Do SMEs and Zombie firms cause the stagnation of the Japanese economy?
～Cross-country evidence from Japan and five European countries～

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Abstract

We examine the effects of Small and Medium-sized Enterprises (SMEs) and Zombie firms on productivity across industries using multinational (Japan, France, Germany, Italy, Spain, and the U.K.) corporate financial data for 2011-2019. Our empirical results first show that, while Zombie firms have negative and statistically significant effects on productivity, the ratio of the number of Zombie firms and the Zombie asset ratio in each country shows a declining trend. Second, we demonstrate that the effects on Non-Zombie firms were negative for the number of employees. Third, we find only Japan's total factor productivity (TFP) level shows positive and statistically significant effects, and a widening gap in productivity between Zombie and Non-Zombie firms. Finally, regarding the barriers to entry for new businesses caused by the retention of Zombie firms, a larger gap in the TFP level was identified for young firms in Japan, indicating possible negative impacts on business startups.

JEL Classification: D21, E22, O16, O47
Keywords: SMEs, Zombie, Total Factor Productivity, Investment, Employment

1. Introduction

Japan's labor productivity has remained low since the 2010s, and its labor productivity growth rate has lagged that of Western countries[1] (Fig. 1). The Japanese economy has been plagued by deflation since the 1990s, and the slump in nominal GDP growth is considered

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[1] Prepared using OECD statistics in which US$ units are converted to PPP (Purchasing Power Parity), commonly used in international comparisons of labor productivity. However, it varies depending on the unit of GDP (Gross Domestic Product).

one of the reasons. The economic slowdown indicates an urgent need for Japan to improve its productivity growth rate.

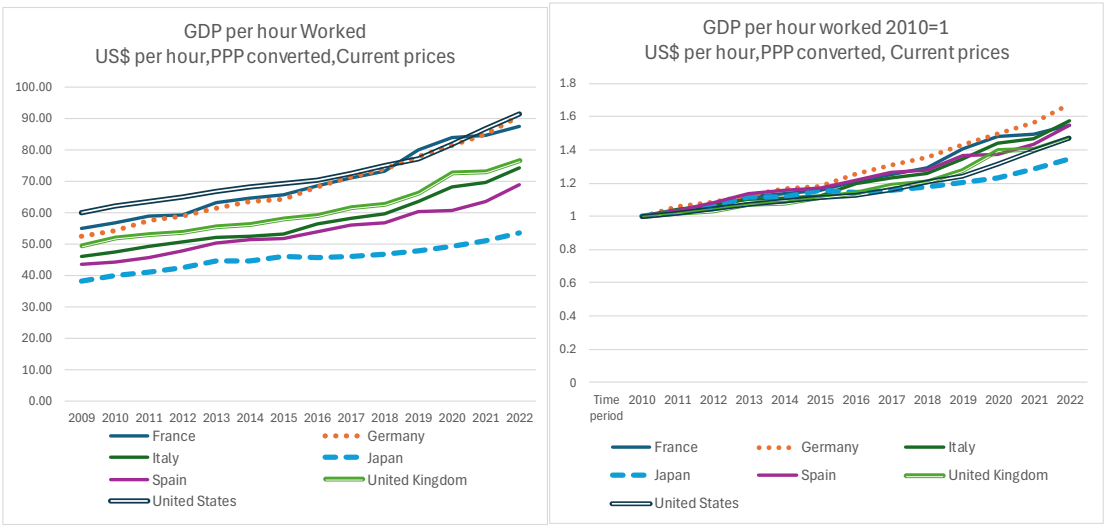

Fig. 1. Trends in labor productivity (GDP/per hour worked), Source: OECD. Stat.

Many factors have been analyzed as contributing to Japan's economic stagnation, including a lack of investment and consumption, low productivity of SMEs, and the existence of Zombie firms (Hayashi & Prescott (2002), Caballero, Hoshi, and Kashyap (2008), etc.). After the European debt crisis (2011-2012), many economists researched the impact of Zombie firms based on the Zombie firm analysis framework in Japan. However, comparative studies of productivity stagnation factors among foreign countries should be included in the literature, including studies on SMEs. Cross-country comparisons across firm sizes and detailed factor analyses have not been conducted.

Our research question is to check whether SMEs and Zombie firms cause the stagnation of the Japanese economy. Specifically, we will explore the relationship between capital investment, growth in the number of employees, TFP level and growth rate as dependent variables, and firm size and Zombie factors as independent variables, based on comparisons between Japan and Europe (France, Germany, Italy, Spain, and the U.K.). We utilized corporate financial data provided by the Orbis Database, which includes companies with less than 10 employees and less than 10 million yen in capital without cutoffs, from 2011 to 2019[2].

[2] The analysis in this paper covers the period up to 2019, before the impact of the coronal vortex. "In analyses using individual data from Japanese government statistics, there is always the presence of

We have two hypotheses. The first hypothesis is to test whether the low productivity of Japanese SMEs relative to five European countries is the cause of the productivity stagnation unique to our country. The second hypothesis tests the existence of Zombie firms as a factor in low productivity in Japan. Specifically, panel data (2011-2019) were compiled from the Orbis Database for six countries with large economies (Japan, France, Germany, Italy, Spain, and the U.K.). The method developed by Levinsohn and Petrin (2003) (hereafter the LP method) was used to account for biases related to productivity. The TFP estimation based on the LP method is newly performed. Based on the estimated TFP, we analyzed country comparisons by firm size, firm age, and industry and the impact of Zombie firms on Non-Zombie firms.

Our empirical results are summarized below. First, in Japan and five European countries, the larger the firm's size, the higher the TFP level and TFP growth rate. However, the ratio of Zombie firms shows a declining or flat trend over the period covered in all countries except France and is in the 4-8% range in 2019.

Second, Zombie firms have a negative impact on Non-Zombie firms in terms of employment, growth in the number of employees, capital investment, and TFP levels in many countries. At the same time, only Japan positively impacts TFP levels. In Japan, the persistence of Zombie firms is thought to have created an inefficient industrial structure and barriers to entry for new firms, widening the productivity gap between Zombie and Non-Zombie firms, and resulting in a significant positive impact on the TFP level. The Japanese results were consistent with previous studies (Caballero et al. (2008), McGowan et al. (2018)).

Third, Zombie firms create barriers to entry for younger firms, especially in Japan. We examined young firms, those less than five years old, to determine whether the congestion effect of Zombie firms creates barriers to entry. The impact of Zombie firms on the capital investment and employment by young firms differs across countries. Still, only Japan shows a more substantial positive impact on the TFP level of young firms, the TFP gap between Non-Zombie firms and Zombie firms, which verifies the barriers to entry.

Based on the results, with regards to the first hypothesis, we do not conclude that SMEs are the "cause of Japan's unique productivity slump". Regarding the second hypothesis, our results suggest that Zombie firms may be a barrier to entry for young firms and an obstacle to metabolism, thus contributing to the long-term stagnation of the Japanese economy.

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mechanical cutoffs regarding firm size (Basic Survey of Business Activities) and industry bias (industrial statistics)." (Sakai, T., Takizawa, M., and Miyagawa, D. (2021), "Labor Productivity of Japanese Firms," Productivity Report Vol. 18, Japan Productivity Center.

This paper is organized as follows: Section 2 summarizes the literature, Section 3 describes the data and analysis methods used, Section 4 reports the results, and Section 5 concludes and discusses future issues.

2. Literature review

This paper contributes to the literature on the causes of economic productivity stagnation in five areas. First, it contributes to the literature on the definition of Zombie firms and the mechanisms by which Zombie firms impact the economy. Caballero et al. (2008) first examined the definition of Zombie firms and pointed out that, in Japan in the early 1990s, the survival of Zombie firms had a negative impact on the growth of Non-Zombie firms. The mechanism identified, which has come to be known as the Zombie firm hypothesis, was that inefficient resource allocation squeezed investment in healthy Non-Zombie firms[3]. On the other hand, regarding the level of TFP, as the ratio of inefficient Zombie firms increases, the market and industrial structure results in low prices and high wages that raise the entry barriers for new entrants, widening the productivity gap between Zombie firms and Non-Zombie firms. The productive gap is because only firms that generate profits in the face of excessive competition can continue in business, and the productivity of Non-Zombie firms must be high (Imani and Uesugi (2024)). Other studies have examined the spillover effect, defined as the congestion effect, which discourages new entrants (Caballero et al. (2008)), and contributes to productivity stagnation (McGowan et al. (2018))[4]). Unlike the existing literature, this study estimates TFP based on the LP method, which considers productivity biases, and analyzes the impact of Zombie firms.

Second, we compiled an empirical analysis of the impact of Zombie firms on productivity slowdowns such as Banerjee and Hofmann (2018), and Carreira et al. (2022). McGowan et al. (2018) examined the performance of Zombie firms based on corporate financial data from 2003-2013 for nine OECD countries, not including Japan. They found slowing growth in investment, employment, and other aspects. In addition, Albuquerque and lyer (2023) analyze the impact of Zombie companies in recent years across 63 countries but do not make individual comparisons between countries.[5] Acharya et al. (2022) apply various

[3] The analysis targets Japanese companies (1990-2004) in NIKKEI Telecom 21, and the framework is used to analyze other OECD countries

[4] Based on the Orbis Enterprise Information DB, the analysis covers firms (2003-2013) from 9 OECD member countries (BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE, SVN), excluding Japan.

[5] It covers listed companies in 63 countries and companies based on Orbis and other corporate information databases (2000-2021).

definitions of Zombie firms to United States-listed firms and find that only interest rate-subsidized Zombie firms have a negative effect on Non-Zombie firms. Imani and Uesugi (2023) examine the impact of Zombie firms in Japan (2002-2018) and show a negative impact on Non-Zombie firms for productivity. The paper differs from our paper in that the definition of Zombie firms and the explained variable is a proxy variable for productivity. (See Appendix B.) This paper is based on firm information for Japan and five European countries in the 2010s. It utilizes a multinational comparison of capital investment, employee growth, and the level and growth rate of TFP rather than proxy variables.

Third, our research is related to the emergence of zombie firms and the factors that lead to their recovery. Prior research has analyzed whether Zombie companies will survive as Zombie companies or recover into healthy companies, In Japan, the performance of Zombie firms recovered in the early 2000s, and the ratio of Zombie firms declined. Fukuda and Nakamura (2011) have analyzed the factors behind this. Fukao (2012) argues that the Zombie problem can explain TFP stagnation only for part of the 1990s. The widening productivity gap between small and large firms may be due to technology transfer associated with overseas production. Although Japanese SMEs have a higher Zombie ratio than large firms, it has been shown that many Zombie firms exit the market or revert to Non-Zombie firms rather than remain in Zombie status (Goto and Wilbur (2017)). Nakamura (2023) analyzes the trends in Japan's "Zombie firms" over the past 50 years and the ease with which they become Zombies. Cheung and Imai (2024) analyze the financing of Zombie firms and the retention of unskilled labor in the construction industry in Japan. Recently, the Zombie firm hypothesis has been increasingly linked to industrial policy, which can enable the survival of Zombie SMEs that do not contribute to overall productivity growth (Imai (2016[a]), Imai (2016[b])). Indeed, Goto (2014) points out that Japan's financial support measures for Zombie firms have prevented bankruptcies and increased the number of SMEs Zombie firms[6]. This paper clarifies the trends of Zombie firm ratios and asset ratios and Zombie firm survival rates in Japan and five European countries in the 2010s. It examines the impact of the persistence of Zombie firm's status. This paper's contribution to the previous studies has provided new material for Zombie research. Zombie research is a reference case for advanced and emerging economies stemming from Japan's prolonged stagnation since the 1990s.

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[6] "The Special Guarantee Program for Financial Stability of SMEs was introduced in 1998 to address financial system instability, and the Financing Facilitation Act, in response to the Lehman Shock of 2008, is cited. These two policies contributed to preventing SME bankruptcies and encouraged the emergence and increase of SME zombie firms in our country," he noted.
(https://www.rieti.go.jp/jp/publications/rd/122.html) (in Japanese)

Fourth, we also relate with an analysis of productivity across firm sizes and industry sectors. There are a few examples of international productivity comparisons by industry, size, and age for each country based on corporate financial data. Berlingieri et al. (2018) find from firm data in 17 countries that productivity increases with firm size in manufacturing industries, but the firm size productivity gap is smaller in service industries than in manufacturing industries. In Japan, the relationship between firm size and productivity has been found to differ by age and industry (Nagahama (2002)). On the other hand, Morikawa (2016) shows that TFP in Japan's service industry has a large inter-firm disparity compared to the manufacturing industry. In the Japanese manufacturing industry, small firms exceeded large firms in terms of TFP growth in industries such as machinery (Urata and Kawai (2002)). In addition, analyses have been compiled to show that TFP growth since the 2000s has been higher for large firms than for SMEs and was higher for the manufacturing industry than for non-manufacturing industries (Goto (2014)). In terms of firm age, Spanish firms have a high growth rate during the first few years of existence, which is followed by stable growth at a lower level (Coad et al. (2013))[7]. In Japan, productivity increases after the creation of a firm and reaches a plateau after about 30 years (Hosono, Takizawa, Yamanouchi (2022))[8]. Fukao and Kwon (2006) compare firms with high TFP to those with low TFP and find significant differences between the two firms in R&D and internationalization indicators. This paper examines the impact of SMEs and Zombie firms on productivity in Japan and five European countries, comparing them by firm size, firm age, and industry, for which there are few examples from previous studies.

Finally, our study complements a study on the barriers to new entries created by Zombie firms and their impact on productivity (TFP). McGowan et al. (2017) find from an analysis of nine OECD countries that there is a negative effect for young firms on TFP which generates significant barriers to entry. Japan's "Labor Economics Analysis" white paper analyzes data from the OECD. Stat and find a positive correlation between the business birth rate and labor productivity growth rate[9]. Various measures are aimed at supporting SMEs and their metabolism by encouraging new entrants. In the USA, for example, industrial policy that uses R&D tax credits are seen to be more effective in a shorter period

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[7] Analysis of manufacturing sector targets based on Iberian Balance Sheets for Spain (1998-2006, compiled by Bureau van Dijk).

[8] Analysis based on the Basic Survey of Business Activities in Japan (1994-2018, Ministry of Economy, Trade and Industry).

[9] The "Analysis of The Labour Economy" white paper (2023, Ministry of Health, Labour and Welfare) analyzes a positive correlation between the business birth rate in 2016 and the labor productivity growth rate from 2016 to 2019 for 28 OECD member countries based on OECD. Stat.

than R&D subsidies (Bloom et al. (2019)) and early-stage R&D subsidies for young startup companies produce effects after two to three years (Howell, S.T. (2017)). This paper utilizes the OECD. Stat to examine the correlation between the business birth rate and labor productivity growth rate.

3. Data used and analysis methods

3.1. Data

This paper utilizes country-specific firm-by-country data from the Orbis Database. The Orbis Database consists of multinational corporate financial data (industry, age, and size classifiable) with no cutoffs for firm size, etc. It is "a rich cross-country firm-level panel dataset" (Alfaro & Chen (2018)). It is considered "the best option at hand (Bajgar et al. (2020))". Yet, when compared to official data, it needs to be more comprehensive, especially concerning data on small and medium-sized companies (see Table 1). It has been pointed out that there is insufficient data for non-European countries (e.g., US, Canada, etc.) (Albuquerque and lyer (2023)).

Table 1

Number and percentage of firms by employee size in the Orbis Firm data vs. government statistics data (2019)

Orbis Data (Unit: Number of companies on the left of each country, % on the right)

Employee Size	Japan	(%)	France	(%)	Germany	(%)	Italy	(%)	Spain	(%)	UK	(%)
500 or more	2,677	1.59	1,744	1.89	2,404	**9.98**	1,401	0.27	1,061	0.22	4,246	3.97
250 or more - less than 500	2,833	1.68	1,912	2.07	2,293	9.52	1,777	0.34	1,286	0.27	3,836	3.58
50 or more - less than 250	22,745	13.50	12,849	13.92	12,667	52.57	20,464	3.95	13,026	2.71	20,371	19.02
20 or more - less than 50	30,471	**18.08**	15,944	**17.27**	2,754	**11.43**	45,565	**8.78**	34,414	**7.15**	10,994	**10.27**
less than 20	109,771	**65.15**	59,877	**64.85**	3,979	**16.51**	449,473	**86.66**	431,537	**89.66**	67,631	**63.16**
total amount	168,497		92,326		24,097		518,680		481,324		107,078	

Number and Percentage of Firms in **Government Statistics Data** for Each Country (2019 Japan only, 2021)

Employee Size	Japan	(%)	France	(%)	Germany	(%)	Italy	(%)	Spain	(%)	UK	(%)
250 or more (Japan:300 or more)	15,520	0.87	6,137	0.15	14,826	0.43	4,179	0.10	4,594	0.14	7,685	0.13
50 or more - less than 250 (Japan: less than 300)	86,990	4.89	152,826	3.72	60,108	1.76	24,288	0.55	20,571	0.61	35,584	0.61
20 or more - less than 50	340,107	**19.14**			331,713	**9.69**	199,340	**4.55**	124,475	**3.70**	211,295	**3.60**
less than 10	1,334,674	**75.10**	3,946,131	**96.13**	3,016,601	**88.12**	4,149,572	**94.80**	3,213,557	**95.55**	5,613,205	**95.66**
total amount	1,777,291		4,105,094		3,423,248		4,377,379		3,363,197		5,867,770	

source：Les entreprises en France Édition 2021(France),Statistisches Bundesamt (Germany),Italian National Institute of Statistics(Italy),Economic Census Activity Survey (2021) (Japan),des Statistischen Bundesamtes,Estrucura y Dinámia Empresarial en Espana 2019(Spain),BUSINESS POPULATION ESTIMATES FOR THE UK AND THE REGIONS 2019(UK)

(Note) For Japan, only corporate enterprises are included, not sole proprietors (approximately 1.61 million).

This paper uses firm data from 2011 to 2019 in Japan and France, Germany, Italy, Spain, and the U.K., the largest economies in Europe. Although Orbis data coverage varies by country, with Italy and Spain having the largest sample sizes and Germany the smallest, it is sufficient for the analysis. However, it should be noted that, compared to government statistics from each country on a 2019 basis, the ratio of small firms with fewer than 50 employees is lower than that of large firms for all six countries, particularly Germany.

Note that this research excludes firms with negative assets for two consecutive years (many of which have less than 20 employees), as they would cause an outlier in the capital stock, and firms with less than 20 employees but classified as Very Large in the Orbis category[10].

[10] Orbis classifies companies as Very Large if they meet at least one of the following requirements: ① Sales of 130 million dollars or more, ② Total assets of 260 million dollars or more, ③ Number of employees of 1,000 or more, ④ Listed company. Companies with less than 20 employees that met the above requirements were considered to have a holding company-like character and were excluded from the productivity analysis.

This analysis was performed on all Orbis data, including SMEs and micro enterprises outside of the public service[11].

We first calculated each firm's labor, capital, and value-added to estimate productivity from the Orbis data. For labor, man-hours were calculated by multiplying the number of employees in each firm by the number of hours worked per person per year[12].

Next, using the permanent inventory method, the real value of capital was calculated for both intangible fixed capital and tangible fixed capital[13]. For Japan, the deflators were calculated from nominal and real values of machinery and equipment and intellectual property output in the National Accounts. In contrast, the deflators for European countries were based on the EUROSTAT deflator for investment goods. The tangible and intangible assets were then used as the total capital.

Finally, value-added was calculated as the sum of net income, taxes, labor costs, interest expense, and depreciation. It was adjusted using the GDP deflator by industry from the National Accounts for Japan and the EUROSTAT value-added deflator for European countries.

For intermediate inputs, gross sales minus value-added were adjusted using the intermediate input deflator of the National Accounts for Japan and the EUROSTAT intermediate goods deflator for European countries.

3.2. Calculation of TFP

This paper uses TFP, a more comprehensive indicator than labor productivity, as an indicator of productivity. The production of goods and services (Y) involves inputs of production factors (labor (L) and capital (K)) and productivity-enhancing factors other than inputs (improvement in the quality of input factors, technological progress, efficiency, invention, etc. (A)). TFP can be defined as the constant term plus the residual, estimated by

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[11] In a previous study based on Orbis, McGowan et al. (2018) uniformly excluded firms with less than 20 employees. On the other hand, an exclusion like this paper with a 3-year financial data continuity condition and other detailed data selection was done in Albuquerque and Iyer (2023), which may be a point to keep in mind when utilizing Orbis data.

[12] Regarding working hours per person, in Japan, we used data on working hours by industry from the national accounts (2015 base) as the basis. European countries were based on the OECD. Stat Dataset: 7A. Labor input by activity, ISIC rev4.

[13] Due to a data limitation in the Orbis data that depreciation is often deficient for Japanese firms, we adopted four capitalization categories for each industry sector from the "Survey of Corporate Statistics" (Ministry of Finance) for the capital depletion rate (depreciation rate).

log-transforming equation (1) described by the production function (Cobb-Douglas type) and using the method of ordinary least squares (OLS).

$Y=AL^{\beta 1}K^{\beta 2}$----------(1)

In firm-level panel data analysis, it is noted that simple OLS would include "productivity shocks that are unobservable to the analyst but observable to managers" in the error term, which could be correlated with the factors of production, labor, and capital, and thus introduce a risk of bias. For this reason, TFP estimation using a fixed-effects model with firms and time dummies to capture firm-specific effects has been widely used. However, it has been pointed out that estimation using a fixed-effects model with the strong assumption that firm-specific production effects are invariant over time results in smaller coefficients on capital (Olley and Pakes (1996), Levinsohn and Petrin (2003), Ackerberg, Caves, and Frazer (2015), Matsuura (2016)). Appendix A summarizes the concepts and model equations for the OP, LP, and ACF methods.

This paper estimates productivity based on the LP method which takes into account the "external productivity shock observable to managers", represented by ω_{it}. For details on the LP method, see Levinsohn and Petrin (2003) and Petrin and Levinsohn (2004)[14].

Therefore, the Cobb-Douglas production function is,

$y_{it}=\alpha+\beta_1 l_{it}+\beta_2 k_{it}+\omega_{it}+u_{it}$----------(2)

where y_{it} is the logarithm of value added, l_{it} is the logarithm of labor input, k_{it} is the logarithm of capital input, and ω_{it} may be correlated with l_{it} and k_{it} by "external shocks that are not observable to the analyst but are observable to managers." The constant term is represented α and the error term by u_{it}. Including the productivity shock, ω_{it}, also affects the firm's intermediate input, m_{it}.

$m_{it}=\mathrm{m}(k_{it},\ \omega_{it})$ ----------(3)

Define the inverse function of equation (2),

$\omega_{it}=\mathrm{m}(k_{it},\ m_{it})$ ----------(4)

(2) Substitute and organize into the equation,

[14] The OP (Olley and Pakes (1996) method made it difficult to utilize data on capital expenditures, the ACF (Ackerberg, Caves, and Frazer (2015)) method did not converge, and the LP method was the method that could be used.

$y_{it} = \alpha + \beta_1 l_{it} + \varphi_{it}(\ k_{it},\ m_{it}) + u_{it}$----------(5)

Estimate β_1 by formulating φ_{it}as a polynomial of the fourth degree. In the second step,

$y_{it} - \widehat{\beta_1}\ l_{it} = \beta_2 k_{it} + g\ (\hat{\varphi}_{it-1} - \beta_2 k_{it-1}) + \xi_{it} + u_{it}$ ----(6)

Estimated by nonlinear OLS to obtain the coefficients of capital. ξ_{it} is the forecast error of ω_{it}

TFP＝$\exp(v_t - \widehat{\beta_l} l_t - \widehat{\beta_k} k_t)$ v_t：Required by Value added[15].

3.3. Identification of Zombie Firms

For the identification of Zombie firms, the criteria were used to identify firms with an interest coverage ratio of less than one for three consecutive years, but only for firms that are over 10 years old (McGowan et al. (2018))[16]. It is hereafter referred to as the MAM criteria. The international comparisons in this paper are based on the MAM standard. The MAM criteria identifies whether financial expenses are covered by profits over three years and excludes newly established firms.

Among the various proposals for defining Zombie firms, Banerjee and Hofmann (2018) based on the MAM criteria in a broad sense. In a narrower sense, they propose a criterion that assumes that future growth potential is lower for Zombie firms and that Tobin's Q is lower than the median value in the securities market for the year and industry in question[17]. In addition, Fukuda and Nakamura (2011) and Imai (2016a) propose criteria such that a company is not considered a Zombie firm if it is subject to an interest rate reduction

[15] In this report, regarding economies of scale, TFP was estimated without assuming constant harvest, $\beta_1 + \beta_2 = 1$. The results of the F test for constant harvest were all rejected for all industries, the manufacturing industry, and the service industry in the six countries, and the results were of the diminishing harvest type with $\beta_1 + \beta_2 < 1$.

[16] Interest coverage ratio = (Operating income + Interest income + Dividend income) / (Interest expense + Discount expenses).

[17] Tobin's Q is a measure of the cost-effectiveness of capital investment (q=level of stock price/cost of capital investment).

exemption but “profitability” is recognized[18]. We use the MAM criteria to identify Zombie firms because it allows us to analyze financial information in a unified manner across countries without limiting the analysis to listed firms.

4. Empirical results

4.1. Comparison of TFP levels, growth rates, and firm size disparities

We compared differences in productivity by firm size among countries across all industries, by the manufacturing industry, and by a broadly defined service industry (excluding agriculture, forestry, fisheries, mining, manufacturing, construction, and public administration). First, the TFP growth rates by country (2011-2019) are shown in Fig. 2 with annual averages for the period of 5.8% for Japan, 2.4% for France, 2.3% for Germany, -1.7% for Italy, 0.7% for Spain, and -0.7% for the U.K., Japan, France, and Germany had TFP growth rates exceeding 2%, but the rates were negative in Spain and the U.K., Japan's growth rate of more than 30% from 2011 to 2012 is due to the investment in reconstruction after the Great East Japan Earthquake, The average annual growth rate for all sectors after 2013 will be about 2.4%, the same as in France. The U.K. dropped more than 20% in 2016, when the country held a referendum on whether to leave the European Union, and in 2019, when it left, indicating the magnitude of the impact. In Germany, the recovery in exports and capital investment, combined with labor market reforms and a thick layer of medium-sized firms, has been analyzed as having put the country back on a growth trajectory since the 2010s[19].

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[18] The requirements for adding “profitability criteria” for identifying Zombie firms (Fukuda and Nakamura (2011), Imai (2016a)) were not used in this paper, which conducted a multinational analysis, and we do not include in the comparison table（See Appendix B.）.

[19] “The once ‘sick man of Europe’ is now the ‘sole victor’ in which country?” NHK NEWS WEB 2017 https://www3.nhk.or.jp/news/special/german-election-2017/german-strength/(viewed 2024.12.29)
“Why the German Economy Revived: Germany's Strength from the Perspective of the Labor Market and Small and Medium-Sized Enterprises,” Mizuho Insight (Mizuho Research Institute), 2014.2.27

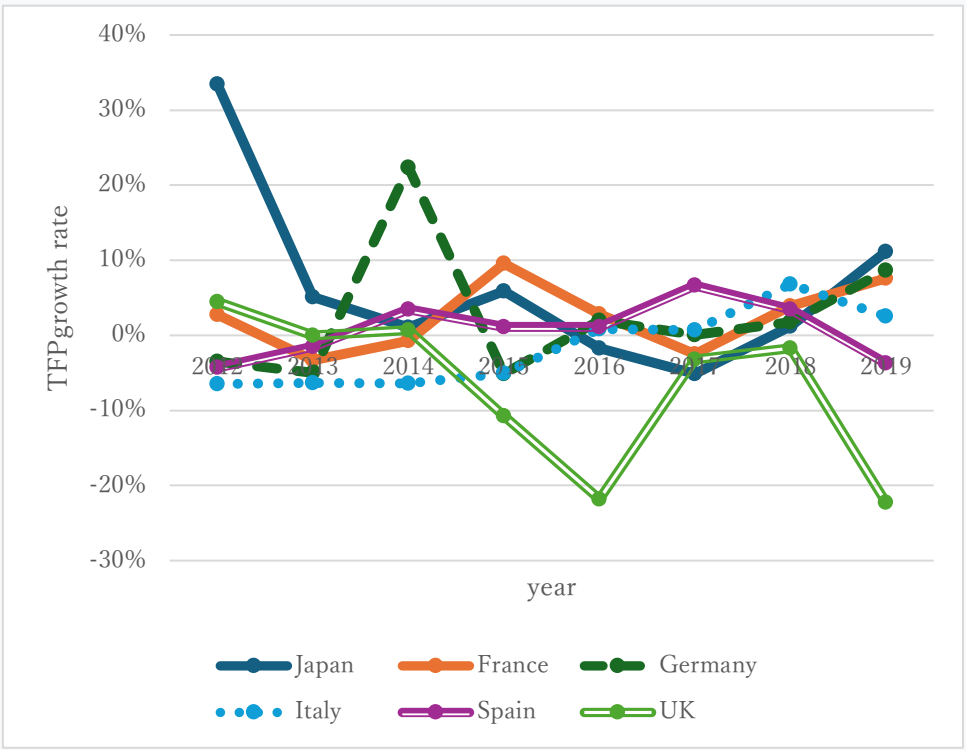

Fig. 2. TFP growth rates by country （2012～2019）

Second, a comparison of the impact of firm size on TFP levels (by industry in each country) was then regressed on the following OLS (ordinary least squares) estimation equation (2011-2019). (See equation (7), Table 2.)

The size variable is a dummy for the firm's size and is classified by the number of employees. Based on the Japanese and European definitions of SMEs, we classified by the number of employees: the dummy equals 1 for firms with 500 employees or more (hereafter referred to as size 1), 2 for between 250 and 499 (size 2), 3 for 50 and 249 (size 3), 4 for between 20 and 49 (size 4), and finally 5 was defined as less than 20 people (size 5).[20] In addition, firm age is included as a control variable.

[20] The Japanese SME Basic Law defines SMEs as "capital of 300 million yen or less or 300 employees or less" in the case of the manufacturing industry; In Europe, the definition of SMEs (2014), which is common among member states of the EU Regulation, is "less than 250 employees, annual turnover of 50 million euro or less and total assets of 43 million euro or less" (see the following website at See Appendix 1 of the Regulation at https://eur-lex.europa.eu/eli/reg/2014/651/2020-07-27). Therefore, for this paper, size1 (large firms) was defined as those with more than 250 or 300 employees (500), and microenterprises (size5) are classified as having less than 20 employees, in line with the previous studies that assumed 20 or more employees (McGowan et al. (2018)) or 10 or more employees (Bajar et al. (2020)).

$$lnTFP_{is} = \beta_0 + \beta_1 SizeDummy_{is} + \beta_2 lnAge_{is} + \varepsilon_{is} \quad \text{-------(7)}$$

The coefficients for the firm size and dummy variable are shown in Table 2. The results indicate the ratio of the increase in TFP level to small firms in size 5, and in all countries, TFP is higher in proportion to firm size. Among these countries, Japan has the largest productivity gap between large and small firms in all industries, in the manufacturing industry, and services industry compared to European countries[21].

Regression analysis was then conducted using the same OLS estimation formula as in equation (7) to compare the impact of firm size on the TFP growth rate (Table 3). The results show that similar to the TFP level, the TFP growth rate is proportional to firm size in all countries. The disparity in TFP growth rates between large and small firms was large in the order of the U.K., Germany, Japan, Italy, and Spain, but it should be noted that Germany and the U.K. data from Orbis shows a high ratio of large firms.

We also compare the impact of firm age on TFP levels and TFP growth rate. Firm age was significantly positive for all industries, the manufacturing industry, and the service industry, when compared to TFP levels in every country. While for TFP growth rates, firm age was significantly negative for all industries, the manufacturing industry, and the service industry in every country except Italy. Italy had a positive significance for all industries. (See Table 2 and Table 3.)

Third, we contrasted TFP growth rates for individual industries for all firms in each country (Table 4). Although there are differences between countries, the top ranked industries are finance and insurance, electrical machinery, equipment and supplies, electronic components and devices, transport equipment, and petroleum products.

[21] Fukao (2012) found that "since the 1990s, there has been a large difference in the increase in TFP growth between large firms, mainly listed firms, and other small and medium-sized firms," and Inui, Kim, Kwon, and Fukao (2011) found from the Survey of Corporate Statistics (1982-2007) that "a widening TFP gap within industries has been observed. The TFP gap in the non-manufacturing sector was large. By size, the TFP gap between large and small firms widened in the non-manufacturing sector." The analysis shows that "the TFP gap between large and small firms widened in the non-manufacturing sector.

Table 2

Impact of each country's industry size on TFP levels (2011-2019)

・dependent Variable: TFP level by industry in each country☒

VARIABLES	Japan			France			Germany			Italy			Spain			UK		
	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry
size1(≧500)	**3.325*** **	**4.240*** **	**2.468*** **	**1.547*** **	**1.985*** **	**1.359*** **	**1.173*** **	**1.116*** **	**1.055*** **	**1.866*** **	**1.642*** **	**1.839*** **	**1.739*** **	**2.159*** **	**1.605*** **	**2.118*** **	**1.892*** **	**2.047*** **
	(0.007)	(0.011)	(0.009)	(0.007)	(0.011)	(0.009)	(0.007)	(0.015)	(0.009)	(0.009)	(0.013)	(0.011)	(0.009)	(0.019)	(0.011)	(0.008)	(0.016)	(0.009)
size2(250≧,<500)	1.853***	2.126***	1.352***	1.112***	1.372***	1.004***	0.669***	0.580***	0.568***	1.359***	1.273***	1.291***	1.402***	1.648***	1.290***	1.659***	1.410***	1.609***
	(0.006)	(0.012)	(0.008)	(0.007)	(0.010)	(0.009)	(0.007)	(0.014)	(0.009)	(0.008)	(0.011)	(0.010)	(0.008)	(0.014)	(0.010)	(0.008)	(0.016)	(0.010)
size3(50≧,<250)	1.271***	1.212***	0.996***	0.738***	0.883***	0.682***	0.363***	0.309***	0.304***	0.988***	0.876***	0.920***	1.009***	1.163***	0.937***	1.274***	0.955***	1.261***
	(0.003)	(0.005)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.012)	(0.006)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.011)	(0.005)
size4(20≧,<50)	0.740***	0.639***	0.585***	0.468***	0.524***	0.448***	0.290***	0.282***	0.261***	0.635***	0.524***	0.592***	0.637***	0.702***	0.602***	0.898***	0.665***	0.866***
	(0.002)	(0.005)	(0.003)	(0.002)	(0.005)	(0.003)	(0.006)	(0.014)	(0.008)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.013)	(0.006)
lnage	**0.130*** **	**0.0853*** **	**0.119*** **	**0.183*** **	**0.173*** **	**0.186*** **	**0.108*** **	**0.0536*** **	**0.121*** **	**0.235*** **	**0.166*** **	**0.252*** **	**0.119*** **	**0.0965*** **	**0.131*** **	**0.0867*** **	**0.0938*** **	**0.0740*** **
	(0.001)	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)
Constant	6.460***	6.651***	6.288***	-1.088***	-0.497***	-1.253***	0.928***	0.0002	1.053***	-1.604***	-1.785***	-1.635***	-1.946***	-1.830***	-1.984***	-0.952***	-0.573***	-0.965***
	(0.004)	(0.009)	(0.006)	(0.002)	(0.005)	(0.003)	(0.006)	(0.013)	(0.008)	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.002)	(0.005)	(0.014)	(0.006)
Observations	1,264,312	220,809	581,634	1,046,303	118,690	760,500	226,881	62,314	147,805	3,569,593	722,130	2,317,811	3,532,654	457,177	2,511,432	497,641	61,007	397,815
R-squared	0.34	0.491	0.234	0.223	0.474	0.173	0.136	0.132	0.115	0.189	0.26	0.16	0.109	0.249	0.093	0.241	0.241	0.219

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Note: Size is based on number of employees.

Note: We use Orbis corporate data excludes the public administration. Service industries: excluding agriculture, forestry, fisheries, mining, manufacturing, construction, and public administration.

Table 3

Impact of each country's industry on TFP growth (2011-2019)

・dependent Variable: TFP growth rate by industry in each country☒

VARIABLES	Japan			France			Germany			Italy			Spain			UK		
	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	all sectors
size1(≧500)	**0.237*** **	**0.320*** **	**0.182*** **	**0.192*** **	**0.294*** **	**0.160*** **	**0.285*** **	**0.322*** **	**0.252*** **	**1.726*** **	**0.163*** **	**0.153*** **	**0.123*** **	**0.169*** **	**0.111*** **	**0.299*** **	**0.456*** **	**0.275*** **
	(0.005)	(0.010)	(0.007)	(0.007)	(0.011)	(0.009)	(0.007)	(0.015)	(0.008)	(0.013)	(0.011)	(0.010)	(0.008)	(0.016)	(0.009)	(0.007)	(0.016)	(0.008)
size2(250≧,<500)	0.129***	0.147***	0.0989***	0.127***	0.185***	0.113***	0.234***	0.267***	0.202***	1.253***	0.107***	0.106***	0.104***	0.132***	0.0926***	0.261***	0.401***	0.235***
	(0.005)	(0.011)	(0.006)	(0.006)	(0.010)	(0.008)	(0.007)	(0.013)	(0.008)	(0.012)	(0.010)	(0.009)	(0.007)	(0.012)	(0.009)	(0.007)	(0.016)	(0.009)
size3(50≧,<250)	0.0863***	0.0804***	0.0706***	0.0981***	0.143***	0.0862***	0.188***	0.218***	0.160***	0.882***	0.0819***	0.0854***	0.0723***	0.0892***	0.0669***	0.242***	0.359***	0.220***
	(0.002)	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)	(0.005)	(0.011)	(0.006)	(0.004)	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.004)	(0.011)	(0.005)
size4(20≧,<50)	0.0503***	0.0375***	0.0395***	0.0831***	0.109***	0.0774***	0.142***	0.173***	0.118***	0.559***	0.0542***	0.0536***	0.0530***	0.0574***	0.0503***	0.187***	0.282***	0.168***
	(0.002)	(0.004)	(0.003)	(0.002)	(0.005)	(0.003)	(0.006)	(0.013)	(0.007)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.005)	(0.013)	(0.006)
lnage	**-0.0171*** **	**-0.0104*** **	**-0.0240*** **	**-0.0191*** **	**-0.0305*** **	**-0.0163*** **	**-0.0101*** **	**-0.0101*** **	**-0.00560** **	**0.200*** **	**-0.0392*** **	**-0.0486*** **	**-0.0232*** **	**-0.0235*** **	**-0.0244*** **	**-0.0512*** **	**-0.0525*** **	**-0.0455*** **
	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)
Constant	0.0471***	0.0133	0.0747***	0.0275***	0.0237***	0.0247***	-0.134***	-0.182***	-0.119***	-0.515***	0.118***	0.158***	0.0606***	0.0558***	0.0641***	-0.0182***	-0.154***	-0.0160***
	(0.003)	(0.009)	(0.005)	(0.002)	(0.006)	(0.002)	(0.006)	(0.013)	(0.008)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)	(0.005)	(0.015)	(0.006)
Observations	1,052,578	190,010	486,110	970,431	112,661	701,353	221,144	61,661	143,065	3,283,754	700,304	2,183,960	3,368,748	444,961	2,394,247	442,339	58,489	350,543
R-squared	0.004	0.007	0.003	0.003	0.015	0.002	0.011	0.009	0.009	0.076	0.005	0.004	0.003	0.003	0.001	0.011	0.021	0.009

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Note: Size is based on number of employees.

Note: We use Orbis corporate data excludes the public administration. Service industries: excluding agriculture, forestry, fisheries, mining, manufacturing, construction, and public administration.

Table 4

TFP Growth Rates by Industry for All Firms in Each Country (Industries by Descending Order;Average2012-2019)

	Japan		France		Germany		Italy		Spain		UK	
(Unit: %)	industrial classification	growth rate	industrial classification	growth rate	industrial classification	growth rate	industrial classification	growth rate	industrial classification	growth rate	industrial classification	growth rate
1	**Finance and insurance**	10.200	**Finance and insurance**	15.768	Electricity, gas and water supply and waste management service	5.555	**Petroleum and coal products**	0.355	**Petroleum and coal products**	3.739	**Finance and insurance**	12.837
2	Transport and postal services	10.124	Human health and social work activities	6.635	**Petroleum and coal products**	5.376	Agriculture, forestry and fishing	0.258	Electricity, gas and water supply and waste management service	3.724	Electricity, gas and water supply and waste management service	0.079
3	**Electric machinery, equipment and supplies**	9.605	Chemicalls	5.606	**Finance and insurance**	4.429	Basic metal	0.129	General-purpose, production and business oriented machinery	3.318	**Petroleum and coal products**	0.060
4	Real estate	9.475	Electricity, gas and water supply and waste management service	5.600	**Transport equipment**	4.104	Construction	0.102	Chemicalls	2.883	Mining	0.057
5	**Electric components and devices**	9.303	Information and communications	5.461	Chemicalls	3.959	**Finance and insurance**	0.099	**Transport equipment**	2.768	Non-metallic mineral products	0.038
6	Chemicalls	9.040	**Electric components and devices**	5.079	Real estate	3.765	Mining	0.098	**Finance and insurance**	2.755	Non-metallic mineral products	0.032
7	Education	8.948	Professional, scientific and technical activities	4.903	Human health and social work activities	1.224	Professional, scientific and technical activities	0.081	Fabricated metal products	2.504	**Transport equipment**	0.006
8	Information and communications	8.938	**Electric machinery, equipment and supplies**	4.172	**Electric machinery, equipment and supplies**	0.858	Education	0.065	**Electric machinery, equipment and supplies**	2.445	Food products and bevarages	0.004
9	Mining	8.736	**Transport equipment**	3.769	Information and communications	0.531	**Electric machinery, equipment and supplies**	0.045	Transport and postal services	2.417	General-purpose, production and business oriented machinery	0.000
10	Accomodation and food service activities	8.383	General-purpose, production and business oriented machinery	3.525	**Electric components and devices**	0.477	Real estate	0.029	Basic metal	2.276	**Electric components and devices**	0.000
11	Non-metallic mineral products	8.089	Basic metal	2.762	General-purpose, production and business oriented machinery	0.422	Fabricated metal products	0.025	Electric components and devices	2.273	Professional, scientific and technical activities	-0.012
12	Human health and social work activities	7.949	Petroleum and coal products	2.490	Food products and bevarages	0.391	Other manufacturing	0.017	Pulp, paper and paper products	1.786	Education	-0.013
13	Construction	7.744	Non-metallic mineral products	2.477	Mining	-0.017	Information and communications	0.013	Non-metallic mineral products	1.532	Information and communications	-0.014
14	Other manufacturing	7.135	Pulp, paper and paper products	2.238	Education	-0.404	Electric components and devices	0.010	Food products and bevarages	1.483	Other manufacturing	-0.018
15	Other service activities	6.899	Mining	2.028	Pulp, paper and paper products	-0.647	Textile products	0.006	Human health and social work activities	1.371	Electric machinery, equipment and supplies	-0.024
16	Professional, scientific and technical activities	6.146	Fabricated metal products	1.908	Professional, scientific and technical activities	-0.887	General-purpose, production and business oriented machinery	0.001	Information and communications	1.271	Pulp, paper and paper products	-0.026
17	Basic metal	6.121	Transport and postal services	1.369	Textile products	-1.094	Accomodation and food service activities	-0.008	Education	1.209	Fabricated metal products	-0.031
18	Transport equipment	5.836	Education	1.231	Non-metallic mineral products	-1.125	Wholesale and retail trade	-0.023	Real estate	1.085	Basic metal	-0.034
19	General-purpose, production and business oriented machinery	5.670	Other manufacturing	0.183	Basic metal	-1.234	Chemicalls	-0.034	Accomodation and food service activities	0.729	Wholesale and retail trade	-0.035
20	Food products and bevarages	5.620	Real estate	-0.017	Other manufacturing	-1.568	Transport and postal services	-0.064	Other manufacturing	0.616	Human health and social work activities	-0.037
21	Wholesale and retail trade	5.149	Construction	-0.333	Transport and postal services	-2.334	Electricity, gas and water supply and waste management service	-0.066	Agriculture, forestry and fishing	0.532	Transport and postal services	-0.039
22	Pulp, paper and paper products	4.900	Wholesale and retail trade	-0.457	Wholesale and retail trade	-2.486	Human health and social work activities	-0.092	Construction	0.195	Construction	-0.041
23	Fabricated metal products	4.348	Food products and bevarages	-0.557	Fabricated metal products	-2.495	Food products and bevarages	-0.102	Mining	0.082	Accomodation and food service activities	-0.050
24	Textile products	3.923	Textile products	-2.171	Other service activities	-4.443	Pulp, paper and paper products	-0.115	Wholesale and retail trade	-0.026	Textile products	-0.084
25	Agriculture, forestry and fishing	3.818	Other service activities	-2.550	Construction	-5.674	Other service activities	-0.147	Professional, scientific and technical activities	-0.464	Real estate	-0.090
26	Electricity, gas and water supply and waste management service	3.243	Agriculture, forestry and fishing	-2.754	Agriculture, forestry and fishing	-7.805	Non-metallic mineral products	-0.188	Other service activities	-0.823	Agriculture, forestry and fishing	-0.096
27	Petroleum and coal products	1.611	Accomodation and food service activities	-7.040	Accomodation and food service activities	-9.526	Transport equipment	-0.579	Textile products	-0.936	Other service activities	-0.097

(Note) Created from Orbis corporate database.

4.2. Analysis of Zombie firms, comparison of Zombie firm ratio and asset ratio

Based on the definition of Zombie firms in Section 3.3, we compared Japan and the five European countries regarding the status of Zombie firms in each country. As shown in Fig. 3, the percentage of Zombie firms in each country (all industries) exceeded 10% in Japan and Spain in 2013, but both countries have been declining since then, reaching 8.69% and 5.81% as of 2019, respectively. Italy has similarly declined, from 9.81% to 5.21%. On the other hand, in Germany and the U.K., the rate is low at around 5% and remains largely unchanged. Only in France has the ratio of Zombie firms increased (from 6.51% to 8.9%). Japan had a high ratio of Zombie firms, but the ratio has since declined to the same level as in other European countries[22].

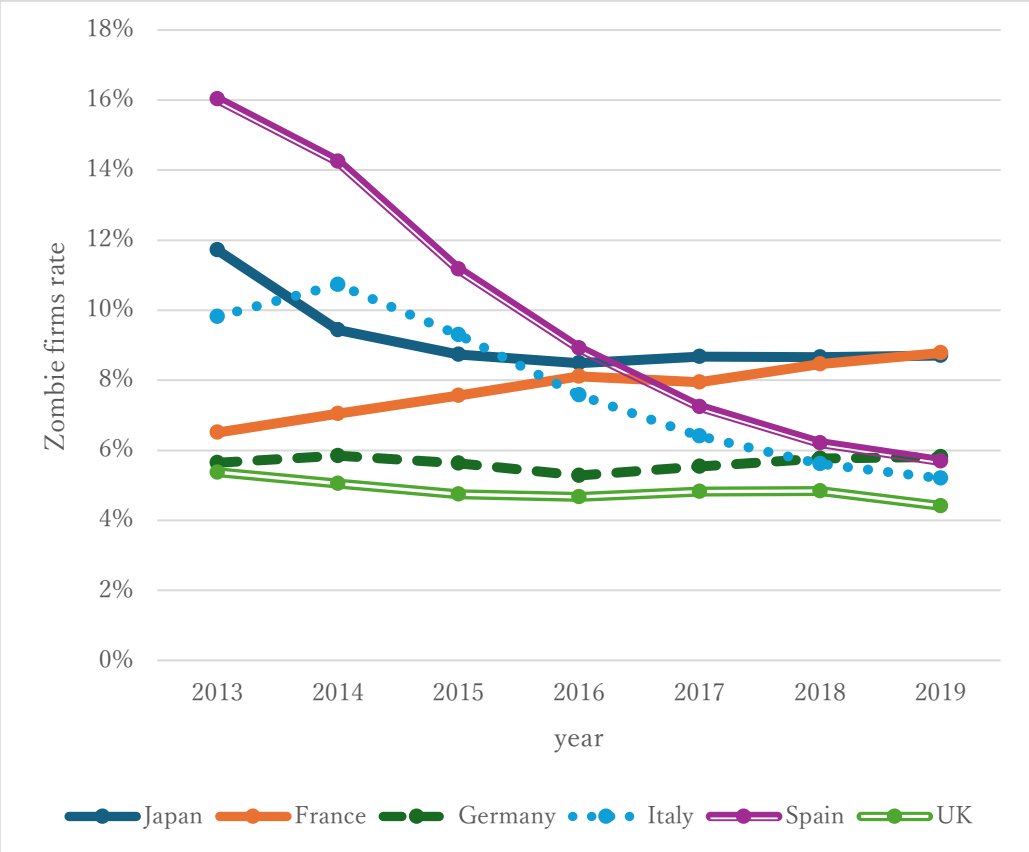

Fig. 3. Percentage of Zombie firms by country, Japan and European countries (2013-2019)

[22] The "Analysis of the Current Status of Zombie Firms (Latest Trends as of November 30, 2023)" (Teikoku Databank, Inc. 2024/1/19) states that "Japan's zombie company rate has been declining, but the Corona disaster will increase the rate from FY2020 (25.1% in FY22).

The ratio of Zombie firms was calculated by company size in each country (see the graph on the left in Fig. 4). In Japan, the ratio of Zombie firms decreases as the size of the company increases, while in the U.K. and France, the ratio of Zombie firms tends to grow as the size of the firm increases. In Germany, Italy, and Spain, the ratio of Zombie firms is higher for the smallest firms (less than 20 employees) but is lower for medium and small firms.

In addition, a comparison of the ratio of Zombie firms (all period average) by firm age, shows that the ratio of Zombie firms tends to increase with firm age in all countries except Germany, (See the graph on the right in Fig. 4)[23]. It should be noted that the definition of Zombie firms in this paper excludes startup firms that have been in business for less than 10 years.

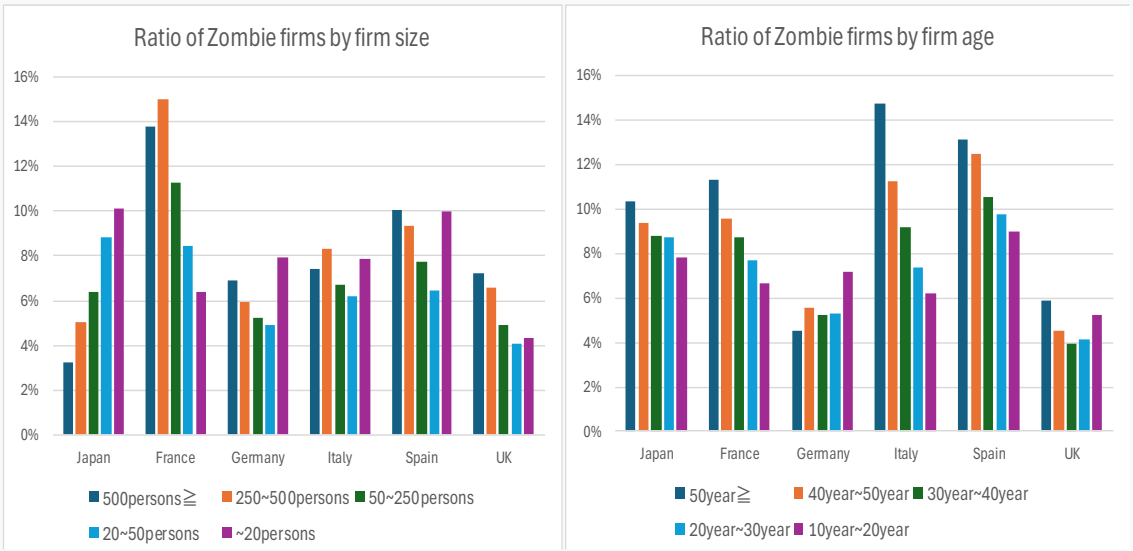

Fig. 4. Ratio of Zombie companies by company size and age by country, Japan and Europe (2013-2019 average)

Next, we will compare Zombie's firm asset ratios. In examining the negative impact of Zombie firms on each country's economy, asset size is more important than the number of such firms. Regarding capital investment and employment, the Zombie status of firms with large asset sizes has a more significant negative impact on the economy than if there are large numbers of small and medium-sized Zombie firms.

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[23] Goto and Wilber (2017) also show that the percentage of firms that become zombies is higher for older firms, and Goto states, "We can infer that younger firms will exit the market at a stage before they become zombies. In contrast, older firms are more likely to become zombies because the financial institutions with which they do business take measures to prolong their lives." (Research Digest No. 0122 https://www.rieti.go.jp/jp/publications/rd/122.html)

After the financial crisis (2008～2009) and the European sovereign debt crisis (2011～2012), a look at the Zombie firm asset ratios in Japan and the five European countries shows a downward trend in each country (see Fig. 5). In particular, it is noteworthy that Japan has remained at the lowest level. An analysis of the same definition for U.S. listed companies also summarizes the ratio of Zombie firms in the 2010s at around 7-9% (Acharya et al. (2022)).

Table 5 shows the top 10 industries in terms of Zombie firm's asset ratios by industry and country. The table shows that basic metal (iron and steel and non-ferrous metal manufacturing) dominates in all five European countries except Italy and that manufacturing industries with large assets, such as transport equipment (France and Italy) and electrical machinery, equipment, and supplies (Italy, Spain, and the U.K.), have a high ratio of Zombie firm assets to total assets. On the other hand, human health and social work activities (medical corporations, farmers' pension funds, etc.) and other services are higher in Japan. The high rates for electricity, gas, etc. and petroleum products, etc. in Japan can be attributed to individual factors related to the energy crisis caused by the Great East Japan Earthquake in 2011.

The above analysis by Zombie firm asset ratios shows that the asset ratios of Zombie large firms (notably construction, wholesale and retail trade, at the time), which are believed to have contributed to Japan's economic downturn since the 1990s, have declined over time since then[24].

[24] Caballero et al. (2008) identified Japan's construction, wholesale and retail trade, and service industries as those with a high percentage of Zombie firms in terms of employment, Fukuda and Nakamura (2011), although their definition of Zombie firms differs from this paper, analyze the large decrease in the ratio of Zombie firms and factors such as restructuring measures based on data for listed companies from 1995 to 2004.

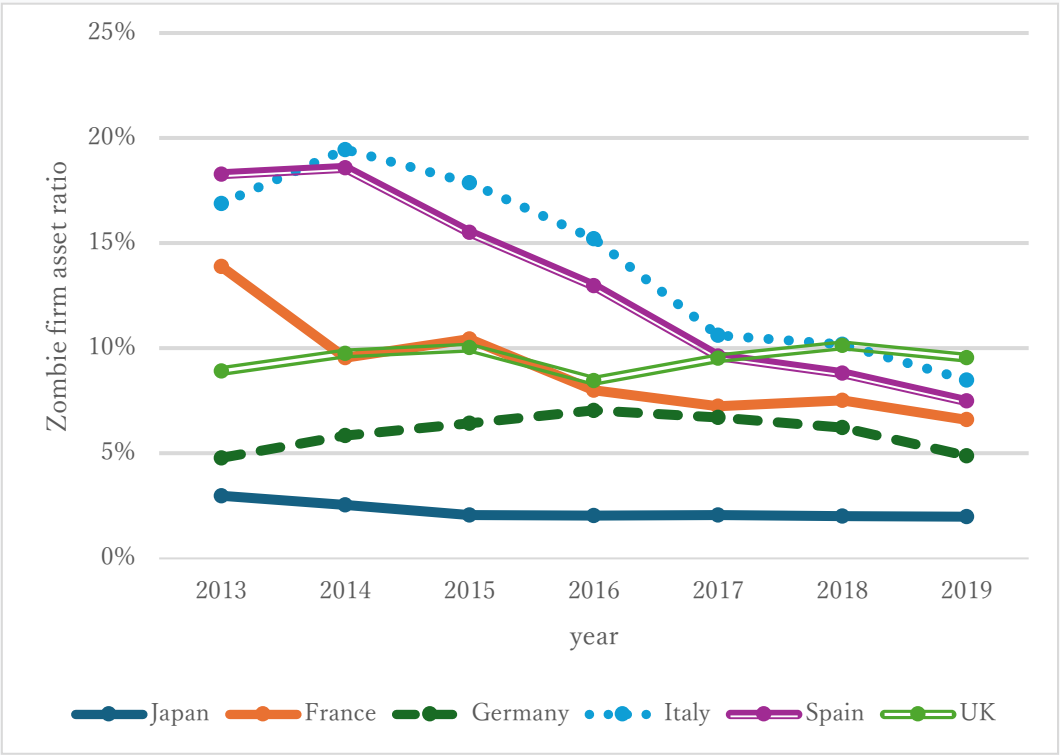

Fig. 5. Zombie firm asset ratios for Japanese and European countries (2013-2019)

Table 5

Top 10 industries in terms of Zombie firm assets in JP and European countries

(Unit:%)

	Japan		France		Germany		Italy		Spain		UK	
Top 10 Industries	industrial classification	Firm assets	industrial classification	Firm assets	industrial classification	Firm assets	industrial classification	Firm assets	industrial classification	Firm assets	industrial classification	Firm assets
1	**Human health and social work activities**	18.5	**Basic metal**	28.9	**Basic metal**	58.6	Other service activities	30.0	Construction	18.9	Other service activities	24.5
2	**Electricity, gas and waters supply and waste managemant servic**	9.6	Transport and Postal services	24.2	Other service activities	14.2	Agriculture, forestry and fishing	25.9	**Basic metal**	17.4	Transport and Postal services	15.7
3	Agriculture, forestry and fishing	7.5	Other service activities	17.9	Electricity, gas and water supply and waste management service	13.9	**Transport equipment**	24.2	Non-metallic mineral products	17.0	**Basic metal**	14.5
4	Other service activities	4.0	Pulp, Paper and paper products	13.5	Information and communications	11.9	Real estate	19.9	Professional, scientific and technical activities	15.4	**Electric machinery, equipment and supplies**	6.9
5	Textile products	3.3	Wholesale and retail trade	10.2	Accomodation and food service activities	10.2	Accomodation and food service activities	17.8	Accomodation and food service activities	13.9	Real estate	6.3
6	Fabricated metal products	2.9	Education	10.1	Human health and social work activities	9.7	Construction	17.1	Real estate	13.0	Human health and social work activities	6.3
7	Petroleum and coal products	2.6	Agriculture, forestry and fishing	8.5	Education	8.0	Petroleum and coal products	17.0	Agriculture, forestry and fishing	12.5	Accomodation and food service activities	6.1
8	Accomodation and food service activities	2.4	Finance and insurance	8.3	Mining	7.4	Non-metallic mineral products	14.7	**Electric machinery, equipment and supplies**	11.7	Fabricated metal products	5.4
9	Other manufacturing	2.3	Accomodation and food service activities	6.9	Pulp, Paper and paper products	7.2	Information and communications	12.9	Electric components and devices	11.4	Professional, scientific and technical activities	5.4
10	Pulp, Paper and paper products	2.2	**Transport equipment**	5.9	Transport and Postal services	6.1	**Electric machinery, equipment and supplies**	12.4	Finance and insurance	11.3	Non-metallic mineral products	5.2

(Note) Created from Orbis corporate database.

4.3. Analysis of the Impact of Zombie Firms on TFP by Industry, Size, and Age

The impact of Zombie firms on productivity and TFP in each country could have two paths: low productivity of Zombie firms themselves and external effects of Zombie firms on healthy firms (McGowan et al. (2018)). Therefore, we conducted the following regression analysis of Zombie firms' productivity and TFP by industry, size, and age in Japan and five European countries, and compared them with Non-Zombie firms (Table 6).

$$lnTFP_{ist} = \beta_0 + \beta_1 Z_{ist} + \beta_2 lnAge_{ist} + \delta_{st} + \gamma_i + \varepsilon_{ist} \quad \text{---------(8)}$$

$$lnTFP_{ist} = \beta_0 + \beta_1 Size_{ist} * Z_{ist} + \beta_2 lnAge_{ist} + \delta_{st} + \gamma_i + \varepsilon_{ist} \quad \text{--(9)}$$

where i is firm, s is industry, t is time (years), Z is Zombie dummy, Size is firm size dummy (5 categories based on the number of employees) with an intersection term with Z, Age is firm age as a control variable, δ is industry and time-specific fixed effects, γ is individual firm fixed effects, and ε is an error term. The upper panel of Table 6 shows the results of equation (8) and the lower panel shows the results of equation (9).

First, equation (8) results show that Zombie firms have a negative and significant impact on TFP in each country for all industries, the manufacturing industry, and the service industry categories (see upper row of Table 6). Next, we analyzed the productivity of Zombie firms by firm size. Equation (9) compares the impact of Non-Zombie firms and Zombie firms (size 1-4) on TFP by performing a regression analysis based on small Zombie firms with less than 20 employees (size 5), using the intersection term between firm Size and Z (Zombie Dummy) as an explanatory variable. The results are positive and significant for the larger Zombie firms. Therefore, the smaller Zombie firms can be understood to have a more negative impact on TFP, as seen in Japan (on aggregate for all industries and the service industry (but size 2 is negatively significant)), Germany (all industries and the service industry), Italy (all industries, service industry), Spain (all industries, service industry), and the U.K. (all industries, manufacturing industry, service industry). Conversely, Zombie firms with larger sizes are negatively significant, and it can be understood that larger Zombie firms have a more negative impact on TFP in France (all industries, manufacturing industry, service industry) (Table 6.).

Furthermore, in the manufacturing industry, large Zombie firms (size 1: 500 or more employees) had a significant negative impact on TFP in Japan, France, and Spain, which is characteristic of this industry. However, in the manufacturing industry, Zombie medium-

sized firms had a significant positive impact in Japan (size 3), Spain (size 3), and the U.K. (size 2), indicating that larger firms do not simply have a negative impact.

The results for firm age are positive and significant except for the U.K. and Germany (manufacturing), and the results show that firms with longer years of operation have a more positive impact on TFP.

The results of the above analysis show that small Zombie firms tend to negatively impact TFP for all industries and the service industry in Japan, Germany, Italy, Spain, and the U.K. On the other hand, in France, the larger the size of the Zombie firm, the more negative the impact on TFP in all industries and the manufacturing industry. The manufacturing industry shows that the effect is not necessarily proportional to size.

In addition, previous studies on Japanese SMEs (Imai (2016a), Imai (2016b)) differ from this report in terms of the definition of Zombie firms, the period covered, and the classification of SMEs (capitalization classification)[25]. Still, the papers found that capital investment by Zombie SMEs had a negative impact on the growth rate of value-added labor productivity and the papers had no effect on productivity growth (1999-2008)[26].

[25] The above prior studies focused on small and medium-sized firms based on the corporate information of Tokyo Shoko Research. In contrast, the definition of Zombie firms was based on Fukuda and Nakamura (2011) and their criteria with some modifications of the profitability criteria.

[26] Value-added labor productivity is "operating income + provision for bonuses + salary allowance + retirement allowance + provision for retirement pay + legal welfare expenses + welfare expenses + miscellaneous wages + depreciation implementation" / "number of employees + working hours index" (Imai (2016b)). the above prior studies focused on small and medium-sized firms based on Tokyo Shoko Research's corporate information. In contrast, the definition of Zombie firms was based on Fukuda and Nakamura (2011) and their criteria with some modifications of the profitability criteria.

Table 6

Analysis of the impact of Zombie firms on TFP by size, industry, and age

Dependent variables:TFP、Panel data Fixed Effect（All Hausman test results support Fixed Effect)

(country)	Japan			France			Germany			Italy			Spain			UK		
(type of industry)	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry	all industry	Manufacturing	service industry
Zombie dummy	-0.169***	-0.188***	-0.136***	-0.141***	-0.153***	-0.142***	-0.151***	-0.148***	-0.150***	-0.249***	-0.214***	-0.248***	-0.297***	-0.270***	-0.280***	-0.242***	-0.244***	-0.229***
	(0.003)	(0.005)	(0.004)	(0.003)	(0.007)	(0.004)	(0.006)	(0.010)	(0.007)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.009)	(0.014)	(0.011)
lnage（firm age)	0.366***	0.258***	0.377***	0.111***	0.247***	0.113***	0.109***	0.070	0.138***	0.149***	0.191***	0.160***	0.173***	0.273***	0.123***	-0.042	0.008	-0.011
	(0.016)	(0.040)	(0.024)	(0.017)	(0.042)	(0.022)	(0.023)	(0.044)	(0.029)	(0.008)	(0.014)	(0.011)	(0.010)	(0.021)	(0.012)	(0.029)	(0.059)	(0.035)
variables																		
z0(non-zombie	0.178***	0.195***	0.145***	0.130***	0.104***	0.138***	0.185***	0.144	0.179***	0.253***	0.210***	0.252***	0.306***	0.278***	0.289***	0.369***	0.309***	0.335***
my)	(0.003)	(0.008)	(0.005)	(0.005)	(0.013)	(0.006)	(0.024)	(0.108)	(0.025)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)	(0.002)	(0.023)	(0.056)	(0.027)
catez1(size1×Z)	0.036	-0.317***	0.0752**	-0.0356**	-0.155***	0.007	0.0618**	0.009	0.0564*	-0.009	-0.016	-0.029	0.0987***	-0.117**	0.115***	0.194***	0.0983	0.165***
	(0.029)	(0.074)	(0.033)	(0.018)	(0.032)	(0.023)	(0.029)	(0.117)	(0.031)	(0.029)	(0.040)	(0.038)	(0.027)	(0.054)	(0.032)	(0.031)	(0.068)	(0.037)
catez2(size2×Z)	-0.008	0.052	-0.0509*	-0.015	-0.0930***	0.015	0.0933***	0.047	0.0945***	0.0378*	-0.025	0.0495*	0.134***	-0.015	0.161***	0.191***	0.160**	0.162***
	(0.023)	(0.049)	(0.028)	(0.015)	(0.027)	(0.020)	(0.028)	(0.112)	(0.032)	(0.022)	(0.030)	(0.030)	(0.025)	(0.038)	(0.030)	(0.032)	(0.068)	(0.038)
catez3(size3×Z)	0.0327***	0.0353**	0.017	-0.0169**	-0.0798***	0.003	0.032	-0.005	0.025	0.0276***	-0.0277***	0.0447***	0.0910***	0.0686***	0.0797***	0.131***	0.063	0.108***
	(0.008)	(0.014)	(0.011)	(0.008)	(0.017)	(0.011)	(0.025)	(0.109)	(0.026)	(0.008)	(0.010)	(0.011)	(0.009)	(0.014)	(0.011)	(0.026)	(0.058)	(0.031)
catez4(size4×Z)	0.0206***	0.003	0.0263***	-0.0223***	-0.026	-0.0224**	-0.0417	-0.139	-0.030	0.0206***	-0.008	0.0219***	0.0799***	0.0369***	0.0747***	0.0975***	-0.013	0.0886***
	(0.006)	(0.012)	(0.009)	(0.008)	(0.019)	(0.010)	(0.028)	(0.114)	(0.031)	(0.005)	(0.008)	(0.007)	(0.006)	(0.010)	(0.007)	(0.029)	(0.064)	(0.034)
lnage	0.365***	0.258***	0.377***	0.111***	0.246***	0.113***	0.109***	0.071	0.138***	0.149***	0.191***	0.160***	0.169***	0.269***	0.120***	-0.043	0.007	-0.011
	(0.016)	(0.040)	(0.024)	(0.017)	(0.042)	(0.022)	(0.023)	(0.044)	(0.029)	(0.008)	(0.014)	(0.011)	(0.010)	(0.021)	(0.012)	(0.029)	(0.059)	(0.035)
Observations	836,532	155,294	385,783	398,247	56,969	282,624	123,732	37,427	78,029	1,612,452	395,877	994,905	1,811,932	272,676	1,253,163	229,066	36,542	175,242
R-squared	0.016	0.015	0.01	0.008	0.014	0.008	0.01	0.008	0.011	0.015	0.019	0.015	0.031	0.045	0.027	0.005	0.011	0.004

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(Note 1) We use Orbis corporate data excludes the public administration. The service industry excludes construction and public administration from the non-manufacturing sector.

(Note 2) The definition of the Zombie dummy is "interest coverage ratio less than one for three consecutive years and over 10years old.Catez is a dummy variable with a cross term of firm size (dummy variable for 5 categories of number of employees) x Zombie dummy. firm size: 500 or more employees = size 1, 250 to less than 500 employees = size 2, 50 to less than 250 employees = size 3, 20 to less than 50 employees = size 4, less than 20 employees = size 5. The analysis（Table 6） in the lower section is based on the 5 categories.

catez0=non-zombie dummy catez1=size1×zombie dummy catez2=size2×zombie dummy catez3=size3×zombie dummy catez4=size4×zombie dummy catez5=size5×zombie dummy

(Note 3) Industry and year fixed effects are added along with lnage as control functions.

4.4. Comparison of Zombie firm survival rate

We compare and verify the survival rates of Zombie companies after one and two terms in Japan and the five European countries. Zombie firms, fuge ones, are known as "too big to fail," where their continued existence and lack of metabolism without exiting the market are seen as problems. On the other hand, in the Japanese case since the 1990s, Zombie firms have either exited or become financially sound, with economic recovery, restructuring, and governance (discipline by shareholders and incentives for executives) being analyzed as contributing factors (Fukuda and Nakamura (2011) and Goto and Wilbur (2017)[27]. Note that

[27] Goto and Wilber (2017), used a panel logit model to analyze the factors contributing to the zombification of small and medium-sized firms. They added a zombie dummy from one period ago as an

the construction and wholesale and retail trade industries, which were regarded as Zombie large companies in the 1990s and were a factor in the downturn of the Japanese economy (Caballero et al. (2008)), were not among the top 10 industries in terms of Zombie corporate asset ratios in the 2010s (see Table 5).

We will, therefore compare and verify the survival rates of Zombie firms after one and two fiscal years[28]. The survival rate of Zombie firms (see Table 7, total) is 65~76% after one term and 45~59% after two terms, indicating that about half of them become healthy in two years and do not stay as Zombie firms. In that order, the countries with the highest survival rates were France, the U.K., and Germany. In Japan, 66% of the firms were out of Zombie status after the first term and 47% after the second term, indicating that half were out of Zombie status in a relatively short period.

Furthermore, when comparing firm sizes, "too big to fail" applies to medium and large companies (size 1, size 2, and size 3) with 50 or more employees in Japan, France, Italy, and Spain, as their survival rate is higher than that of small companies (size 5) with less than 20 employees in these countries. The fact that a higher percentage of larger firms continue to remain zombie firms than firms with 20 to 50 employees (size 4) in all countries except Germany and the U.K. (except for size 1 and size 2 in Spain) suggests that the transformation of SMEs into zombie firms cannot be linked to the economic downturn.

explanatory variable. They found it negative and significant, suggesting that zombie firms are not continuously in a zombie state.

[28] Only firms with data for three consecutive periods from 2013 to 2017 are included, so there is a bias in not including firms that lose data in the middle of the period due to exits or other reasons.

Table 7

Zombie firm survival rates in Japanese and European countries (overall and by size after 1 and 2 terms)

(Unit:%)

	t+1term						t+2term					
firm scale	Japan	France	Germany	Italy	Spain	UK	Japan	France	Germany	Italy	Spain	UK
size 1	71.25	82.48	76.40	77.72	73.25	71.29	51.64	69.57	62.13	62.28	52.44	55.65
size 2	72.65	80.09	67.16	69.16	73.19	70.02	55.44	67.18	48.89	52.31	56.62	49.82
size 3	67.16	79.01	70.59	69.74	67.48	71.37	49.20	63.11	52.73	51.54	46.86	54.13
size 4	66.71	74.32	70.12	65.44	63.91	71.82	48.65	57.55	58.46	46.47	43.22	54.66
size 5	65.37	73.61	85.63	66.77	65.31	78.32	45.99	57.17	66.54	47.13	44.82	62.50
total	66.21	76.04	71.19	67.05	65.32	73.75	47.39	59.96	54.43	47.65	44.86	56.66

(note) firm size: 500 or more employees = size 1, 250 to less than 500 employees = size 2, 50 to less than 250 employees = size 3, 20 to less than 50 employees = size 4, less than 20 employees = size 5

4.5. Impact of Zombie firms on Non-Zombie firms

It has been noted that there is a congestion effect when the survival of Zombie firms negatively affects the investment and employment aspects of Non-Zombie firms (Caballero et al. (2008), McGowan et al. (2018)). Therefore, we examined the impact of Zombie firms on Non-Zombie firms using the capital investment/capital stock ratio (I/K ratio), employment growth rate (change in number of employees), and TFP level as explained variables in the Orbis DB for 2011-2019 (I/K ratio only from 2012 to 2019). The results of the panel data analysis for each country and the model equation are as follows.

$r_{ist}^{k} = \beta_1 nonZ_{ist} + \beta_2 Z_{st} + \beta_3 nonZ_{ist} * Z_{st} + \beta_4 Firm\ Controls_{st-1} + \delta_{st}$ (industry and year-fixed effect) $+\varepsilon_{ist}$ ----------(10)

where r refers to three separate dependent variables (log(I/K): (capital investment/capital stock ratio), ΔE: change in the number of employees, TFP: total factor productivity level, k=three variables), in firm i, in industry s, at time t. The non-Z is a dummy equal to 1 if a firm is a Non-Zombie firm, Z is Zombie firm tangible and intangible fixed assets ratio and firm controls include dummies for firm age (young=1 if age<6) and firm size (number of

employees), δ is industry and year fixed effects, and ε is the error term[29].

To include the impact on younger firms, we did not require Non-Zombie firms to have been in business for at least 10 years, but rather to have had financial data for at least three years.

4.6. Hypotheses of previous studies on the impact of Zombie firms on Non-Zombie firms and the results of the analysis in this paper

Previous studies such as Caballero et al. (2008) and McGowan et al. (2018) show the impact of Zombie firms on Non-Zombie firms is negative (β_3 in equation (10)) for investment and employee growth, and for productivity proxy and TFP level is positive. Non-Zombie firms will need high productivity to stay in business under distorted excessive competition, and the Zombie firm asset share will have a positive impact (β_3 in equation (10) is positive) on the TFP level of Non-Zombie firms. Based on the assumptions of the previous studies described above, we analyzed the impact of Zombie firms on Non-Zombie firms using the model equation (10) with the three dependent variables (capital investment, employment, and TFP level) as explained variables (Table 8).

The results are as follows. Examples of previous representative studies are shown in Appendix Table B. The impact on the capital investment/capital stock ratio (I/K ratio) is negative and significant for Japan and Germany, and positive and significant for Italy, Spain, and the U.K., in terms of the sum of the coefficients of the Zombie asset ratio and the interaction term between Non-Zombie dummy and Zombie asset ratios. France did not obtain significant results. Previous studies by Caballero et al. (2008) and Imani and Uesugi (2023) found negative significance in Japan. McGowan et al. (2018) findings were negative and significant for 9 OECD countries, and Albuquerque and lyer (2023)[30] were negative and significant for nonfinancial listed companies in 63 countries, the verification results are consistent for the Japanese and German examples.

The impact of Zombie firms on the changes in the number of employees is negative and significant in Japan and the five European countries, as seen in the sum of the coefficients of the Zombie asset ratio and the interaction terms between Non-Zombie dummy and Zombie asset ratios. Previous studies such as Caballero et al. (2008), McGowan et al. (2018), Albuquerque and lyer (2023)[31]. And Imani and Uesugi (2023) also analyzed the results as

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[29] Caballero et al. (2008) do not take one period lag in firm control, and McGowan et al. (2018) do not add Z as an explanatory variable by itself but take one period lag in firm control.

[30] The explained variables are not I/K, but K (capital stock) and intangible assets.

[31] The explained variable is not TFP, but Log sales-2/3logE-1/3logK as a productivity proxy.

negative and significant, consistent with the current validation results.

The impact of Zombie firms on the level of TFP can be seen by the sum of the coefficients of the Zombie asset ratio and the interaction term between Non-Zombie dummy and Zombie asset ratios. Only Japan has a positive significance, France, Germany, Italy, and Spain have a negative significance and the results are not significant for the UK. The positive significance of Japan is consistent with the effects on the productivity proxy variables of Caballero et al. (2008) and TFP of McGowan et al. (2018)). On the other hand, Albuquerque & lyer (2023) also find negative significance for TFP, but the results are based on a combined analysis of firms from many countries, and the characteristics of each country are unclear[32]. Imani and Uesugi (2023) also tested the effect on productivity proxy variables, which is similar to Caballero et al. (2008), for Japan and found it negative and significant. Each prior study differs in the year of analysis, the target firm data, the definition of Zombie, and the explained variable. Appendix B summarizes the examination of the previous central studies on the external effects (investment, employment, and productivity) of Zombie firms.

In addition, Acharya et al. (2022) analyze U.S. listed companies (2004-2020) based on each of the six definitions of Zombie firms, covering employment and investment. As an external effect of Non-Zombie firms, the interaction term between Non-Zombie firms and Zombie asset ratios is negative and significant only when receiving interest rate subsidies (see Appendix Table B). The report clarifies the differences between the analysis method categories and the results, but the analysis does not include productivity.

This paper defines Zombie firms based on the MAM criterion, which allows for a multinational analysis. It summarizes the results of a study using Orbis firm data on investment, employment, and productivity in Japan and the five selected European countries in the 2010s.

[32] Analysis using data from the U.S. (Standard & Poor's) and listed firms in 63 countries (Compustat Global on nonfinancial listed firms) and other Orbis firm data; individual Japanese examples are unknown.

Table 8

Performance of Zombie and Non-Zombie firms: Three dependent variables

(See (Caballero.et al (2008) and (McGowan.et al (2018)) Panel of Japan and 5coutries

Country	Japan		France		Germany		Italy		Spain		UK	
VARIABLES	**log(I/K) : dependentVariable** 2012～2019											
Non-Zombie dummy	0.0738***	0.0930***	0.166***	0.176***	0.214***	0.262***	0.243***	0.250***	0.342***	0.256***	0.0148	-0.0212
	(0.005)	(0.004)	(0.038)	(0.033)	(0.032)	(0.028)	(0.022)	(0.015)	(0.031)	(0.019)	(0.021)	(0.019)
Industry Zombie asset ratio	**-0.912*** **		-0.154		**-0.985*** **		**-0.063**		**0.804*** **		**0.710*** **	
	(0.124)		(0.319)		(0.302)		(0.137)		(0.224)		(0.171)	
Non-Zombie dummy	**0.500*** **	**-0.307*** **	0.073	-0.064	**-0.065**	**-0.955*** **	**0.252***	**0.190*** **	**0.486** **	**1.257*** **	**0.199**	**0.839*** **
×Industry Zombie asset ratio	(0.127)	(0.064)	(0.339)	(0.185)	(0.299)	(0.121)	(0.142)	(0.044)	(0.235)	(0.094)	(0.212)	(0.146)
Observations	872,887	872,887	465,750	465,750	148,266	148,266	2,541,116	2,541,116	1,828,281	1,828,281	270,045	270,045
AdjR2	0.004	0.004	0.0004	0.0004	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.002
VARIABLES	**ΔE（log Change in number of employees）: dependentVariable** 2011～2019											
Non-Zombie dummy	0.0335***	0.0314***	0.0502***	0.0509***	0.0360***	0.0331***	0.0783***	0.0856***	0.0991***	0.107***	0.0649***	0.0637***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Industry Zombie asset ratio	**0.0965*** **		-0.009		**0.0573***		**-0.0589*** **		**-0.0689*** **		**0.024**	
	(0.026)		(0.013)		(0.034)		(0.009)		(0.009)		(0.017)	
Non-Zombie dummy	**-0.135*** **	**-0.0444*** **	-0.0466***	**-0.0554*** **	**-0.0987*** **	**-0.0454*** **	**-0.227*** **	**-0.285*** **	**-0.539*** **	**-0.606*** **	**-0.165*** **	**-0.144*** **
×Industry Zombie asset ratio	(0.027)	(0.012)	(0.015)	(0.007)	(0.034)	(0.013)	(0.009)	(0.003)	(0.009)	(0.004)	(0.022)	(0.016)
Observations	1,413,549	1,413,549	921,561	921,561	229,358	229,358	3,538,470	3,538,470	3,631,829	3,631,829	509,187	509,187
AdjR2	0.856	0.856	0.871	0.871	0.926	0.926	0.706	0.706	0.703	0.703	0.858	0.858
VARIABLES	**TFP : dependentVariable** 2011～2019											
Non-Zombie dummy	0.108***	0.0962***	0.0566***	0.0592***	0.134***	0.127***	0.161***	0.184***	0.125***	0.174***	0.0685***	0.0634***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)
Industry Zombie asset ratio	**0.540*** **		-0.0370**		0.132***		-0.185***		-0.455***		0.0934***	
	(0.054)		(0.016)		(0.042)		(0.011)		(0.012)		(0.030)	
Non-Zombie dummy	**0.430*** **	**0.938*** **	-0.015	-0.0503***	-0.198***	-0.0747***	-0.0527***	-0.234***	0.159***	-0.281***	-0.053	0.031
×Industry Zombie asset ratio	(0.057)	(0.026)	(0.017)	(0.008)	(0.042)	(0.016)	(0.012)	(0.004)	(0.013)	(0.005)	(0.037)	(0.026)
Observations	1,187,593	1,187,593	840,958	840,958	219,066	219,066	3,373,541	3,373,541	3,271,201	3,271,201	389,820	389,820
AdjR2	0.054	0.054	0.007	0.007	0.011	0.011	0.025	0.025	0.023	0.023	0.004	0.004

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(Note) For each of the above three activities, one-period lag of company age, one-period lag of employee size, and industry & year dummy are used as control functions. Regarding the influence on log(I/K), the one-period lag in firm age is negative and significant for Italy, Spain, and the U.K.
The one-period lag for the size of the number of employees is positive and significant for Italy, and the U.K., and negative and significant for Germany, Spain.
Regarding the influence on log changes in the number of employees, the one-period lag of firm age is positively significant for France and the U.K., and negatively significant for Japan, Germany, Italy and Spain. The one-period lag of the number of employees showed negative significance in all 6 countries.
Regarding the impact on TFP, the one-period lag of firm age was positively significant for France, negative significant for Japan, Italy,Spain, and the U.K. and the one-period lag of employee size was positive and significant for all 6 countries. Others were not significant.

4.7. Barriers to entry by Zombie firms to young firms

Using a young firm's dummy, we will examine whether the existence of Zombie firms creates barriers to entry for young firm dummies. Specifically, we use the intersection of non-Zombie dummy×young dummy (firms that are less than 5 years old), the intersection of non-Zombie dummy x Zombie firm asset ratio, and the triple intersection of non-Zombie dummy x Zombie firm asset ratio×young dummy as explanatory variables (McGowan et al. (2018)) to test whether there are "barriers to entry" for young firms (see Table 9).

The results show that for capital investment, the triple intersection of Non-Zombie dummy ×Zombie asset ratio×Young dummy is negative in Japan, Italy, and Spain, with a particularly large negative impact in Japan.

No country is negatively significant for the triple intersection of Non-Zombie dummy× Zombie asset ratio×young dummy in terms of employment growth, and Japan, France, and

Italy are positively significant, so there is no confirmation of a negative impact on young firms in terms of employment.

As for TFP, the coefficient of the triple cross term of the Non-Zombie dummy×Zombie asset ratio×young dummy is positively significant in Japan, France, and the U.K. In Japan, the coefficient of the triple cross term of Non-Zombie dummy×Zombie asset ratio×young dummy is greater than that of the former cross term of Non-Zombie dummy×Zombie asset ratio. The coefficient indicates that the TFP gap between Zombie and Non-Zombie firms is larger for young firms, which is evidence of barriers to entry (McGowan et al. (2018)).

The above analysis confirms that the congestion effect by Zombie firms in Japan creates barriers to entry and suggests that this impacts the Japanese economy's sluggish "metabolism".

Therefore, to infer the existence of a TFP gap and barriers to entry due to the presence of Zombie firms, we compared the TFP levels of young firms by industry in each country in descending order (see Table 10) and the TFP levels of all firms in similar descending order (see Appendix C.)[33]. Comparing young firms, we find that firms have high TFP levels in finance and insurance in Japan, France, and the U.K., At the same time, equipment-type industries such as petroleum products, transport equipment (excluding the U.K.), and chemicals (excluding Japan) also rank high in all countries.

In addition, while manufacturing industries related to electric machinery, equipment, and supplies are relatively high in Europe, in Japan, service industries such as accommodation, and food services activities, real estate, and human health and social work activities are characterized by high TFP levels of young firms.

Regarding TFP levels for all firms in each country, finance and insurance, and manufacturing (electrical machinery-related industries and transportation equipment) commonly have the highest TFP levels.

Although it is challenging to compare TFP levels by industry across countries due to differences in their industrial structures, the TFP level of young Japanese firms in the service industry is relatively high compared to that of the manufacturing industry. The TFP gap created by Zombie firms and the extent to which barriers to entry contribute to this gap are issues to be examined in the future, as various factors are assumed for each industry.

[33] Due to mergers and reorganizations, etc., the industry leader in petroleum products in Japan and France and one megabank in the Japanese financial sector are included. However, since this differs from "opening for business," companies in the Very Large category are excluded in each country.

Table 9

Performance of Zombie and Non-Zombie firms: Three dependent variables and Young dummy

(See (Caballero.et al (2008) and (McGowan.et al (2018))　　Panel of Japan and 5coutries

Country	Japan	France	Germany	Italy	Spain	UK
VARIABLES	**log(I/K) : dependentVariable** 2012～2019					
Non-Zombie dummy	0.0836***	0.0650***	0.251***	0.252***	0.208***	-0.00137
	(0.004)	(0.002)	(0.028)	(0.015)	(0.020)	(0.019)
Non-Zombie dummy	0.332***	-0.0603***	0.145***	-0.022	0.398***	-0.171***
×Young dummy	(0.010)	(0.003)	(0.045)	(0.015)	(0.031)	(0.037)
Non-Zombie dummy	-0.262***	-0.0626***	-1.023***	0.248***	1.453***	0.806***
×Industry Zombie asset ratio	(0.064)	(0.008)	(0.122)	(0.049)	(0.098)	(0.149)
Non-Zombie dummy×Industry Zombie	**-2.460*** **	0.0714***	1.672***	**-0.264*** **	**-1.243*** **	0.0831
asset ratio×Young dummy	(0.342)	(0.023)	(0.432)	(0.102)	(0.257)	(0.537)
Observations	872,887	840,958	148,266	2,541,116	1,828,281	270,045
AdjR2	0.006	0.007	0.002	0.001	0.001	0.002
VARIABLES	**ΔE** (log Change in number of employees) **: dependentVariable** 2011～2019					
Non-Zombie dummy	0.0381***	0.0658***	0.0398***	0.104***	0.128***	0.0717***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)
Non-Zombie dummy	-0.174***	-0.130***	-0.0701***	-0.110***	-0.153***	-0.0440***
×Young dummy	(0.002)	(0.002)	(0.004)	(0.001)	(0.001)	(0.004)
Non-Zombie dummy	-0.0592***	-0.0910***	-0.0475***	-0.299***	-0.625***	-0.151***
×Industry Zombie asset ratio	(0.013)	(0.007)	(0.013)	(0.003)	(0.004)	(0.017)
Non-Zombie dummy×Industry Zombie	**0.478*** **	**0.207*** **	0.0004	**0.0811*** **	0.004	-0.007
asset ratio×Young dummy	(0.060)	(0.020)	(0.044)	(0.007)	(0.010)	(0.048)
Observations	1,413,549	921,561	229,358	3,538,470	3,631,829	509,187
AdjR2	0.857	0.872	0.926	0.707	0.705	0.858
VARIABLES	**TFP : dependentVariable** 2011～2019					
Non-Zombie dummy	0.102***	0.0650***	0.132***	0.194***	0.183***	0.0787***
	(0.002)	(0.002)	(0.004)	(0.001)	(0.001)	(0.004)
Non-Zombie dummy	-0.183***	-0.0603***	-0.0571***	-0.0743***	-0.0723***	-0.117***
×Young dummy	(0.004)	(0.003)	(0.005)	(0.001)	(0.002)	(0.007)
Non-Zombie dummy	**0.907*** **	-0.0626***	-0.0789***	-0.174***	-0.269***	0.002
×Industry Zombie asset ratio	(0.026)	(0.008)	(0.016)	(0.004)	(0.006)	(0.027)
Non-Zombie dummy×Industry Zombie	**0.930*** **	0.0714***	0.0403	-0.219***	-0.170***	0.145*
asset ratio×Young dummy	(0.139)	(0.023)	(0.054)	(0.008)	(0.014)	(0.084)
Observations	1,187,593	840,958	219,066	3,373,541	3,271,201	389,820
AdjR2	0.056	0.007	0.011	0.027	0.025	0.005

Standard errors in parentheses　*** p<0.01, ** p<0.05, * p<0.1

(Note) For each of the above three activities, one period lag of firm age, one period lag of employee size, and industry & year dummy were used as control functions.
Regarding the influence on og(I/K), the one-period lag of firm age is negative and significant for Italy, Spain, and the U.K. and the one-period lag of employee size is positive and significant for France, Italy, and the U.K., and negative for Germany, and Spain. Regarding the influence on log changes in the number of employees, the one-period lag of firm age is positive and significant for France and the U.K., negative and significant for Japan, Germany, Italy, and Spain, and the one-period lag in the size of the number of employees is negative and significant for all 6 countries. Regarding the impact on TFP, the one-period lag in firm age was negatively significant in Japan, Italy, Spain, and the U.K., and the one-period lag in employee size was positive and significant in all 6 countries.

Regarding barriers to entry for young firms, there is concern about the impact on new entrants. As shown in Table 11, the business birth rate in each country remains low in Japan compared to Western countries[34]. A multinational comparison by Criscuolo et al. (2014) multinational comparison of company age and size shows that the proportion of SMEs (with fewer than 50 employees) founded less than 5 years ago in Japan (just over 10%), Italy (just under 30%), France, Germany, and Spain (30-40%). In comparison, only Japan has over 70% of SMEs that have been in business for 10 years or more, Italy has over 50%, and France, Germany, and Spain have just under 50%. That analysis of Japanese SMEs shows that a small percentage of them are young and a high rate of them have been in business for a long time, which is cited as an example of the stagnant metabolism in Japan.

The low business birthrate and the aging population due to the lack of metabolism in companies have been cited as reasons for the stagnant economy (Kato (2024)).

Based on government statistics, we find correlations between business birth rates and labor productivity growth rates by focusing on 28 OECD countries, including Japan and the five European countries (see Appendix D.)[35].

The correlation mechanism between the business birth rate and labor productivity growth rate has not been fully verified. Since various factors are possible, analysis of the causal relationship is an issue for future research, including the external effects of Zombie firms and their impact on young firms.

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[34] In Japan, the "opening rate" is often presented as the "opening/closing rate by the number of employment establishments" in the White Paper on Small and Medium Enterprises (Ministry of Economy, Trade and Industry), etc. However, the above indicator based on the "Annual Report on Employment Insurance Business" does not represent the actual situation. The "Economic Census" is the preferred indicator. Still, due to the restrictions of a triennial survey, the Ministry of Justice's "Annual Report on Civil, Litigation, and Human Rights Statistics" and the National Tax Agency's "National Tax Agency Statistical Annual Report," which are cited in the White Paper, were used. For other countries, OECD and UK statistics were used.

[35] We define labor productivity as GDP/working hours and use the 2011-2019 data. Still, the White Paper on the "Analysis of The Labour Economy" (Ministry of Health, Labour and Welfare) (2023) discusses the relationship between the business birth rate and labor productivity, the paper defines labor productivity as GDP/employee.

Table 10

Young Firm TFP Levels in Each Country (Industry by Descending Order, Average 2011-2019)

TFP level is a logarithmic value	Japan		France		Germany		Italy		Spain		UK	
	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level
1	**Petroleum and coal products**	7.838	**Finance and insurance**	-0.124	Mining	2.115	Basic metal	-0.761	**Transport equipment**	-1.325	**Finance and insurance**	0.665
2	**Finance and insurance**	7.824	**Chemicalls**	-0.253	**Transport equipment**	1.655	**General-purpose, production and business oriented machinery**	-0.802	Electricity, gas and water supply and waste management service	-1.330	**Chemicalls**	0.460
3	**Accomodation and food service activities**	7.578	Mining	-0.311	**Chemicalls**	1.550	Mining	-0.835	**Finance and insurance**	-1.351	Mining	0.396
4	**Real estate**	7.413	Basic metal	-0.331	Electricity, gas and water supply and waste management service	1.524	Electricity, gas and water supply and waste management service	-0.843	**General-purpose, production and business oriented mach**	-1.359	**General-purpose, production and business oriented machinery**	0.253
5	Non-metallic mineral products	7.336	**Electric components and devices**	-0.357	**Petroleum and coal products**	1.521	**Chemicalls**	-0.864	Basic metal	-1.438	Education	0.230
6	Other service activities	7.187	**General-purpose, production and business oriented machinery**	-0.427	Basic metal	1.482	**Transport equipment**	-0.922	**Chemicalls**	-1.462	**Electric components and devices**	0.150
7	**Human health and social work activities**	7.179	Human health and social work activities	-0.479	**General-purpose, production and business oriented machinery**	1.466	**Electric machinery, equipment and supplies**	-0.939	**Electric machinery, equipment and supplies**	-1.464	**Petroleum and coal products**	0.080
8	**Transport equipment**	7.154	**Transport equipment**	-0.508	**Electric machinery, equipment and supplies**	1.464	**Electric components and devices**	-0.986	**Electric components and devices**	-1.517	Basic metal	0.059
9	Education	7.145	Electricity, gas and water supply and waste management service	-0.509	**Electric components and devices**	1.444	**Finance and insurance**	-1.029	**Petroleum and coal products**	-1.530	**Electric machinery, equipment and supplies**	-0.002
10	Wholesale and retail trade	7.112	Electric machinery, equipment and supplies	-0.512	**Finance and insurance**	1.369	Fabricated metal products	-1.040	Mining	-1.560	Electricity, gas and water supply and waste management service	-0.007
11	Electric components and devices	7.112	Fabricated metal products	-0.584	Fabricated metal products	1.320	Petroleum and coal products	-1.122	Fabricated metal products	-1.600	Non-metallic mineral products	-0.063
12	Mining	7.083	Information and communications	-0.598	Textile products	1.309	Other manufacturing	-1.182	Human health and social work activities	-1.648	Other manufacturing	-0.166
13	Textile products	7.067	Professional, scientific and technical activities	-0.601	Other manufacturing	1.304	Textile products	-1.197	Information and communications	-1.648	Food products and bevarages	-0.205
14	Electricity, gas and water supply and waste management service	7.027	Non-metallic mineral products	-0.607	pulp, paper and paper products	1.296	pulp, paper and paper products	-1.210	Real estate	-1.651	Fabricated metal products	-0.209
15	Basic metal	7.022	pulp, paper and paper products	-0.665	Human health and social work activities	1.269	Non-metallic mineral products	-1.214	Professional, scientific and technical activities	-1.706	Professional, scientific and technical activities	-0.233
16	Electric machinery, equipment and supplies	6.970	Other manufacturing	-0.726	Information and communications	1.256	Information and communications	-1.321	Non-metallic mineral products	-1.706	Transport equipment	-0.273
17	Other manufacturing	6.957	Real estate	-0.880	Real estate	1.247	Transport and postal services	-1.332	Transport and postal services	-1.728	pulp, paper and paper products	-0.310
18	General-purpose, production and business oriented machinery	6.880	Transport and postal services	-0.910	Non-metallic mineral products	1.216	Construction	-1.345	pulp, paper and paper products	-1.729	Textile products	-0.360
19	Information and communications	6.864	Education	-0.921	Food products and bevarages	1.169	Professional, scientific and technical activities	-1.361	Education	-1.758	Information and communications	-0.434
20	Chemicalls	6.857	Wholesale and retail trade	-0.954	Professional, scientific and technical activities	1.083	Food products and bevarages	-1.438	Other manufacturing	-1.780	Wholesale and retail trade	-0.518
21	Food products and bevarages	6.829	Construction	-0.974	Wholesale and retail trade	1.064	Wholesale and retail trade	-1.453	Construction	-1.821	Real estate	-0.538
22	Fabricated metal products	6.825	Textile products	-0.976	Other service activities	1.013	Education	-1.462	Food products and bevarages	-1.822	Transport and postal services	-0.647
23	Professional, scientific and technical activities	6.743	Food products and bevarages	-1.111	Education	1.004	Human health and social work activities	-1.505	Wholesale and retail trade	-1.889	Accomodation and food service activities	-0.763
24	Transport and postal services	6.723	Agriculture, forestry and fishing	-1.163	Transport and postal services	0.943	Real estate	-1.570	Other service activities	-1.937	Agriculture, forestry and fishing	-0.817
25	Agriculture, forestry and fishing	6.662	Other service activities	-1.217	Agriculture, forestry and fishing	0.721	Other service activities	-1.605	Agriculture, forestry and fishing	-1.952	Human health and social work activities	-0.833
26	pulp, paper and paper products	6.628	Accomodation and food service activities	-1.323	Construction	0.684	Agriculture, forestry and fishing	-1.868	Accomodation and food service activities	-1.967	Construction	-0.872
27	Construction	6.481	Petroleum and coal products	–	Accomodation and food service activities	0.501	Accomodation and food service activities	-1.884	Textile products	-1.985	Other service activities	-1.031

(Note) Created from Orbis corporate database. Exclusion of companies in the Very large category (for Orbis' definition of Very large companies, see p. 7 of the text and note 6). TFP level is the geometric mean for the period.

Table 11

Percentage of business birth rate in each country

(Unit:%)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019
Japan	3.5	3.6	3.8	4.2	4.3	4.4	4.5	4.4	4.4
France	11.0	10.1	9.5	9.9	9.4	9.7	10.0	10.9	12.1
Germany	8.7	7.9	7.4	7.2	7.1	6.7	6.8	8.0	9.1
Italy	6.7	7.0	7.1	7.1	7.3	7.7	7.2	7.1	7.4
Spain	8.0	8.2	8.4	9.8	9.2	9.9	9.1	9.7	9.4
UK	11.6	11.8	14.7	14.3	14.8	15.1	13.5	13.5	12.6

Source: Japan, Ministry of Economy, Trade and Industry, "White Paper on Small and Medium Enterprises 2024"; Ministry of Justice, "Annual Report on Civil, Commercial and Human Rights Statistics"; National Tax Agency, "National Tax Agency Statistical Annual Report", number of establishment registrations. Tables for France, Germany, Italy, Spain and the U.K(2011～2018) are based on Euro.Stat ESTT Business demography by size class and NACE Rev. 2 activity (2004-2020) [bd_9bd_sz_cl_r2$defaultview], Population of active enterprises in t - number, Births of enterprises in t - number and UK Office for National Statictics Business demography. The author has processed and created the data.

5. Conclusions

This paper attempts to examine the research question. "Do SMEs and Zombie firms cause the stagnation of the Japanese economy?", We use the Orbis database for Japan and the five European countries (2011-2019).

Our findings are as follows. First, TFP positively correlates with firm size in all countries, Japan had the largest TFP gap between SMEs and large companies, especially in the manufacturing industry. The TFP growth rate is also higher for larger firms, but the gap between small and large firms is greater in the U.K. and Germany than in Japan. While the point that SMEs are a factor in determining TFP and productivity stagnation applies to Japan as well, it cannot be said to be unique to Japan.

Second, as to whether Zombie firms are a factor in Japan's sluggish growth, it is common in all countries that Zombie firms harm productivity. In the 2010s, the ratio of Zombie firms in each country, except for France, was on a declining or flat trend. It is noteworthy that Japan has the lowest ratio of Zombie assets. The survival rate of Zombie firms has ranged from a little more than 40% to 60% in two years in each country, indicating that Zombie firms are moving out of the Zombie category. When we examine the impact of Zombie firms on Non-Zombie firms, we find a negative significance for growth in the number of employees relative

to Non-Zombie firms in all of the above countries. For capital investment, the results are negative and significant, for Japan and Germany, positive and significant for Italy, Spain, and the U.K., and not significant for France. On the other hand, only Japan is positive and significant regarding the TFP level. Still, the results are negative and significant for France, Germany, Italy, and Spain, while no significant results were obtained for the UK. In Japan, the persistence of Zombie firms is thought to have created an inefficient industrial structure and barriers to entry for new firms, widening the productivity gap between Zombie and Non-Zombie firms, and resulting in a significant positive impact on the TFP level.

Third, we analyzed young companies (5 years or younger). The impact of Zombie firms on the capital investment and employment of young firms differs across countries. Again, only Japan shows a stronger positive impact on the TFP level of young firms, with a TFP gap between Zombie firms and Non-Zombie firms, which verifies the obstacles to entry. The results are similar to those of Caballero et al. (2008) and McGowan et al. (2018). In particular, Zombie firms may be contributing to the long-term stagnation of the Japanese economy.

Finally, the implication of this paper is that we were able to verify the possibility that the existence of inefficient Zombie firms has a negative effect on employment and capital investment. We find that the TFP gap between Zombie and Non-Zombie firms in Japan is expanding and creating barriers to entry for new businesses. In fact, Japan has yet to see productivity growth through the reallocation of funds from low-productivity firms to high-productivity firms among SMEs, and there remains room for financial support (Uesugi (2022)). It has also been pointed out that financial support measures prevented bankruptcies and simultaneously, caused the generation and increase of SMEs Zombie firms (Goto (2014)). However, R & D subsidies to young firms at the time of start-up and R & D tax credits among various measures have been analyzed as effective in the short term (Howell, S.T. (2017), Bloom et al. (2019)). The bottom line message is that it is effective to take measures at an appropriate time and in a timely manner to eliminate the negative aspects of Zombie firms and to nurture the seeds of their future health. Furthermore, possible avenues for future research include an analysis of the spillover effects of Zombie firms, the relationship between the business birth rate and the productivity growth rate, and the cause of these effects is an issue for future study.

It is reported that the ratio of zombie firms is on the rise again after the coronavirus disaster, and the trend after 2020, which was not the subject of analysis in this report, must be monitored closely.

Declaration of AI-assisted technologies in the writing process.

During the preparation of this work, we used DeepL and Grammarly_Pro to improve the readability and language of the manuscript. After using this tool, we reviewed and edited the content as needed and took full responsibility for the content of the published article.

References

Acharya, V., Crosignani, M., Eisert, T., and S. Steffen, Zombie Lending: Theoretical, International, and Historical Perspectives. Annual Review of Financial Economics 14(1) (2022) 21-38.

Ackerberg, D.A., Caves, K., Frazer, G., 2006. Structural identification of production Functions. mimeo, UCLA.

Ackerberg, D.A., Caves, K., Frazer, G., Identification Properties of Recent Production Function Estimation. Econometrica. 83 (2015) 2411-2451.

Albuquerque, B., & lyer, R., The Rise of the Walking Dead: Zombie Firms Around the World. IMF Working Papers JUN (2023) 1-67.

Alfaro, L., and Chen, M., Selection and Market Reallocation: Productivity Gains from Multinational Production. American Economic Journal: Economic Policy. 10(2) (2018) 1-38.

Bajgar, M., Berlingieri, G., Calligaris, S., Criscuolo, C., Timmis, J., Coverage and representativeness of Orbis data. OECD Science, Technology and Industry Working Papers (2020)/06 1-63.

Berlingieri, G., Calligaris, S., Criscuolo, C., The Productivity-Wage Premium: Does Size Still Matter in a Service Economy? American Economic Associations Papers & Proceedings, Vol.108 (2018) 328-333.

Banerjee, B., and Hofmann, B., The rise of zombie firms causes and consequences. BIS Quarterly Review, September (2018) 67-78.

Bloom, N., Reenen, J. V., Williams, H, A Toolkit of Policies to Promote Innovation. The Journal of Economic Perspectives, Vol. 33, No. 3, Summer (2019) 163-184.

Caballero, R. J., Hoshi, T., Kashyap, A. K., Zombie Lending and Depressed Restructuring in Japan. American Economic Review, 98:5, (2008) 1943-1977.

Carreira, C., Teixeira, P., Neito-Carrilo, E. 2022. Recovery and exit of zombie firms in Portugal. Small Bus Econ.

Cheung, J. K. W., Imai, M., Zombie lending, labor hoarding, and local industry growth. Japan & The World Economy 71(2024) 101266 1-15.

Coad, A., Segarra, A., Teruel, M., Like milk or wine: Does firm performance improve with age? Structural Change and Economics Dynamics 24 (2013) 173-189.
Corrado, C., Haskel, J., Jona-Lasinio, C., Iommi, M., Innovation and intangible investment in Europe, Japan, and the United States. Oxford Review of Economic Policy Vol29, No2 (2013) 261-286.
Criscuolo, C., Gai, P. N., Menon, C., The Dynamics of Employment Growth. OECD Science, Technology and Industry Policy Papers No.14 (2014) 1-96.
Fukao, K., Kwon, H. U., Why did Japan's TFP Growth Slow Down in The Lost Decade? An Empirical Analysis Based on Firm-Level Data of Manufacturing Firms, The Japanese Economic Review 57-2, June (2006) 195-228.
Fukao, K., The "Lost 20 Years" and the Japanese Economy., Nihon Keizai Shimbun Publishing., Tokyo, 2012. (in Japanese).
Fukuda, S., Nakamura, J., Why Did 'Zombie' Firms Recover in Japan? The World Economy. (2011) 1124-1137.
Fukuda, S., Beyond the "Lost 20 Years"., NTT Publishing., Tokyo, 2015. (in Japanese).
Goncalves, D., Martins, A., The Determinants of TFP Growth in the Portuguese Manufacturing Sector. GEE Papers Novwmbro de (2016) 1-29.
Goto, Y., Wilbur, S., Efficiency among Japanese SMEs: In the context of the zombie firm hypothesis and firm size. RIETI Discussion Paper Series 17-E-123 (2017) 1-32. December 2017.
Goto, Y., Macro performance of SMEs, Nihon Keizai Shimbun Publishing., Tokyo, 2014. (in Japanese).
Hayashi, F., Prescott, E. C., The 1990s in Japan: A Lost Decade. Review of Economic Dynamics. 5(1). (2002) 206-235.
Hoshi, T., Kashyap, A K., What has stopped Japan's economic growth? Nihon Keizai Shimbun Publishing., Tokyo, 2013. (in Japanese).
Hosono, K., Takizawa, M., Yamanouchi, K., Firm Age, Productivity, and Intangible Capital (Revised). RIETI Discussion Paper Series 20-E-001 (2022) 1-35.
Howell, Sabrina T, Financing Innovation: Evidence from R&D Grants. American Economic Review (2017) 107(4) 1136-1164.
Imai, K., 2016. A panel study of zombie SMEs in Japan: Identification, borrowing and investment behavior, Journal of the Japanese and International Economies 39 (2016a) 91-107.
Imai, K., Zombie SMEs and Productivity, THE KOKUMIN-KEIZAI ZASSHI 313-2 (2016b) 1-16 (in Japanese).
Imani, Y., Uesugi, I., Financing of Japanese companies Existence of zombie companies and

debt-free companies, TEIKOKU Databank・Center for Advanced Economic Research and Demonstration (TDB-CAREE) Discussion・Paper Series No. J-2023-01 (2023) 1-29 (in Japanese).

Inui, T., Kim, Y., Kwon, H. U., Fukao, K., Productivity Dynamics, and Japan's Economic Growth: An Empirical Analysis Using Individual Data from the Census of Corporate Activities. RIETI Discussion Paper Series 11-J-042 (2011) 1-33 (in Japanese).

Kato, M., What is a Startup - A Prescription for Economic Revitalization, Iwanami Shinsho, Tokyo, 2024 (in Japanese).

Kitamura, Y., Nishiwaki, M., and Murao, T., On the estimation of production functions under incomplete capital markets, KEIZAI KENKYU. 60-3 (2009) 193-204.

Kusaka, S., Ozaki, T., Onishi, K., Wakamori, N., The Decline of Labor Share and New Technology Diffusion: Implication for markups and monopsony power RIETI Discussion Paper Series (2023) 23-E-047.

Kwon, H U., Narita, F., Narita, M., Resource reallocation and zombie lending in Japan in the 1990s. Review of Economic Dynamics 18 (2015) 709-732.

Levinsohn, J., Petrin, A., Estimating Production Functions Using Inputs to Control for Unobservables, Review of Economic Studies. 70 (2003) 317-341.

Manjon, M., Manez, J., Production function estimation in Stata using the Ackerberg-Caves-Frazer method. The Stata Journal 16-4 (2016) 900-916.

Matsuura, T., On estimating firm / establishment-level production functions in panel data, Journal of Statistics, 44-4 (2016) (in Japanese).

McGowan, A. M., Andrews, D., Millot, V., The Walking Dead? Zombie Firms and Productivity Performances in OECD Countries. OECD Economics Department Working Papers No.1372 (2017) 1-45.

McGowan, A. M., Andrews, D., Millot, V., The Walking Dead? Zombie Firms and Productivity. Performances in OECD Countries. Economic Policy October (2018) 686-736.

Miyagawa, T., The Economics of Productivity: How Far Have We Come in Our Understanding? Bank of Japan Discussion Paper, (2016) 06-J-06 (in Japanese).

Miyoshi Koyo, The Decline in The Labor Share: Evidence from Japanese Manufacture's Panel Data PRI Discussion Paper Series (2021) No.21-A-4.

Morikawa, M., Service Nation Theory., Nihon Keizai Shimbun Publishing., Tokyo, 2016 (in Japanese).

Nagahama, T., Overview of changes in industry structure, size, etc. Financial Review June (2002) (in Japanese).

Nakamura, J., A 50-year history of "Zombie firms" in Japan: How banks and shareholders have been involved in corporate bailouts? Japan & The World Economy 66 (2023) 101188 1-24.

Olley, G.S., Pakes, A., The Dynamics of Productivity in the Telecommunications Equipment industry, Econometrica. Vo.l64, No6. (1996) 1263-1297.
Petrin, A., Poi, B. P., Levinsohn, J., Production Function Estimation in Stata Using Inputs to Control for Unobservables. Stata Journal. 4 (2004) 113-123.
Sakai, T., Takizawa, M., Miyagawa, D., Labor Productivity of Japanese Companies, Japan Productivity Center Productivity Report, Vol.18 (2021) 1-33 (in Japanese).
Uesugi, I., Economics of Small Business Finance., Nihon Keizai Shimbun Publishing., Tokyo, 2022 (in Japanese).
Urata, S., Kawai, H., Technological Progress by Small and Medium Enterprises in Japan. Small Business Economics. 18 (2002) 53-67.
Yamamoto, I., Kuroda, S., Does employment mobility enhance firm performance?: an examination using firm panel data, RIETI Discussion Paper Series (2016) 16-J-062 (in Japanese)

Appendices

Since the main text omits a detailed explanation of the LP method used for TFP estimation, we have added the analytical model and other details in Appendix A, We have also added an overview of the leading previous research on the external effects of Zombie firms in Appendix B. The TFP levels of all companies in Japan and the five European countries are summarized in Appendix C.

Appendix A. Analytical method of the LP method

Suppose the firm's decision (management) determines $k_{i,t}$, l_{it} in response to the change in circumstances $\varepsilon_{i,t-1}$ contained in the error term. The error term and the explanatory variables will be correlated in that case. A possible way to deal with this is to use an instrumental variable. Still, even if a time-lagged variable $\{ y_{i,t-2}, \cdots \}$ is used as the instrumental variable, it cannot be verified whether it corresponds to the firm's decision making. Therefore, a method that considers a production function that follows the flow of corporate decision making (a control function approach that addresses endogeneity without using instrumental variables) is proposed.

In the production function, ω_{it} is the “external shock that cannot be observed by the analyst but can be observed by the manager” and “productivity that can be known by the firm manager but cannot be observed by the analyst”. (Olley and Pakes (1996) Matsuura, T., (2016), Kitamura, Y., Nishiwaki, M., and Murao, T., (2009))

$Y_{it}=L_{it}^{\beta_1}K_{it}^{\beta_2}e^{\varepsilon_{it}}$ (1)

$y_{it}=\alpha+\beta_1 l_{it}+\beta_2 k_{it}+\omega_{it}+u_{it}$ (1')

ω_{it} is exogenous and unaffected by other variables but is affected by its past values

It follows a first-order Markov process. It is also assumed to affect firms' capital investment.

$P(\omega_{it}|\ \omega_{i1},---,\ \omega_{it-1})=p(\omega_{it}|\ \omega_{it-1})$ (2)

$i_{it}=\ i_i(k_{it},\ \omega_{it})$ (2')

As the inverse function, equation (3) is defined and substituted into equation (1').

$\omega_{it}=\omega(\ k_{it},\ i_{it})$ (3)

※ In Olley & Pakes (1996) $\omega_{it}=h(\ i_t,a_t,k_t)$ a：firm age

$y_{it}=\alpha+\beta_1 l_{it}+\beta_2 k_{it}+\omega(\ k_{it},\ i_{it})+u_{it}$ (4)

In this equation, k_{it} appears twice on the right-hand side and β_2 cannot be identified.

Where $\varphi_{it}=\beta_2 k_{it}+\omega(\ k_{it},\ i_{it})$ and the following estimating equation is defined

$y_{it}=\alpha+\beta_1 l_{it}+\varphi_{it}(\ k_{it},\ i_{it})+u_{it}$ (5) specify φ_{it} and estimate β_1

$\varphi_{it}\approx\sum_{n1=0}^{N}\sum_{n2=0}^{N-n1}\eta_{n1n2}(i_{it})^{n1}(k_{it})^{n2}$

Formulate a polynomial of the fourth order and substitute it into equation (4) for estimation.

In Olley & Pakes (1996), $\sum_{j=0}^{4-m}\sum_{m=0}^{4})$

Estimation equation for the first stage

$\varphi_{it}\approx\sum_{n1=0}^{N}\sum_{n2=0}^{N-n1}\eta_{n1n2}(i_{it})^{n1}(k_{it})^{n2}+u_{it}$

Since $\omega_{it}=\varphi_{it}-\beta_2 k_{it}$,

$g(\omega_{it-1})=g(\hat{\varphi}_{it-1}-\beta_2 k_{it-1})$ (6)

Substitute equation (6) into equation (1')

The second stage estimation equation

$y_{it}-\widehat{\beta_1}\ l_{it}=\beta_2 k_{it}+g(\hat{\varphi}_{it-1}-\beta_2 k_{it-1})+\xi_{it}+u_{it}$ (7)

ξ_{it} is uncorrelated with ω_{it} due to noise in ω_{it}

※For the sample selection bias that includes exiting firms, the bias is corrected by introducing a separately estimated predicted value of the probability of firm survival, $\hat{P}_{it}$ Equation (7) is modified

$g(\omega_{it-1})=g(\hat{\varphi}_{it-1}-\beta_2 k_{it-1},\ \hat{P}_{it})$

y_{it}-$\widehat{\beta_1}$ l_{it}= $\beta_2 k_{it}$+ g ($\hat{\varphi}_{it-1}$- $\beta_2 k_{it-1}$,$\hat{P}_{it}$) +ξ_{it}+ u_{it} (8)

This estimation method is also called a control function approach because φ_{it} created from the first stage estimated value is estimated as an independent variable that controls bias.

※ In Olley & Pakes (1996), y_{t+1}- $b_l l_{t+1}$=c+$\beta_a a_{t+1}$+ $\beta_k k_{t+1}$+ $\sum_{j=0}^{4-m}\sum_{m=0}^{4}\beta_{mj}\hat{h}_t^m$ $\hat{P}_t^j$ +e_t

In equation (2) of Olley & Pakes, capital investment and productivity are assumed to be monotonically increasing functions, but since capital investment by SMEs and large capital investments are carried out opportunistically, equation (5) is rewritten into equation (10) in the first stage using intermediate inputs m, and equation (7) in the second stage is changed into equation (11) (Levinsohn and Petrin (2003)).

LP method

m_{it}=m (k_{it}, ω_{it}) (9)

y_{it}= α +$\beta_1 l_{it}$+ φ_{it} (k_{it}, m_{it}) + ω_{it} +u_{it} (10)

Estimate coefficients of labor using the first stage estimating equation.

y_{it}-$\widehat{\beta_1}$ l_{it}= $\beta_2 k_{it}$+ g($\hat{\varphi}_{it-1}$- $\beta_2 k_{it-1}$) +ξ_{it}+ u_{it} (11)

In the second step, the above equation is estimated by nonlinear OLS to obtain the capital coefficients.

Equation (11) is a Cobb-Douglas type production function with intermediate inputs added: Q_{it}=$L_{it}^{\beta_1}$ $k_{it}^{\beta_2}$ $M_{it}^{\beta_3}$ $e^{\varepsilon^{it}}$ as representing the production function, the second-step estimating equation can be modified as follows

q_{it}-$\widehat{\beta_1}$ l_{it}= $\beta_2 k_{it}$+ $\beta_3 m_{it}$+g($\hat{\varphi}_{it-1}$ - $\beta_2 k_{it-1}$- $\beta_3 m_{it-1}$) +ξ_{it}+ u_{it} (12)

m_{it}, which is m_{it-1} lagged by one period, is uncorrelated with ξ_{it} (the prediction error of ω_{it}).

The following moment conditions are set and the Generalized Method of Moments (GMM) is used to estimate equation (12)

E[$\xi_{it}(\beta)\cdot k_{it}$]=0

E[$\xi_{it}(\beta)\cdot m_{it-1}$]=0

Labor input is also a variable factor, and l_{it} also varies with changes that improve productivity (Ackerberg, Caves, and Frazer (2015)). Note that the LP method assumes that l_{it} is independently determined.

ACF method

l_{it}=l(k_{it}, ω_{it}) (13)

m_{it}=m(k_{it}, l_{it}, ω_{it}) (14)

y_{it}= α +$\beta_1 l_{it}$+ $\beta_2 k_{it}$+ ω_{it} +u_{it} =φ_{it} (k_{it}, l_{it}, m_{it}) +u_{it} (15)

Then, using the one period lag $\hat{\varphi}_{it-1}$ of this prediction, we estimate the following equation

y_{it}=$\beta_1 l_{it}$+ $\beta_2 k_{it}$+ g($\hat{\varphi}_{it-1}$ - $\beta_1 l_{it-1}$ − $\beta_2 k_{it-1}$) +ξ_{it}+ u_{it} (16)

The result of analyzing the Orbis data using the ACF method was "convergence not achieved." In the exceptional case of Germany, where the result could be estimated, it was not significant. Therefore, in this report, we estimated TFP based on the LP method and conducted a comparative analysis of productivity in each industry and country.

Appendix B. Comparison of the central previous studies examining the external effects (investment, employment, productivity) of Zombie firms between multinational countries

Many previous studies have been conducted on the external effects that Zombie firms have on investment, employment, and productivity in each country. Each of the earlier studies examined the target country and year, and the definitions of target firms and Zombie firms, as well as investment, employment, and productivity as explained variables, differently. A comparison table with the analysis in this paper has been added.

Note that the criteria for adding "profitability criteria" and "financial support criteria" for identifying Zombie firms (Fukuda and Nakamura (2011), Imai (2016a)) were not used in this paper, which conducted a multinational analysis, and are not included in the comparison table.

Table B. Comparison of the main previous studies examining the external effects (investment, employment, productivity) of Zombie firms between multinational countries.

previous study	target country	target year	Data & target firms	definition ofZombie	(dependent v) investment variable × zombie asset ratio	(dependent v) employment variable × zombie asset ratio	(dependent v) productivity variable × zombie asset ratio
Caballero, Hoshi and Kashyap (2008) American Econimic Review 2008, 98:5	Japan	1990~2004	NIKKEI Telecom 21 companies 2.5% abobe & below winsorize (CHK standard)	Interest Rate Exemption Companies : a firm as receiving subsidized credit (CHK criteria)	I/K Invest/Stock (financial statements) negative	ΔLogE full-time Number of Employees Change negative	Log sales −2/3LogE −1/3LogK positive
McGowan et al. (2018) OECD discussion paper No.1372 and 67th Panel Meeting of Economic Policy(2018)	9 OECD countries (excluding Japan)	2003~2013	Orbis.DB Excluding less than 20 employees (MAM standard)	・More than 10 years since establishment ・Intrest Coverage Ratio (ICR) below 1 for the third consecutive year (MAM criteria)	log(I/K) Invest/Stock (financial statements) negative	dLogEmp Number of Employees Change negative	MFP (Multi Factor Productivity) positive
Albuquerque and Iyer (2023.1) IMF discussion paper WP/23/125	Advanced Economies 32 countries Emerging Economies 31 countries	2000~2021	S&P Compustat and Orbis.DB Listed & Unlisted companies excluding financial-related companies 2.5/97.5% winsorize	For two or more 2consecutive fiscal years ・ICR below 1 ・Insufficient cash to generate interest payments Earnings before interest and taxes(EBIT) to interest expense ratio indicates default risk	logK他 Invest (financial statements) negative	ΔEmp Number of Employees Change negative	TFP (Total Factor Productivity) negative
Imani and Uesugi (2023.4) TEIKOKU Data Bank TDB-CAREE discussion paper series No. J-2023-01	Japan	2002~2018	Listed company : Nikkei NEEDS Unlisted company : TEIKOKU DB excluding financial-related companies Net sales or property, plant and equipment excluding companies under 10million yen winsorize Listed com : I/k=5%, others=1% Unlisted com : I/k=2.5%, others=1%	Companies that fall under either (1) or (2) (Fukuda Nakamura standard) ① Exclude the following from Zombie based on CHK criteria ・EBIT exceed the minimum loan interest ・Companies with interest-bearing debt less than 20% of total assets ②The following are considered Zombie based on CHK criteria Companies with EBIT below minimum loan interest, interest-bearing debt exceeding 20% of total assets, and positive debt growth rate	I/K Invest/Stock (financial statements) negative	d_Ln_E Number of Employees Change negative	Log sales −2/3LogE −1/3LogK negative
Acharya et al. (2022) The Annual Review of Financial Economics 2022-14	United States	2004~2020	publicly traded company Compustat−Capital IQ database		Capital expenditures/fixed assets	Employment growth	−
				①Low-Quality1 : Three-year average ICR implied rating of BB(ICR cut off: 2.5) or lower	Not significant	Not significant	
				②Zombie1 : Low-Quality1 and $\chi^* < 0$ (χ^* : R−R*(median interest rate ×debt)) R: actual interest paymens of sample	negative	negative	
				③Zombie2a : ICR below 1 for 3 consecutive years and an age of at least 10 years(MAM criteria)	Not significant	Not significant	
				④Zombie2b : Zombie2a and $\chi^* < 0$	negative	negative	
				⑤Zombie3a : Two consecutive years with (a) ICR below 1 and (b)a Tobin's q below the median with in firm's sector	Not significant	Not significant	
				⑥Zombie3b : Zombie3a and $\chi^* < 0$	negative	negative	
Our Study	JP & Europe6countries JP,FN,GM,IT,SP,UK	2011~2019	Orbis.DB excluding the followimg companies Companies with negative assets for two consecutive years Very Large with less than 20 employees	・More than 10 years since establishment ・interest coverage ratio less than 1 for three consecutive fiscal years (MAM criteria)	log(I/K) Invest/Stock (financial statements) negative (JPGM) positive(IT,SP,UK)	ΔE Number of Employees Change negative	TFP (Total Factor Productivity) Estimation by LP method positive(JP) negative(FN,GM,IT,SP)

Note: The coefficients of the cross terms are the coefficients of the explanatory variables (non-Zombie dummy x Zombie asset ratio) on the respective explained variables of investment, employment, and productivity.

Appendix C. TFP levels for all firms in each country (industry by descending order; average 2012-2019)

In conjunction with the list of TFP levels for young firms in each country in descending order by industry, the TFP levels for all firms in each country are listed in descending order for comparison.

Appendix C

TFP levels for all firms in each country (industries by descending order; 2011-2019 average)

contrafactoral value	Japan		France		Germany		Italy		Spain		UK	
	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level	industrial classification	TFP level
1	**Finance and insurance**	8.816	**Petroleum and coal products**	0.918	**Petroleum and coal products**	2.230	**Petroleum and coal products**	-0.069	**Petroleum and coal products**	0.397	Mining	1.140
2	**Petroleum and coal products**	8.398	**Chemicalls**	0.376	**Finance and insurance**	2.009	**Chemicalls**	-0.217	Electricity, gas and water supply and waste management service	-0.911	**Petroleum and coal products**	1.132
3	**Chemicalls**	8.366	**Finance and insurance**	0.156	**Chemicalls**	1.964	Basic metal	-0.240	**Transport equipment**	-0.914	**Chemicalls**	0.931
4	**Transport equipment**	8.364	Mining	0.153	**Transport equipment**	1.918	Electricity, gas and water supply and waste management service	-0.329	**Chemicalls**	-0.985	**Finance and insurance**	0.908
5	**Accomodation and food service activities**	8.257	Basic metal	0.101	Real estate	1.916	**General-purpose, production and business oriented machinery**	-0.365	**General-purpose, production and business oriented machinery**	-1.074	**Transport equipment**	0.660
6	**Real estate**	8.073	**Electric components and devices**	0.065	**Electric components and devices**	1.890	**Transport equipment**	-0.468	Basic metal	-1.100	**Electric components and devices**	0.657
7	**Education**	7.989	**Transport equipment**	0.056	Information and communications	1.847	**Electric machinery, equipment and supplies**	-0.482	**Electric machinery, equipment and supplies**	-1.136	Electricity, gas and water supply and waste management service	0.640
8	Basic metal	7.900	**Electric machinery, equipment and supplies**	0.039	**General-purpose, production and business oriented machinery**	1.830	**Electric components and devices**	-0.512	**Electric components and devices**	-1.158	**General-purpose, production and business oriented machinery**	0.574
9	**Electric components and devices**	7.890	**General-purpose, production and business oriented machinery**	0.027	Electricity, gas and water supply and waste management service	1.813	Mining	-0.571	**Finance and insurance**	-1.193	Food products and bevarages	0.538
10	Mining	7.871	Electricity, gas and water supply and waste management service	-0.051	**Electric machinery, equipment and supplies**	1.810	Fabricated metal products	-0.616	Mining	-1.273	Non-metallic mineral products	0.499
11	Other service activities	7.771	Non-metallic mineral products	-0.121	Basic metal	1.795	Finance and insurance	-0.734	Real estate	-1.306	Electric machinery, equipment and supplies	0.484
12	Wholesale and retail trade	7.771	Information and communications	-0.124	Mining	1.787	Other manufacturing	-0.752	Fabricated metal products	-1.413	Basic metal	0.471
13	Electricity, gas and water supply and waste management service	7.733	Human health and social work activities	-0.155	Professional, scientific and technical activities	1.741	pulp, paper and paper products	-0.757	Information and communications	-1.428	Other manufacturing	0.322
14	Food products and bevarages	7.729	Fabricated metal products	-0.253	Textile products	1.615	Textile products	-0.763	Food products and bevarages	-1.451	pulp, paper and paper products	0.317
15	General-purpose, production and business oriented machinery	7.721	Professional, scientific and technical activities	-0.276	Fabricated metal products	1.615	Non-metallic mineral products	-0.780	Human health and social work activities	-1.454	Fabricated metal products	0.282
16	Electric machinery, equipment and supplies	7.689	pulp, paper and paper products	-0.316	Human health and social work activities	1.606	Food products and bevarages	-0.818	Transport and postal services	-1.455	Professional, scientific and technical activities	0.269
17	Non-metallic mineral products	7.640	Other manufacturing	-0.350	Other manufacturing	1.603	Information and communications	-0.924	Non-metallic mineral products	-1.518	Wholesale and retail trade	0.265
18	Information and communications	7.531	Transport and postal services	-0.396	Non-metallic mineral products	1.601	Construction	-0.941	pulp, paper and paper products	-1.531	Information and communications	0.249
19	Other manufacturing	7.522	Real estate	-0.413	pulp, paper and paper products	1.573	Education	-0.945	Education	-1.571	Transport and postal services	0.245
20	Transport and postal services	7.500	Textile products	-0.414	Wholesale and retail trade	1.558	Human health and social work activities	-0.951	Professional, scientific and technical activities	-1.577	Textile products	0.207
21	Human health and social work activities	7.480	Education	-0.513	Food products and bevarages	1.534	Transport and postal services	-1.037	Other manufacturing	-1.578	Construction	0.057
22	Fabricated metal products	7.421	Wholesale and retail trade	-0.530	Transport and postal services	1.470	Wholesale and retail trade	-1.059	Wholesale and retail trade	-1.648	Education	-0.024
23	Textile products	7.396	Food products and bevarages	-0.559	Education	1.464	Professional, scientific and technical activities	-1.067	Construction	-1.725	Real estate	-0.184
24	Agriculture, forestry and fishing	7.081	Construction	-0.599	Other service activities	1.449	Real estate	-1.081	Other service activities	-1.730	Accomodation and food service activities	-0.304
25	Professional, scientific and technical activities	7.057	Other service activities	-0.745	Construction	1.384	Other service activities	-1.239	Textile products	-1.733	Agriculture, forestry and fishing	-0.385
26	Pulp, paper and paper products	6.950	Agriculture, forestry and fishing	-0.793	Accomodation and food service activities	1.038	Accomodation and food service activities	-1.527	Agriculture, forestry and fishing	-1.755	Human health and social work activities	-0.525
27	Construction	6.904	Accomodation and food service activities	-1.046	Agriculture, forestry and fishing	1.022	Agriculture, forestry and fishing	-1.617	Accomodation and food service activities	-1.798	Other service activities	-0.662

(Note) Created from Orbis corporate database. TFP level is the geometric mean for the period.

Appendix. D. Correlations between the business birth rate and labor productivity and labor productivity growth rate

To examine barriers to entry for young firms and their impact on economic metabolism, we analyzed the correlation between the business birth rate and labor productivity growth rate, using macroeconomic data for each country's economy.

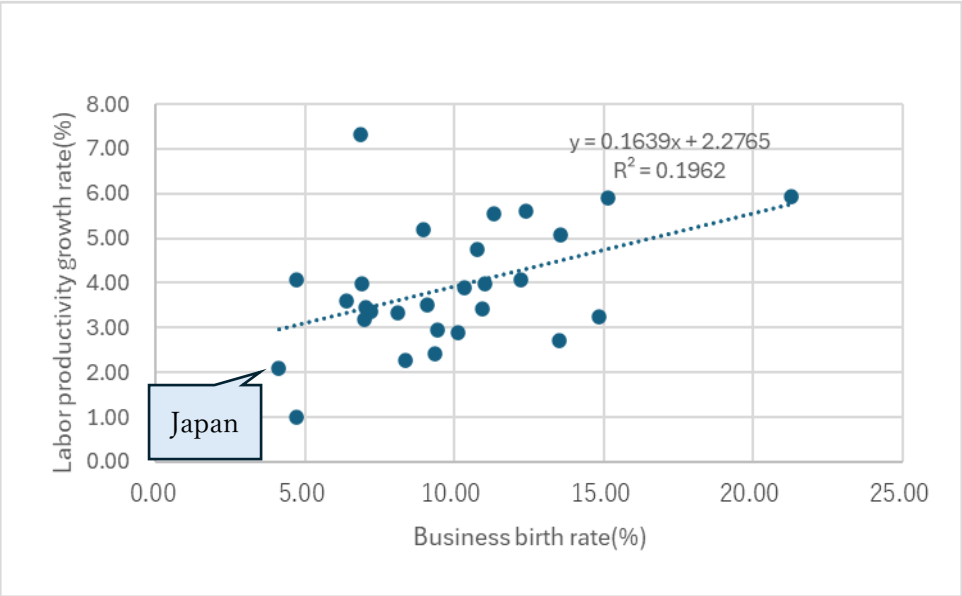

Fig. D. Business birth rates and Labor productivity growth rate

Table D Business birth rates and Labor productivity growth rate

(2011～2019) （Unit:%）

Country（28）	Business birth rate	Labor productivity growth rate
Austria	6.90	4.00
Belgium	6.38	3.59
Czechia	8.97	5.19
Denmark	11.00	3.98
Estonia	11.31	5.55
Finland	8.10	3.34
France	10.31	3.91
Germany	4.70	4.07
Greece	4.70	1.01
Hungary	10.92	3.42
Iceland	12.22	4.08
Italy	7.18	3.36
Ireland	6.86	7.32
Japan	4.12	2.09
Latvia	15.12	5.90
Lithuania	21.29	5.94
Luxembourg	9.41	2.94
Netherlands	10.12	2.90
Norway	8.35	2.27
Poland	12.39	5.62
Portugal	14.82	3.25
Slovenia	10.77	4.75
Spain	9.08	3.52
Sweden	6.96	3.20
Switzerland	7.01	3.45
Türkiye	13.56	5.07
United Kingdom	13.52	2.73
USA	9.33	2.43

Source： Business birth rate: EU. Stat, UK. Office for National Statistics, Japan. White Paper on SMEs, Annual Report on Civil, Litigation, and Human Rights Statics, National Tax Agency Annual Report, USA. Census Bureau.
Labor productivity： OECD. Stat