*zombie=0*). The coeficients for zombie and d_COVID_zombie in Table 7 correspond to the constant term and year fixed effect in Table 6.

Our interest lays on the marginal effect by zombie, which is found in the coefficients for *d_score_zombie* and *d_COVID_score_zombie*. On the one hand, the coefficients of *d_score_zombie* present the possible difference of cleansing mechanism between zombie and non-zombie in normal times when *d_COVID* equals 0. We found that the coeficients are negative for all types of firm exit, implying that cleasing mechanism is stronger for zombie firms for total exit , bankruptcy, and voluntary exit (the same sign with the coefficients of *score*). But for merger, the effect of score is weaker for zombie firms compared to non-zombie firms (the opposing sign with the coefficients of *score*).

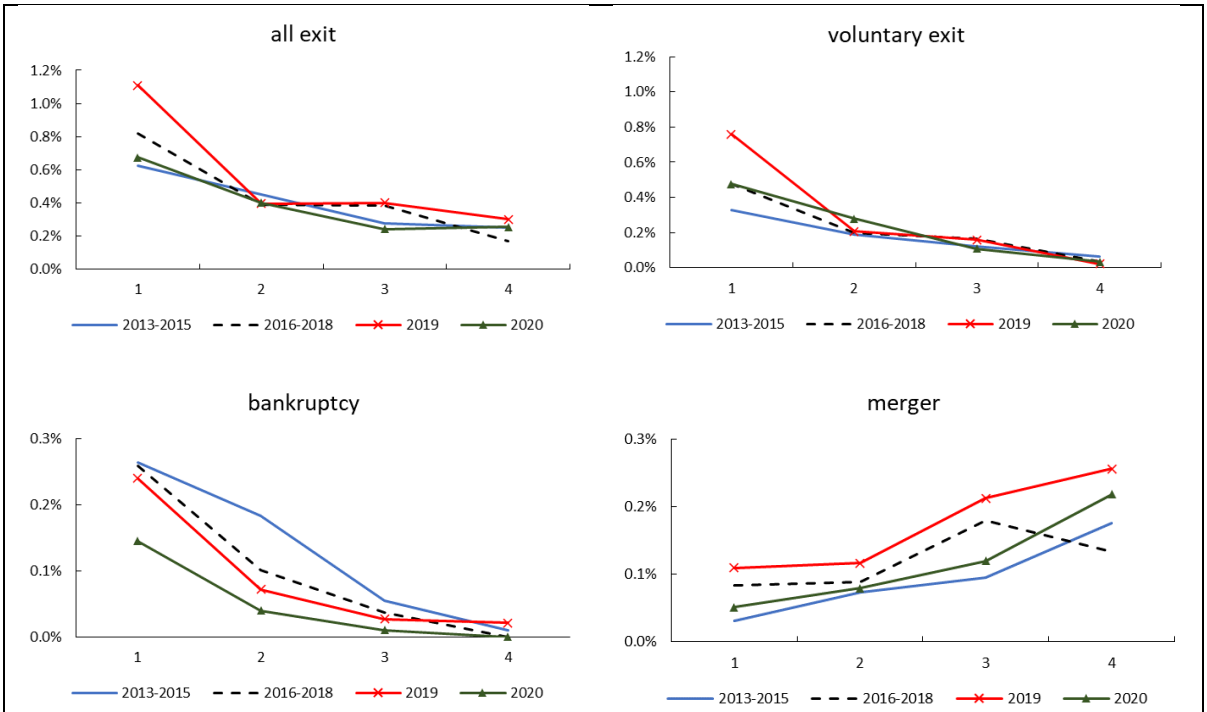
On the other hand, we found that during COVID, the cleansing mechanism has been further strengthened for zombie firms for voluntary exit, with *d_COVID_score_zombie* taking the same negative sign with *d_score_zombie* and *d_COVID_score*. This means that cleasing mechanism is already stronger for zombie in normal time and increased further during COVID, on one side, and that cleansing mechnism increased for non-zombie firms and the such change during COVID is stronger for zombie firms, on the other. This result of voluntary exit seems to be the main influence on the result of total exit. For bankruptcy and merger, there is no significant difference for the triple term *d_COVID_score_zombie*

In short, we have found that during COVID, cleansing mechanism of non-zombie firms weakened for bankruptcy but strengthened for voluntary exit and merger. For zombie firms, the cleansing dynamism—already stronger than non-zombie firms prior to COVID—had further reinforced during the pandemic for voluntary exit. But the same as non-zombie, the dynamism was found to have weakened for zombie firms that exitting through bankruptcy.

This finding of a stronger cleansing mechanism among zombie firms in normal time is encouraging when putting in the context of fear of zombie stickiness and their absorption of resources and productivity (so-called congestion effects) as these 'dead firms' keep living in the economy (Banerjee and Hofmann, 2018). Our results in fact challenge this statement and suggest that there is a stronger market cleansing dynamism among this group compared to the non-zombie group. That said, in normal time, zombie firms in Japan endure from a stronger dynamism of cleansing effect and are under stronger forces of being catapulted to outside the market than non-zombie firms. This finding is supported by Goto and Wilbur (2019), who find that zombie may often escape from zombie status through recovery or exit, rather than perpetually remaining zombies. Under a strong cleaning dysnamism among zombie firms, the fear of them keep remaining and crowding out resources from healthy firms might not be as worrisome as it sounds.

Further more, our findings shed light to a new possible answer to the questions on zombies and their cleansing mechanism during COVID that have been increasingly being discussed in recent studies. We show in Table 6 that the already-stronger cleansing mechanism of zombie firms compared to non-zombie firms in normal time has been further bolstered during COVID for voluntary exit, but weakened for bankruptcy. Linking this to the decrease in exit ratio of zombie firms in Figure 9, the bolstering cleansing dynamism for voluntary exit could imply two scenarios: either (1) relatively-in-good shape zombie firms (with high score) now have higher chance to stay in business by less exit through voluntary; or (2) bad zombie firms (with low score) exit less through voluntary. Similar implication can be made for bankruptcy. A weakening cleansing mechanism for bankruptcy could imply another two scenarios of either (3) higher exit rate of relatively good zombie firms or (4) lower exit rate of bad zombie firms. We checked the correlation of firm exit rate with firm healthiness by score bins for zombie firms (Figure 10) to detect the true causes.

Figure 10. Correlation of firm exit rate with firm healthiness for zombie firms



Source: Tokyo Shoko Research, LTD and authors' calculations.
Note: Firms are categorized in quantiles based on the score measure by year. Bin 1 represents firms in the lowest quartile of each variable. Firms are healthier with higher scores.

It is scenarios (2) and (4) that drive the low exit rate in 2020. Voluntary exit of unhealthy zombie firms declined in 2020—a normalization after a spike in 2019. It is likely that in the early stage of the pandemic, the severe impact of the econmic shock has pushed zombie firms in bad shapes to massively exit voluntarily, but the effect did not last long. In constrast, what is more alarming is the decline in exit ratio of bad zombie firms through bankruptcy. Exit ratio has constantly declined for the lowest quartile of score in 2019 and 2020. Furthermore, this finding is extremely robust for non-zombie firms as well and in both the whole sample as well as the sub-sample. While not investigated in this paper, the declining exit of unhealthy firms, zombie defined or not, might relate to the government support rolled out during the pandemic and could potentially become a source of market distortion in the near term if not monitored closely.

Moreover, it is interesting to see a spike in voluntary exit among zombie firms in the early stage of the pandemic (2019 year in our dataset) but actually a decline in bankruptcy exit. Two possibilities is drawn here. One, the spike could be due to a limited access to government support that led to massive exit by voluntary in unhealthy zombie firms. Given firms in the same score

bin managed to exit less through bankruptcy, this possibility is less likely, but not impossible if firm size matters—firms exitting through bankruptcy are likely bigger (therefore easier to access to support) than firms exitting voluntarily. If it is the case, policy effectiveness and access to support by firm size should be investigated for possible firm size bias (Nguyen et al., 2022). Second, as a less worrisome scenario, the spike is driven by other factors due to different characteristics between firms, such as CEO ages, etc. In the end, firms facing bankruptcy risks may simply have more desire to 'live' than firms choose to end business voluntarily.

5. Policy implications and Concluding remarks

In this paper, we investigate how firms' exit patterns and corporate indebtedness has changed during the pandemic. Using a detailed firm-level dataset, we document the trend of firm exit over time in Japan as well as in 2020 amid the COVID shock, investigating possible change in market's cleansing mechanism by zombie status and answering questions of whether zombie firms have increased after massive support was rolled out by the government.

Our findings reveal that the pandemic and the consequential massive government support may have side-effects on deteriorating market cleansing mechanism. Utilizing the *score* variable as a proxy for firm healthiness, we document that while less healthy firms are more likely to exit in normal time, this likelihood became smaller during COVID, indicating unhealthy firms to have higher chance of remaining in business. This is particularly true for bankruptcy exit. The results are corroborated by other similar findings that smaller firms, less productive firms, and firms with lower growth tend to exit more in general, but these characteristics has mattered less during 2019-20 period. These findings suggest the cleansing mechanism, in which weaker firms exit to allow rooms for more efficient resource reallocation, has weakened during the pandemic.

Exploring the zombie issues, we further discover an economic-wide increase of zombification in 2020, with zombie ratio increased considerably in manufacturing sector and, to a lesser extent, non-manufacturing sector. At the same time, exit ratio of zombie firms declined in 2020. However, our empirical results suggest that cleansing mechanism had been strong for zombie firms prior to COVID, and even got strengthened during the pandemic. However, such strengthened cleansing mechanism is driven by voluntary exit as we also see a weakened cleansing mechanism for bankruptcy for both zombie and non-zombie firms. This might result from support packages for

firms during COVID, supporting the concerns of overly generously and prolonged support—while helping firms coping with the unprecedented economic shock—having generated more zombie firms and hampered productivity.

Taken together, our findings carry two general implications for policy and the future studies of zombie firms. First, it is important to understand the linkages between government support, corporate cleansing mechanism, and zombification. While continued government support for the firms affected by the pandemic may be warranted until the economy recovers fully from the pandemic, it could result in a weakening cleansing mechanism and make less healthy firms having higher chance of remaining alive, crowding out resources and hampering productivity. Second, it requires a better understanding of difference in exit patterns during COVID by exit type, including their linkages with the nature of access to government support, to efficiently address different bottlenecks in different exit type. Additional studies to shed light on this topic will help better policy design to facilitate faster exit of weaker firms to allow more rooms for healthy firms to develop. However, at the bottom line, Japan should be appraised for creating a well-functioning market dynamism to clean up zombie firms from the market in normal time. How it has been able to do so, what factors have helped it happen, are interesting and important questions to answer.

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Appendix Table 1: Regression of firm exit rate on firm characteristics using alternative COVID dummies

Panel A: firm healthiness by score

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
score	-0.00131***	-0.000197***	-0.00125***	0.000133***
	(7.60e-06)	(2.79e-06)	(6.58e-06)	(2.65e-06)
d_2019_score	4.22e-05**	2.47e-05***	1.84e-06	1.57e-05**
	(1.91e-05)	(7.01e-06)	(1.66e-05)	(6.66e-06)
d_2020_score	0.000252***	7.86e-05***	0.000155***	1.89e-05***
	(1.92e-05)	(7.05e-06)	(1.67e-05)	(6.71e-06)
Fixed-Effects	Y	Y	Y	Y
Observations	10,244,978	10,244,978	10,244,978	10,244,978

Panel B: firm size by the number of employees

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
lnemp	-0.00486***	-7.66e-05***	-0.00572***	0.000940***
	(3.66e-05)	(1.39e-05)	(3.15e-05)	(1.27e-05)
d_2019_lnemp	8.80e-05	-4.88e-05	6.45e-05	7.22e-05**
	(8.87e-05)	(3.37e-05)	(7.63e-05)	(3.07e-05)
d_2020_lnemp	0.000939***	-6.71e-05**	0.000789***	0.000217***
	(8.87e-05)	(3.37e-05)	(7.63e-05)	(3.07e-05)
Fixed-Effects	Y	Y	Y	Y
Observations	9,707,705	9,707,705	9,707,705	9,707,705

Panel C: productivity by sales per employee

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
lnlp	-0.00621***	0.000200***	-0.00697***	0.000556***
	(4.08e-05)	(1.59e-05)	(3.51e-05)	(1.38e-05)
d_2019_lnlp	-1.22e-05	-0.000117***	0.000121	-1.56e-05
	(9.82e-05)	(3.82e-05)	(8.45e-05)	(3.31e-05)
d_2020_lnlp	0.000320***	-0.000204***	0.000481***	4.30e-05
	(9.81e-05)	(3.82e-05)	(8.44e-05)	(3.31e-05)
Fixed-Effects	Y	Y	Y	Y
Observations	9,529,472	9,529,472	9,529,472	9,529,472

Panel D: CEO age

VARIABLES	Exit Dummy			
	ALL	Bankruptcy	Voluntary	Merger
age_exe	0.000541***	7.02e-06***	0.000556***	-2.23e-05***
	(4.34e-06)	(1.75e-06)	(3.73e-06)	(1.43e-06)
d_2019_age_exe	7.24e-05***	7.68e-06*	5.87e-05***	6.03e-06
	(1.15e-05)	(4.65e-06)	(9.90e-06)	(3.79e-06)
d_2020_age_exe	3.24e-05***	5.37e-06	1.86e-05*	8.53e-06**
	(1.19e-05)	(4.77e-06)	(1.02e-05)	(3.90e-06)
Fixed-Effects	Y	Y	Y	Y
Observations	7,209,082	7,209,082	7,209,082	7,209,082

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Fixed-effects control for industry, prefecture, and year.