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Firms' Interest Payment Burden and Productivity under a Low Interest Rate Environment^{*}

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Abstract

For a long period, a low interest rate environment has continued on in Japan. While this environment puts upward pressure on the real economy through a decline in real interest rates, it also hinders the business dynamics of firms and induces inefficient resource allocation.

Taking this into account, in this paper, we first try to extract a group of firms that continue to survive with support from banks or other entities despite performing poorly and having no prospect of recovery. We refer to these firms as "financially-supported firms." We find that the share of financially-supported firms in Japan has remained at a low level in recent years. The productivity of financially-supported firms is lower than that of other firms and despite their limited number, they put downward pressure on aggregate productivity. We then analyze the spillover effects of financially-supported firms on the macroeconomy, i.e., through distortion in resource allocation. The analysis of large firms in recent years does not suggest that the presence of financially-supported firms has suppressed the productivity of other firms.

Next, we conduct an empirical analysis on the relationship between a low interest rate environment and financially-supported firms. No direct relationship is confirmed between the two, partly due to the fact that the emergence of financially-supported firms was prevented under a stable financial system. However, in recent years, while the share of firms facing a significant deterioration in business conditions, such as financiallysupported firms, has been at a low level after having declined from the mid-1990s through the mid-2000s, the share of firms remaining at relatively low productivity has been flat; this suggests the possibility that the low interest rate environment might be one of the attributable factors.

JEL Classification: D22, D24, D30

Keywords: Resource allocation, Low interest rate, Financially-supported firms

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1. Introduction

Since the burst of the bubble economy in the early 1990s, Japan has experienced an ongoing low interest rate environment. A series of monetary easing policies implemented by the Bank of Japan, including low interest rate policies, have pushed up the real economy by, for example, encouraging a decline in real interest rates and calling for positive investment from firms.¹ On the other hand, some argue that the prolonged low interest rate environment may have hindered firms' business dynamics and distorted resource allocation. In general, distortion in resource allocation is said to entail the risk of obstructing sustainable economic growth. Specifically, in a low interest rate environment, there are often concerns that such distortion may consequently lead to an increase in the number of firms that continue to survive with support from banks or other entities despite performing poorly and having no prospect of recovery — hereafter "financially-supported firms" — (e.g., Banerjee and Hoffman [2018, 2022], Bowman [2022]). The concerns also relate to the distortion leading to an emergence and an increase in firms which continue to have low productivity, with deteriorated business conditions but not ones as bad as financially-supported firms. However, many oppose these concerns, noting that a clear relationship between a low interest rate environment and financially-supported firms cannot be confirmed (e.g., Obstfeld and Duval [2018], Bindseil and Schaaf [2020]). In addition, there are studies pointing out that the emergence and survival of financiallysupported firms is attributable to various financial supports, including subsidies, as seen in times of the global financial crisis (GFC) and the COVID-19 pandemic, regardless of the low interest rate environment.² Even if a low interest rate environment leads to the emergence of financially-supported firms in some sense, such an environment can also prevent their emergence as monetary easing prevents recession and firms' business performance recovers.

As described above, there is no consensus in views on the effect that a low interest rate environment may have on firms' business dynamics and resource allocation, e.g., the emergence and survival of financially-supported firms. There are two reasons which make an assessment of the effects difficult. First, as a prerequisite, it is difficult to identify financially-supported firms. While many existing studies regard those firms that only survive with support from banks or other entities, despite their poor performance and with no prospect of recovery, as problematic, it is not easy to define them quantitatively. Some

¹ By carrying out counterfactual simulations, Bank of Japan (2016) and Bank of Japan (2021) show that QQE (and QQE with Yield Curve Control) has had positive effects to some extent on economic activity and prices.

² For example, Uesugi *et al.* (2022) point out that firms which were zombie firms prior to these shocks may have been saved by actively using such support.

studies even note that financially-supported firms increase and decrease in accordance with economic fluctuations, which contradicts their definition as firms that are "performing poorly with no prospect of recovery." Second, there are many theoretical approaches showing the effects of a low interest rate environment on the emergence of financially-supported firms. However, to the best of our knowledge, there are not, as yet, sufficient empirical studies that extract financially-supported firms appropriately and analyze the situation of these firms, especially in Japan over recent years. Further, in situations where there has not been a significant increase in financially-supported firms in recent years as discussed in Yamada *et al.* (2025) and Uesugi *et al.* (2022), it seems useful to broaden the analysis to include low productivity firms — whose performances have not worsened to the extent of financially-supported firms.

In this paper, we attempt to extract financially-supported firms and low productivity firms, taking into account the aforementioned issues and referencing existing studies. We then carry out an empirical analysis with the aim of clarifying if there is a relationship between a low interest rate environment and these firms.

The results of the analysis can be summarized by the following three points. First, among large firms, the number of financially-supported firms with relatively low productivity remains at a low level in recent years. Due to their limited number, we cannot clearly see a relationship in which those financially-supported firms are negatively affecting the productivity of other firms; in other words, we cannot confirm that those financiallysupported firms are distorting macroeconomic resource allocation. While in the 1990s, the number of large financially-supported firms was relatively high, currently there are more financially-supported SME firms; in these cases, we cannot deny the possibility that financially-supported firms may be negatively affecting the productivity of other firms. Second, we cannot see a direct relationship between a low interest rate environment and financially-supported firms. This is consistent with the fact that the number of financiallysupported firms has not increased despite the low interest rate environment continuing since the 2000s. Third, in recent years, although firms facing a significant deterioration in business conditions — like financially-supported firms — have not been increasing in number, there is a possibility that a low interest rate environment is one of the factors attributable to firms continuing to have relatively lower productivity; in other words, the environment may enable low productivity firms to continue their businesses while maintaining low productivity, and without improving their business conditions. However, our estimation results should be taken with considerable latitude when it comes to the quantitative impact of the low interest rate environment on the survival of low productivity firms. Our analysis does not necessarily identify the causal relations between the two. Going forward, further research is required. Moreover, it is also possible that low productivity firms have survived, mainly owing to various financial support measures.

The rest of this paper is outlined as follows. Section 2 briefly surveys existing studies on financially-supported firms and notes the contribution made by this paper. Section 3 defines financially-supported firms and low productivity firms then extracts those firms in Japan. It also summarizes the characteristics of those firms from the finance side. Section 4 focuses on the prolonged low interest rate environment in Japan and examines whether there is a relationship between the low interest rate environment and financially-supported firms and low productivity firms. Section 5 concludes.

2. Existing Studies

Yamada *et al.* (2025) summarize existing studies on financially-supported firms comprehensively. In this section, we mainly summarize the subjects in existing studies, then review existing studies on the relationship between a low interest rate environment and financially-supported firms which we are focusing in this paper.

2.1. What are financially-supported firms?

Caballero et al. (2008), who pioneer a series of studies on financially-supported firms, analyze Japan after the burst of the bubble economy and refer to firms whose "lives are prolonged" by financial support from banks or other entities. These firms, whose financial conditions suggest that it is difficult to remain in business, are described figuratively as "zombie firms." The method of identification differs according to previous studies; however, many studies, including Fukuda and Nakamura (2011) and Adalet McGowan et al. (2018), regard these firms as problematic in their analysis. Firms are generally unable to continue business when their performance is poor and they have no prospect for recovery: however, these previous studies consider the support provided by banks or other entities prolong their life for some reason. These past studies are unique as they take into account not only the performance of firms but also the financial support they receive. These firms are referred to in previous studies using a variety of terms. Many refer to them as zombie firms following Caballero et al. (2008) and others refer to them as low quality firms, non-viable firms, and troubled firms. In this paper, we refer to firms that survive with support from banks or other entities despite poor performance and which have no prospect of recovery as "financially-supported firms."

What are the financial characteristics of financially-supported firms? Yagi *et al.* (2022) and Albuquerque and Iyer (2023) report that the productivity of financially-supported

firms is lower than that of other firms in Japan and in 63 advanced and emerging economies, respectively. Moreover, Albuquerque and Iyer (2023), Favara *et al.* (2021), and Banerjee and Hofmann (2022) make a comparison between financially-supported firms and other firms by comparing financial indicators such as return on assets (ROA), which shows profitability, and interest coverage ratio (ICR), which shows a firm's ability to pay interest. They point out that financially-supported firms are vulnerable on these financial indicators.

In Japan, as the financial system regained stability following the burst of the bubble economy and the GFC, an extreme type of lending called forbearance lending — pointed out by Sekine *et al.* (2003) — is considered to have decreased significantly. Given this, the number of financially-supported firms is likely to be limited, as shown in Yamada *et al.* (2025). Taking this into account, to analyze distortion in aggregate resource allocation, sluggish business dynamics, and their effects on the economy, it seems useful to analyze not only financially-supported firms but also firms identified in broader terms. In this paper, we refer to firms with relatively low productivity as "low productivity firms" and include them in our analysis. Low productivity firms do not necessarily include financially-supported firms, but it is important to consider them when discussing business dynamics, as pointed by Nakamura *et al.* (2019) and Yagi *et al.* (2022).

Based on the above, in this paper, we extract financially-supported firms in Japan with methods used in existing studies. While many studies extract financially-supported firms based on certain thresholds, this may result in differences depending on the extracting method. With this in mind, we compare and analyze extraction results using several thresholds. We then attempt to describe the characteristics in terms of the finance of financially-supported firms and low productivity firms in Japan. As we will mention later, the number of studies on financially-supported firms have been on the increase reflecting large-scale financial support due to the spread of COVID-19 in many countries. That being said, as pointed in Yamada *et al.* (2025), there are few studies that examine quantitatively whether financially-supported firms have increased since the spread of COVID-19.³ On this point, we extract financially-supported firms, based on recently collected data, and note additional empirical results regarding developments surrounding financially-supported firms since the spread of COVID-19.

³ An example of quantitative analyses of an increase in financially-supported firms since the spread of COVID-19 is Favara *et al.* (2021); they point out that while financially-supported firms increased after the spread of COVID-19, their increase was limited compared to past recession periods. Moreover, Haynes *et al.* (2021) notes that more data need to be accumulated, although financially-supported firms have increased since the spread of COVID-19.

2.2. The emergence of financially-supported firms: the relationship between low interest rate environment and financially-supported firms

The number of studies on financially-supported firms increased since 2000, focusing on Japan after the collapse of the bubble economy. They note that the vulnerability of bank balance sheets was the cause of financially-supported firms (Hoshi [2000], Sekine et al. [2003], Peek and Rosengren [2005], and Caballero et al. [2008]). That being said, those studies are focused on the period when nonperforming loans became a major issue. As nonperforming loans decreased and the financial system regained stability, analyses on financially-supported firms in Japan declined. In Europe, after the GFC and European debt crises in the latter half of the 2000s, discussions on financially-supported firms increased. In those discussions, the emergence of these firms were said to be the result of a low interest rate environment and the inadequacy of insolvency resolution schemes, in addition to the vulnerability of bank balance sheets. In the 2010s, studies on Chinese state-owned enterprises (SOEs) increased. In those studies, government support is noted as a cause for the emergence of financially-supported firms (Tan et al. [2016], Shen and Chen [2017]). After the spread of COVID-19, the presence of government support has become the subject of discussions globally (Helmersson et al. [2021), Barnes et al. [2021], Gourinchas et al. [2021], Core and De Marco [2024], and Chetty et al. [2020]).

Consequently, existing studies analyzing the low interest rate environment and financiallysupported firms have mainly focused on European firms and to the best of our knowledge, there is still an insufficient number of analyses focusing on Japan. Further, there has not yet been a consensus on the relationship between a low interest rate environment and financially-supported firms among existing studies, including those focusing on firms outside of Japan, as described below. We expect more research on these themes in the future.

In existing studies that note a low interest rate environment as the cause for the emergence of financially-supported firms, Banerjee and Hofmann (2018 and 2022) carry out analyses in 14 advanced economies and point out that as banks' risk-taking become bolder and firms are less incentivized to reduce debt in a low interest rate environment, financially-supported firms increase in number.⁴ Acharya *et al.* (2020) also point to the appetite for risk of the lending side as becoming bolder in their analysis on EU countries. Moreover, in their study analyzing 20 advanced economies, Bowman (2022) points out that monetary easing has led to an increase in financially-supported firms and that such a trend is more

⁴ Banerjee and Hofmann (2018 and 2022) note that it is necessary to keep in mind that there are tradeoffs as monetary easing prevents recessions and contains the emergence of financially-supported firms.

apparent in countries where the banking system is less stable. Hong et al. (2021), which analyzed Japanese firms, points out that financially-supported firms with a lower ICR may be benefiting from a low interest rate and that their lives may be prolonged as a result. Moreover, many studies (for example, Caballero et al. [2008], Adalet McGowan et al. [2018], Andrews and Petroulakis [2019], and Acharya et al. [2020]) point out that there is a possibility that financially-supported firms push down aggregate productivity through, for example, distortion in resource allocation. Taking this into account, it means that, theoretically, there is also a possibility that a low interest rate environment affects resource allocation, leading to a decline in productivity. There are studies analyzing these points theoretically, including the more macroeconomic effects. Kiyotaki et al. (2021) build a model with investors and entrepreneurs and argue that, when the funds raised from investors is mainly affected by the near-term revenue of the entrepreneur, the expected present discounted value of the earning from investments is not very sensitive to interest rate fluctuations. However, as the low interest rate environment is prolonged, the value of the land and the plant tend to increase. They note that, as a result, the initial cost necessary for entrepreneurs to start a business is likely to exceed funding from investors, which can hold back new investments. Moreover, Liu et al. (2022) note that - through a theoretical model — when interest rates decline, firms' investments increase in a short term, but when interest rates remain at very low levels, the degree of oligopoly increases due to fierce competition, consequently leading to firms with lower market shares refraining from investment, pushing down the aggregate productivity.

There are also studies that rebut the idea that a low interest rate environment is the cause for the emergence of financially-supported firms. For example, Obstfeld and Duval (2018), Laeven et al. (2020), and Schularick (2021) claim that the share of financially-supported firms vary across countries in the euro zone, despite the same policy interest rate, therefore, it is difficult to consider that monetary easing was the cause of the emergence of financially-supported firms. Bindseil and Schaaf (2020) point out the possibility that a low interest rate encourages firms' innovation and growth and leads to less competitive firms exiting from the market. Albuquerque and Mao (2023) analyze 49 advanced and emerging economies and point out that banks may increase lending to financially-supported firms, even when interest rates are rising, to avoid impairment of their capital. This suggests that the emergence of financially-supported firms is affected by the vulnerability in the financial system rather than the interest rate environment. Moreover, Jafarov and Minnella (2023) analyze 21 advanced economies and note that monetary easing while facing the lower bound on interest rates prevents firms' turning into financially-supported ones. Regarding these points, many theoretical studies show that a low interest rate environment leads to more active investment behavior by firms and improved productivity, and deny that a low interest rate environment pushes down productivity. Colciago and Silvestrini (2022) construct an economic model that includes firms' entry and exit into the market and show a path on which productivity increases as monetary easing induces more firms to enter the market, increasing the competition among firms and correcting distortion on resource allocation. Baqaee *et al.* (2024) note that there is heterogeneity in markups across firms and that as demand increases and marginal costs rise due to monetary easing, demand shifts from low-markup firms — assuming that they tend to pass a higher portion of marginal cost changes into prices — to high-markup firms. This increases production at high-markup firms and reallocates resources, raising the aggregate productivity.

Considering the above discussion, in this paper, we carry out an empirical analysis of extracted data on financially-supported firms and low productivity firms to reveal the relationship between the prolonged low interest rate environment and financially-supported and low productivity firms.

3. Extracting Financially-Supported Firms

3.1. Estimates based on methods proposed by existing studies

Financially-supported firms

In this section, we extract financially-supported firms in Japan using three methods used in existing studies: (1) a method employed by the Bank of Japan staff, (2) a method employed by the Bank of International Settlements (BIS) staff, and (3) a method employed by the International Monetary Fund (IMF) staff.

An analysis by the BOJ staff (Yamada *et al.* [2025]) attempts to quantify firms that continue to survive with support from banks or other entities despite performing poorly and having no prospect of recovery, the qualitative definition of financially-supported firms, as discussed in the previous section. Specifically, they point out that many existing studies extract firms that satisfy (1) the interest rate requirement, (2) the solvency requirement, and (3) the growth potential requirement for a certain length of period. They then combine requirements employed by many existing studies and extract firms that meet the following three requirements for three consecutive years:

Interest rate requirement:

Rate of interest paid < Average contracted interest rate on loans (stock base); or

Current term borrowings > Previous term borrowings.

Solvency requirement: ICR < 1.

Growth potential requirement: Founded at least 10 years prior.

They make meeting the requirements for three consecutive years a precondition in order to avoid accidentally including firms suffering from a temporary deterioration in business performance and to ensure that they accurately extract only firms that have no prospect of recovery.

The interest rate requirement was often used in early-stage studies on financially-supported firms. This method is used to identify financially-supported firms from the viewpoint of bank support and was used with the intention of extracting firms that are provided with a bank's reduction or waiver of interest. Some recent studies do not use this requirement for extraction. For example, a study by the BIS staff (Banerjee and Hofmann [2018]) and another by the IMF staff (Albuquerque and Iyer [2023]) do not include the interest rate requirement when they extract financially-supported firms due to the following potential drawbacks; firms in good standing that receive preferential interest rates would be misidentified as financially-supported firms and, when policy interest rates are close to zero for a long time facing the lower bound, subsidized lending rates would not be lowered further.⁵ Moreover, Yamada *et al.* (2025) focus on firms' profitability in the solvency requirement and extract firms that are unable to cover debt servicing costs from current profits. They seem to have devised the growth potential requirement, focusing on whether they can expect future growth, so that young firms such as startups are not included in financially-supported firms.

⁵ Fukuda and Nakamura (2011) claim that it is possible to lower the possibility of identifying firms in goodstanding with low credit risks as financially-supported firms by considering the solvency requirement in addition to the interest rate requirement. Other existing studies including Acharya *et al.* (2020), Goto and Wilbur (2019), and Yamada *et al.* (2025) analyze similarly.

Banerjee and Hofmann (2018) define financially-supported firms as those meeting the solvency requirement and the growth potential requirement for three consecutive years, as in Yamada *et al.* (2025), eliminating the interest rate requirement.^{6,7}

Solvency requirement: ICR < 1.

Growth potential requirement: Founded at least 10 years prior.

Albuquerque and Iyer (2023) also eliminate the interest rate requirement. They refer to firms that meet both the solvency requirement and the growth potential requirement for two consecutive years as financially-supported firms, as shown below.

Solvency requirement:

ICR < 1; and leverage ratio > the median of leverage ratio in each sector.

Growth potential requirement: Real sales growth < 0.

In this paper, we use the abovementioned three methods to calculate the share of financially-supported firms in large firms and SMEs. Data on large firms are taken from the "Corporate Financial Databank" provided by the Development Bank of Japan (DBJ) and those on SMEs are taken from the database provided by the CRD (Credit Risk Database) Association.⁸ The sample period is fiscal 1990-2022 for large firms and fiscal 2005-2022 for SMEs.

⁶ Similar definitions are used in Adalet McGowan *et al.* (2018). Banerjee and Hofmann (2018) use another definition of the growth potential requirement based on Tobin's q, defined as the ratio of market value of the firm's assets and their replacement cost. This paper does not use such definition as it includes unlisted SMEs.
⁷ In Banerjee and Hofmann (2018) and Albuquerque and Iyer (2023), these requirements are not precisely

indicated as the interest rate requirement, the solvency requirement, or the growth potential requirement. However, in this paper, we use those terms for convenience.

⁸ The database houses data on management of client SMEs provided by credit guarantee corporations and financial institutions that participate in the CRD association.

In the extracted results shown in Figure 1, we can point out the following. Although levels differ across the three methods, their direction is largely the same.⁹ All the results show that the share of large financially-supported firms increased in the first half of the 1990s and has been hovering at a low level ever since. Recently, the share has been slightly increasing, but its level is generally lower than in the past. We can say that since the COVID-19 pandemic there has not been an acute increase in these firms, i.e., firms that survive with support from banks or other entities despite performing poorly and having no prospect of recovery. Comparing the three methods in more detail, the share extracted by the method proposed in Yamada *et al.* (2025) which sets three requirements for three consecutive years is at a lower level and it fluctuates less in a short term. In contrast, using methods proposed in Banerjee and Hofmann (2018) and Albuquerque and Iyer (2023), the share of financially-supported firms fluctuates to a larger extent compared to the results in Yamada *et al.* (2025); after having risen, partly due to the spread of COVID-19, it has declined in fiscal 2022.

We were only able to extract the share of financially-supported firms among SMEs for a short period. These firms have been hovering at a low level after having risen during the GFC. The number has been increasing slightly recently, albeit at a level lower than in the post-GFC period. In more detail, the results obtained with the method proposed in Yamada *et al.* (2025) tend to be lower, as was the case with large firms. In the method in Banerjee and Hofmann (2018), the share increased relatively to a larger extent in fiscal 2022. During the pandemic, many SMEs borrowed through interest-free loans and loans at low rates. The interest paid in a number of such loans was set to increase three years after borrowing. Those firms that borrowed immediately after the spread of COVID-19 were faced with increased interest payment at the end of fiscal 2022; through a rise in the interest coverage ratio (ICR), the share of financially-supported firms seems to have risen. The share calculated with the method in Albuquerque and Iyer (2023) rises relatively to a larger extent in fiscal 2021 and returns to a pre-pandemic level in fiscal 2022. This method uses decreased profits as one of requirements to identify financially-supported firms, so the share seems to reflect a temporary dip in profitability.

The method in Albuquerque and Iyer (2023) may be affected by short-term economic fluctuations because they impose only two requirements to be met for two consecutive years and firms with decreased profitability are extracted by the growth potential requirement. Furthermore, in methods in Banerjee and Hofmann (2018) and Albuquerque

⁹ Yamada *et al.* (2025) note that, when assessing the share of financially-supported firms, it is important to focus on the direction of changes, not simply on the levels of numbers because the number of financially-supported firms identified changes significantly depending on the requirements used when extracting firms.

and Iyer (2023), the interest rate requirement is omitted to avoid risks of misidentifying firms in good standing as financially-supported firms; however, those firms in good standing are highly likely not to meet the solvency requirement, i.e., they are sufficiently solvent. While setting the interest rate requirement on its own seems to increase risks of misidentifying financially-supported firms, pairing the solvency requirement with the interest rate requirement mitigates such risks. On the other hand, without setting the interest rate requirement, firms with reduced interest rates cannot be extracted, meaning that firms that survive with support from banks or other entities are not identifiable.

The results of extracted financially-supported firms during the spread of COVID-19 are consistent with results of analyses such as by Uesugi *et al.* (2022). Morikawa (2020) and Hoshi *et al.* (2023) survey the use of the government's various support measures for firms in Japan following the spread of COVID-19. They suggest that financial support was given not only to firms whose performance temporarily worsened but also to firms whose performance had been lackluster even before the pandemic. This paper's empirical results suggest that financially-supported firms did not increase notably due to the series of urgent support. It should be noted, however, that many of financial support measures during the pandemic took in new applications and provided loans until around 2022. Once these measures come to an end, and when repayments begin in full, attention should be paid to whether financially-supported firms increase. It is therefore a little too early to draw a final conclusion on the effects of COVID-19 on financially-supported firms, and thus we use data from the pre-pandemic period in our analysis below.¹⁰

Low productivity firms

Next, we discuss the coverage of "low productivity firms." As each firm's productivity is higher or lower relative to other firms, in this paper, we define firms in the lower 20 percentile in terms of the real labor productivity by industry in each fiscal year as low productivity firms.^{11,12} Low productivity firms do not necessarily include financially-supported firms. Many of them do not perform as poorly as financially-supported firms but have similar characteristics as they are inferior to other firms in terms of their financial soundness and profitability, as we will touch upon later. Their low productivity may be

¹⁰ As suggested by the fact that the number of financially-supported firms did not increase significantly after the spread of COVID-19, our main empirical results do not change even if we include data up to fiscal 2022.
¹¹ Real labor productivity is calculated by the following method, referencing Yagi *et al.* (2022): real values of the value added (the sum of operating profits and personal expenses) — measured from individual firm's finance data — are obtained using the value-added deflator by industry, and they are divided by the total

working hours (the number of workers, measured from the finance data, times hours worked in each industry). ¹² There is a possibility that the differences in productivity among industries affect the results in the analysis on firms' productivity. Therefore, we extract firms that in the lower 20 percentile in terms of the real labor productivity by industry as low productivity firms.

contributing to downward pressure on the macroeconomy. Similar to the above discussion on financially-supported firms, using a single year criterion to extract low productivity firms may lead to mistakenly including firms whose productivity has only temporarily decreased. To avoid this, we extract firms that continue to have low productivity for certain length of time, i.e., more than 3 years or 5 years, as "firms staying in the market in spite of low productivity" and analyze their relationship with the low interest rate environment.¹³ Extracted results in Figure 2 show that, in both large firms and SMEs, there are some firms that continue to have relatively low productivity. In addition, for large firms, while the share of financially-supported firms has declined as the disposal of nonperforming loans progressed, the share of firms whose productivity remains low has been more or less flat.

3.2. Characteristics of financially-supported firms

Before starting a detailed analysis, we confirm the characteristics of financially-supported firms and low productivity firms from the viewpoint of finance and profit.

The financial soundness and profitability of financially-supported firms' are poorer compared to other firms.¹⁴ Table 1 shows this in terms of four indicators, i.e., leverage ratio, ratio of cash and deposits, ROA, and ICR. For both large firms and SMEs, the performance of financially-supported firms are relatively poor. Regarding this point, we conducted a t-test for the difference between means by firm group, to see whether there are differences even when we control the fixed effects of individual firms, industries, and time. We confirmed that they were almost all statistically significant — suggesting the vulnerability of financially-supported firms' financial situation. These results are generally consistent with existing studies (Albuquerque and Iyer [2023], Favara *et al.* [2021], and Banerjee and Hofmann [2022]). Large firms' ICR and ratio of cash and deposits do not differ significantly between financially-supported firms mainly among large firms in recent years.

Comparing low productivity firms and other firms (hereafter "non-low productivity firms") shows that for both large firms and SMEs, low productivity firms' financial indicators are poorer than those of non-low productivity firms, as was the case in financially-supported firms. Even after controlling for the fixed effects of individual firms, industries, and time,

¹³ Colacelli and Hong (2019) define a firm to be a "laggard" when it shows two consecutive years of productivity growth in the bottom 10th percentile and note that "laggard" firms tends to be smaller and older firms.

¹⁴ Estimation in this paper is carried out based on the data of the share of financially-supported firms extracted by Yamada *et al.* (2025). Similar results can be obtained from methods in Banerjee and Hofmann (2018) and Albuquerque and Iyer (2023).

the results are statistically significant. Their poorer financial soundness and profitability are similar to characteristics of financially-supported firms.

4. Empirical Analysis of Financially-Supported Firms

4.1. Analysis of the effects of financially-supported firms on the macroeconomy

As many studies point out (such as Caballero *et al.* [2008] and Andrews and Petroulakis [2019]), there is a view that the presence of financially-supported firms distort aggregate resource allocation and exert negative effects on the macroeconomy through a decline in productivity. Specifically, many claim that human resources, capital stock, and lending remaining in financially-supported firms prevents other healthy firms from obtaining necessary resources for growth. As confirmed in the previous section, the share of financially-supported firms has been at a low level in recent years, and it is unlikely that financially-supported firms are seriously hindering economic growth. In this section, we would like to confirm this point empirically.

First, we simply draw the distribution of labor productivity for financially-supported firms and other firms, and then we compare them. The productivity distribution for all large firms by period indicates that the variation in productivity across firms has increased over time and some firms continue to have low productivity and profitability (Figure 3). The distribution for all SMEs also shows some variation in productivity across firms. Then, we draw distribution by firm group to see the variation in further detail. Among large firms, the distribution of financially-supported firms is on the left side (lower productivity) relative to other firms (Figure 4). This is consistent with existing studies (Yagi *et al.* [2023], Adalet McGowan *et al.* [2018], and Albuquerque and Iyer [2023]). More specifically, the distribution of financially-supported firms has been generally unchanged over the years. On the other hand, the tail of the distribution of other firms has been gradually shifting to the right, suggesting the possibility that disparities in productivity between other firms with higher productivity and financially-supported firms are increasing.¹⁵ The distribution of financially-supported firms is also on the left side (lower productivity) relative to other firms (Figure 5).

Second, we confirm whether the productivity of financially-supported firms is statistically low, using a panel analysis. When doing so, we refer to Caballero *et al.* (2008) and also

¹⁵ Figures 3, 4, and 5 show kernel smoothing distributions. Kernel smoothing distributions on large financially-supported firms in the 2010s should be regarded as being subject to a considerable margin of error as their number was limited.

confirm whether financially-supported firms negatively affect other firms' productivity. The estimation equation is as follows:

$$LaborProd_{i,s,t} = \beta_1 I (NonSupported_{i,s,t}) \\ + \beta_2 I (NonSupported_{i,s,t}) \times SupportedShare_{s,t} + \delta_i + \rho_s + \theta_t + \epsilon_{i,s,t}.$$

LaborProd_{*i*,*s*,*t*} is real labor productivity, $I(NonSupported_{i,s,t})$ is a dummy that takes a value of 1 when firms are not financially-supported firms, and SupportedShare_{*s*,*t*} is a variable of the share of financially-supported firms in the industry. *i*, *s*, *t* represent individual firm, industry, and time, and δ_i , ρ_s , θ_t represent fixed effects on individual firm, industry, and time, respectively.

When β_1 , the first term in the right hand side of the equation above, is positive, it shows that productivity of other firms is higher relative to financially-supported firms. The second term is an interaction term of a dummy variable for other firms and the share of financiallysupported firms in each industry. If financially-supported firms negatively affect the productivity of other firms, such a tendency would surface more clearly in industries where the share of financially-supported firms is high, suggesting that β_2 would be negative. For our estimation, we use the results extracted using the three methods mentioned above to distinguish financially-supported and other firms, partly to examine the robustness of empirical results. The estimation period is from fiscal 1990 to fiscal 2019 for large firms and from fiscal 2005 to fiscal 2019 for SMEs. Estimates are made for large firms and SMEs separately due to the shorter time-series for SMEs. When estimating, we eliminate samples with excessively high or low figures in real labor productivity to prevent outliers from affecting the results.¹⁶

First, the empirical results for large firms in Table 2 indicate, regardless of the sampling method of identifying financially-supported firms, β_1 is significantly positive, showing that other firms' productivity is significantly higher than that of financially-supported firms, as we already saw in the distribution of their productivity. On the other hand, we cannot obtain significant results for β_2 and we cannot confirm spillovers from financially-supported firms.¹⁷ We interpret these results in the following way. Since the

¹⁶ Specifically, regarding labor productivity, the top and bottom 0.5-percentile samples are excluded for large firms — relatively less in number — and 1.0-percentile samples for SMEs. Also, to use the same samples for each estimation, we also excluded the top and bottom 0.5-percentile samples for large firms and 1.0-percentile samples for SMEs for paid interest rates which we will use in a later analysis.

¹⁷ The results of spillover effects from financially-supported firms to other firms on productivity (β_2) were different among existing studies that conducted estimation with a similar framework to this paper. Adalet McGowan *et al.* (2018) and Caballero *et al.* (2008) claim that β_2 is significantly positive. Caballero *et al.* (2008) interpret that, when financially-supported firms survive with, for example, subsidies, the competition gets more severe and the productivity of other firms increases. In contrast, Imani *et al.* (2023) and

number of financially-supported firms is limited and there are few cases of larger firms with more influence (with asset and/or sales volume in the 10th percentile) turning into financially-supported firms (Figure 6), it seems that negative externalities due to the presence of financially-supported firms were not observed.

Moreover, as described above, the share of financially-supported firms among large firms increased significantly in the 1990s but has been at a low level since the 2000s. To inspect the possibility that such differences in the level of the share affects spillover effects from financially-supported firms to other firms, we also carry out estimation in two sample periods, from fiscal 1990 to 1999 and from fiscal 2000 to 2019. Empirical results in Table 2 show that β_1 is significantly positive, regardless of the sampling methods used to identify financially-supported firms, in each of the sampling periods. In detail, the coefficient is greater when using samples after the 2000s, suggesting that a disparity in productivity between financially-supported firms and other firms is growing amid a decrease in the number of financially-supported firms. In the sample period from fiscal 1990 to 1999, we could not obtain significant results for β_2 with sampling methods in Yamada et al. (2025) and Banerjee and Hofmann (2018). On the other hand, with the method in Albuquerque and Iyer (2023), we obtained significantly negative results for β_2 . The results of the latter suggest that, during the period when there were more financiallysupported firms, the presence of these firms was likely to push down other firms' productivity in industries where there were many financially-supported firms. In addition, in the sample period after the 2000s, we could not obtain statistically significant results with any of the sampling methods and therefore we did not observe spillovers from financially-supported firms to other firms.

Second, empirical results for SMEs in Table 3 show that β_1 is significantly positive, regardless of the sampling methods used to identify financially-supported firms. As is the case of large firms, the results suggest that productivity of other firms is statistically significantly higher than that of financially-supported firms among SMEs. We cannot obtain significant results with the method in Yamada *et al.* (2025) for β_2 ; however, the results turn out to be significantly negative when we use different methods. We are therefore unable to deny the possibility that financially-supported firms are pushing down

Albuquerque and Iyer (2023) reach a conclusion that β_2 is significantly negative. In Japan, low interest rates and low productivity have been prolonged in recent years; taking this into account, it is unlikely that financially-supported firms are increasing other firms' productivity (β_2 is significantly positive). On the other hand, as the number of financially-supported firms is limited, it is also not likely to have negative externalities (β_2 is significantly negative). Therefore, we suppose that, on the whole β_2 was not statistically significant.

the productivity of other SME firms, for which the share of financially-supported firms is higher than large firms.

Discussion of empirical results

Summarizing the above, the results of the empirical analysis in Section 4.1. suggest the following points with regard to the effects of financially-supported firms on the macroeconomy. First, financially-supported firms' productivity is lower than that of other firms. Consequently, financially-supported firms are automatically pushing down aggregate productivity, despite their limited number; in other words, they are pushing down the arithmetic average of productivity.

Second, although financially-supported firms' productivity is low, we cannot say that they are exerting negative effects on other firms' productivity, or distorting resource allocation, among large firms in recent years. The number of financially-supported firms is limited in Japan, and they do not seem to make enough impact to exert effects on other firms' resource allocation. That being said, we cannot deny the possibility that large financially-supported firms exerted negative effects on the productivity of other firms in the 1990s where there were more financially-supported firms relative to recent years and for SMEs where there are more financially-supported firms relative to large firms.

4.2 Relationship between a low interest rate environment and financially-supported firms/low productivity firms

As we discuss in Section 2, many existing studies raise a low interest rate environment as a factor for the emergence and survival of financially-supported firms. In this study, as we follow Yamada *et al.* (2025) and extract firms that continue to be identified as financially-supported firms from the previous quarter, we can see that some financially-supported firms stay in the market, especially among SMEs. There is a possibility that the economic situation and fiscal and monetary policy during this time contribute to the survival of financially-supported firms, though this needs to be verified (Figure 7).¹⁸ That being said, as previously mentioned, there are many who oppose this hypothesis (that the low interest rate environment affects the emergence of financially-supported firms), and as yet, there have been no clear conclusions drawn on this relationship.

This section examines the relationship empirically. Note that even if the continuation of low interest rate environment does not affect the emergence and survival of financially-

¹⁸ In Figure 7, we classify financially-supported firms into three categories: (1) firms that continued to be identified, (2) firms that are identified for the first time in the current quarter, and (3) firms that have been identified before, up to 2 quarters prior to the current quarter, and after having been a non-financially-supported firm in the previous quarter, identified as a financially-supported firm again in the current quarter.

supported firms facing extreme business conditions, there is a reasonable possibility that the environment is impeding the management reforms of low productivity firms and their exit from the market. Indeed, in Japan, low productivity firms tend to stay in the market while continuing to have low productivity (Yagi *et al.* [2022]). Taking this point into account, we analyze the relationship between the low interest rate environment and firms with continued low productivity.

Relationship between the low interest rate environment and low productivity firms

To see whether there is a relationship between the low interest rate environment and financially-supported firms, we first check a simple correlation between them for large firms for which we can obtain long-time-series data. Figure 8 shows the scatter plots of the share of financially-supported firms and payment interest rates aggregated by industry and fiscal year. We do not confirm a correlation. This seems consistent with the fact that the share of financially-supported firms has hovered at a low level while interest rates follow a declining trend.

Next, we conduct an econometric analysis of the relationship between the two while controlling information such as those related to finance of individual firms. Specifically, we estimate the following logit model,¹⁹

$$Prob\{I(Supported_{i,s,t})\} = F(\phi \ \widehat{r_{i,s,t-1}} + X_{i,s,t}\gamma' + \gamma_{gdp}X_{t-1}^{gdp} + \omega_s + \epsilon_{i,s,t}),$$

where $\widehat{r_{i,s,t-1}} = \widehat{\alpha_s}InterestRate5Y_{t-1} + \widehat{\rho_s}.$

Here, I (Supported_{i,s,t}) is a dummy that takes a value of 1 when firms are financiallysupported firms and the model estimates the probability of a firm turning into a financiallysupported firm. We use the three methods shown in Section 3 to extract financiallysupported firms. To analyze how macroeconomic interest rates are related to the probability of the emergence of financially-supported firms, for the explanatory variable $r_{i,s,t-1}$, we use an estimate obtained from the regression of the rate of interest paid by individual firms on 5-year Japanese government bond (JGB) yields and the constant term. We use this explanatory variable to consider the difference of interest rate sensitivity across industry mainly due to borrowing terms and amounts outstanding. $X_{i,s,t} = [X_{i,s,t}^{ROA} X_{i,s,t}^{lev} X_{i,s,t}^{age}]$ and X_t^{gdp} are control variables and use the ROA, leveraged ratio, corporate vintage (log), and real GDP growth rate to control individual firms' finance

¹⁹ For estimation, we referred to Jafarov and Minnella (2023). They examine the relationship between monetary easing and financially-supported firms using a probit model with panel data consisting of firms in several countries.

information and aggregate business cycle. *i*, *s*, *t* mean individual firms, industry, and time. ω_s means industry fixed effects.

 ϕ and $\gamma = [\gamma_{ROA} \ \gamma_{lev} \ \gamma_{age}]$ as well as γ_{gdp} show a change in probability of a firm becoming a financially-supported one when each variable changes by one unit. When ϕ is a negative figure, it suggests a possibility that a decline in interest rates (low interest rate environment) exerts effects on the emergence of financially-supported firms. Estimation period is from fiscal 1990 and 2019 for large firms, and from fiscal 2007 to 2019 for SMEs.

Table 4 shows empirical results on large firms, the average marginal effects of each variable — that is, when they change by one unit, given that other variables are average values, what percent of the probability of a firm turning into a financially-supported one would change (as for ϕ , what percent of the probability of a firm turning into a financiallysupported one would change when interest rates change by 1 percent). We could not obtain statistically significant average marginal effects on interest rates regardless of the sampling method of identifying financially-supported firms. Moreover, we obtained only positive figures. Consequently, we cannot confirm a direct relationship between a low interest rate environment and financially-supported firms. In addition, we also conducted a sub-sample estimation, similar to the analysis in Table 2 on the productivity of financially-supported firms, dividing the sampling period into the 1990s and the 2000s onward; however, we did not obtain significant results. For average marginal effects on the ROA and the leverage ratio that are control variables, on the basis of all samples (sampling period: fiscal 1990-2019), results were statistically significant depending on the sampling method of financially-supported firms. On the sub-sample basis, however, there were no statistically significant results, thus the relationship between these finance indicators and financiallysupported firms was not confirmed. Also, with regard to the real GDP growth rate, extracting by the methods in Yamada et al. (2025) and Banerjee and Hofmann (2018) did not display statistically significant results. Since we extract firms that are performing poorly with no prospect of recovery as financially-supported firms, it is likely that there is no relationship between financially-supported firms and short-term economic fluctuations. Thus, we can say that the empirical results prove how financially-supported firms are identified according to the definition. In contrast, when we extract with the method in Albuquerque and Iyer (2023), we were able to get statistically significantly negative figures in all of the sample periods and in the sub-sample period after 2000. As this method counts a decrease in profits as one of the requirements for financially-supported firms, it seems to have shown that the emergence of financially-supported firms, according to this definition, is linked to short-term economic fluctuations.

Table 5 shows empirical results for SMEs. When extracted with methods in Yamada et al. (2025) and Banerjee and Hofmann (2018), the average marginal effects of interest rates are not statistically significant, as is the case for large firms, and thus we do not confirm a direct relationship between a low interest rate environment and financially-supported firms. On the other hand, when we employ the method in Albuquerque and Iyer (2023), the average marginal effects of interest rates are significantly positive. This method is supposed to reflect short-term economic fluctuations, which may also be affecting empirical results.²⁰ Although the economic fluctuations factor is controlled using the real GDP growth rate, it is not statistically significant, which is different from the results for large firms. This may be due to the fact that fluctuations in SMEs' profits vary more than what can be captured by macroeconomic fluctuations. In addition, other control variables, including the leverage ratio, showed statistically significant results with all of the methods. Although a direct, clear relationship between a low interest rate environment and financially-supported firms is not confirmed, in continuing accommodating financial conditions (where it is easy for SMEs to borrow funds, mainly due to measures to support corporate financing and a low interest rate) a rise in the leverage ratio (a weakening of corporate finance) is shown to be exerting upward pressure on the probability of a firm turning into a financially-supported one.

Relationship between the low interest rate environment and low productivity firms

Next, we analyze the relationship between the low interest rate environment and low productivity firms using a similar framework as above. First, as shown in the scatter plot in Figure 9, a decline in paid interest seems to have some correlation with the survival of low productivity firms although this relationship is not very clear. On this point, we econometrically test the relationship between the firms remaining with low productivity and interest rates, using the following logit model,

$$Prob\{I(LowProd_{i,s,t})\} = F(\phi \widehat{r_{i,s,t-1}} + X_{i,s,t}\gamma' + \gamma_{gdp}X_{t-1}^{gdp} + \omega_s + \epsilon_{i,s,t}),$$

where $\widehat{r_{i,s,t-1}} = \widehat{\alpha_s}InterestRate5Y_{t-1} + \widehat{\rho_s}.$

Here, $I(LowProd_{i,s,t})$ is a dummy variable that takes a value of 1 when a firm's productivity continues to be low for a number of years, surpassing the threshold used in this estimation of 3 or 5 years. Other variables are the same as the ones used in the logit model for financially-supported firms. ϕ and $\gamma = [\gamma_{ROA} \ \gamma_{lev} \ \gamma_{age}]$, γ_{gdp} show a change in probability of a firm continuing to have low productivity when each variable

 $^{^{20}}$ While it is difficult to interpret empirical results obtained by using the method in Albuquerque and Iyer (2023), in a case where "amid low interest rates, the economy headed toward recovery," our estimation method could lead to positive average marginal effects of interest rates just as in Table 5.

changes by one unit. If ϕ is negative, a decline in the interest rate (low interest rate environment) may result in firms having ongoing low productivity. The estimation periods are from fiscal 1990 to 2019 for large firms and from fiscal 2007 to 2019 for SMEs.

Table 6 shows empirical results for large firms. The average marginal effects of interest rates are not statistically significant during the sub-sample period in the 1990s, in both cases where low productivity continued for more than 3 years or more than 5 years. However, in all sample periods and in the sub-sample period of the 2000s, the effects are statistically significantly negative. This means that the low interest rate environment in recent years is likely to lead to maintaining low productivity firms. Nevertheless, while the analysis of subsamples after the 2000s shows a greater impact of the low interest rate environment leading to maintaining low productivity firms, the analysis of all samples shows a smaller impact. Quantitative impact should therefore be interpreted with considerable latitude. For control variables, the average marginal effect of corporate vintage is significantly negative regardless of the sample period, showing that young firms are in the midst of constructing their business models and tend to continue to have low productivity. Also, the results of the ROA are statistically significant in general. With regard to the real GDP growth rate, we do not obtain any significant results, which means that low productivity firms — as defined in this paper — are not affected by short-term economic cycles.

As shown in empirical results for SMEs in Table 7, in both cases where the low productivity continued for more than 3 years and more than 5 years, the average marginal effects of interest rates are significantly negative, as is the case for large firms. This shows the possibility that a low interest rate environment is leading to maintaining low productivity firms. Moreover, significant results are found regarding the ROA and the leverage ratio. The real GDP growth rate, however, do not show significant results.

Discussion of empirical results

We can point out the following from the results of our analysis on the low interest rate environment and financially-supported as well as the low interest rate environment and low productivity firms in Section 4.2. First, there seems to be no direct relationship between the low interest rate environment and financially-supported firms. This is consistent with the fact that financially-supported firms that cannot survive without support from banks or other entities have not increased since the 2000s, despite the low interest rate environment. Nevertheless, for SMEs, when the leverage ratio increases, the probability of them turning into financially-supported firms rises in a statistically significant manner. Although we cannot confirm a direct relationship between a low interest rate environment and financially-supported firms, as accommodating financial conditions continue (where it is easy for SMEs to borrow funds, mainly due to measures to support corporate financing and low interest rate), a rise in the leverage ratio (a weakening of corporate finance) exerts upward pressure on the probability of a firm turning into a financially-supported one. It is possible to say that a series of our estimation results regarding the low interest rate environment and financially-supported firms indirectly supports claims by Sekine et al. (2003) and Caballero et al. (2008) that the cause of the emergence of financially-supported firms in the 1990s was not due to a decline in interest rates but due to the vulnerability of the financial system — the forbearance by banks stemming from nonperforming loans. We can interpret that, since the 2000s, amid the continued low interest rate environment, the disposal of nonperforming loans progressed and the strengthening of global financial regulation and the accumulation of capital by financial institutions advanced, and Japan's financial system became more robust, containing the emergence of financially-supported firms. In other words, as the financial system has been stable in recent years, "life support" type of loans like forbearance are very limited in the macroeconomy.

Second, while financially-supported firms have not increased in the low interest rate environment in recent years, the results suggest that low productivity firms are increasingly likely to remain so. The low interest rate environment seems to push up the real economy by, for example, encouraging firms' active investment through a decrease in real interest rates, as previously described. On the other hand, there is a possibility that such an environment leads to a decline in incentives for firms toward deleveraging. In this situation, we cannot deny that business dynamics, e.g., the entry and exit of firms, do not occur, hindering the dynamics of the overall macroeconomy. That is to say, the prolonged low interest rate environment of recent years has not contributed to an increase in the number of firms facing a deterioration in business conditions like financially-supported firms; however, it may create a situation where firms with relatively low productivity can remain in business while maintaining low productivity. Nonetheless, in the analysis using long time-series data, the effects of a low interest rate environment on the remaining of low productivity firms is relatively small, suggesting the quantitative impact needs to be interpreted with considerable latitude.

Moreover, the results of the empirical analysis in this paper suggest that, a low interest rate environment is likely to lead to the remaining of low productivity firms, as described above, in a sense that there is a relationship confirmed between interest rates and firms remaining with low productivity. That said, the results do not specify the causal relationship between the two, i.e., whether the low interest rate environment is the cause of the emergence of financially-supported firms and for continued existence of low productivity firms. It is necessary to also consider the following points. First, as noted by Yagi *et al.* (2022), Japan has been faced with structural factors, such as the deceleration of capital accumulation and usage of capital, inefficiency in the labor market, and sluggish aggregate demand. There is a possibility that these factors have allowed low productivity firms to remain in the market and caused the potential growth rate to decline, maintaining the low interest rate environment. This means that, taking into account the results of the empirical analysis in this paper, it is simplistic to think that the number of low productivity firms will decrease if the Japanese economy is able to move beyond a low interest rate environment. It is also necessary to consider the structural problems described above.²¹

In addition, many studies raise various policy supports (such as grants and subsidies to firms), rather than low interest rates, as a cause of the emergence of and maintaining of financially-supported firms and low productivity firms, as pointed out by Morikawa (2021). As mentioned above, Morikawa (2020) and Hoshi *et al.* (2023) suggest that, in the pandemic period, policy support was extended not only to firms whose performance temporarily worsened but also to firms that performed poorly even before the pandemic, consequently leading to the survival of such firms. Uesugi *et al.* (2022) note that policy support measures have been extended to firms many times since the burst of the bubble economy in the 1990s.²² Taking these studies into account, it is evident that while policy support is a powerful form of support in that it helps maintain employment and sustains businesses, it could also lead to maintaining financially-supported firms and low productivity firms.

Regarding the points raised above, Chart 2 shows that the share of low productivity firms has been more or less flat on average in the past 35 years, although it rose very slightly in the 2010s. This seems to strongly suggest not only that the low interest rate environment has had an impact, but also suggests the existence of other factors on the low productivity firms enabling them to continue on. There are different views on the cause of financially-supported firms, as displayed in Section 2, on previous studies. Hopefully there will be some momentum in both theoretical and empirical research on this topic going forward, particularly in grasping Japan's economic structure and system design appropriately, in addition to financial conditions.

²¹ While issues like low labor mobility and sluggish aggregate demand are not dealt with, if only the interest rates rise and the number of firms exiting the market increases, it is highly likely that unemployment rises and further downward pressure is exerted on the economy.

²² In addition, Atkinson (2019, 2020) notes that the smaller the firm size is the lower the productivity and that in Japan SMEs are treated favorably by government policy. They point out that there is a possibility that there is an incentive for SMEs to maintain their firm size smaller without growing.

5. Conclusion

In this paper, we extract financially-supported firms, defined as firms that survive with support from banks or other entities despite performing poorly and having no prospect of recovery, and analyze their impact on the macroeconomy. In addition, we carry out an empirical analysis to clarify if there is a relationship between a low interest rate environment and such financially-supported firms. The results of the analysis in this paper are summarized as below.

First, in recent years the share of financially-supported firms has been hovering at a low level in Japan. Although their number is limited, given the productivity of financially-supported firms is lower than that of other firms, the fact that they exist automatically puts downward pressure on the aggregate productivity — in other words, the arithmetic average is pushed down. In addition, we find that it cannot be said that the presence of financially-supported firms which have relatively lower productivity exert negative effects on other firms' productivity, i.e., it cannot be said that financially-supported firms distort the aggregate resource allocation, among large firms. That said, while in the 1990s, the number of large financially-supported firms was relatively high, currently there are more financially-supported SMEs; in these cases, we cannot deny the possibility that financially-supported firms are negatively affecting the productivity of other firms.

Second, there seems to be no direct relationship between a low interest rate environment and financially-supported firms. This is consistent with the fact that financially-supported firms did not increase in the low interest rate environment since the 2000s. Amid the continued low interest rate environment, the disposal of nonperforming loans progressed and the strengthening of global financial regulation and the accumulation of capital by financial institutions advanced. Consequently, Japan's financial system became more robust, containing the emergence of financially-supported firms.

Third, the share of financially-supported firms facing significant deterioration in business conditions has been at a low level in recent years, having declined from the mid-1990s through to the mid-2000s. On the other hand, the share of firms with relatively low productivity has been more or less flat. This suggests the possibility that the low interest rate environment has been one attributable factor; in other words, in the current environment, low productivity firms can continue with their businesses, even while their productivity remains at low levels, and without any improvement in their business conditions. The low interest rate environment. On the other hand, there is a possibility that such an environment leads to a decline in incentives for firms to deleverage. In this

situation, we cannot deny that business dynamics, e.g., the entry and exit of firms, do not take place, hindering the dynamics in the overall macroeconomy. Nevertheless, depending on the estimations, considerable latitude should be applied to the quantitative impact of the low interest rate environment on the survival of low productivity firms. Moreover, it is not only the low interest rate environment that is attributable to low productivity firms continuing their business, but also the various support measures provided for the financing of these firms.

Lastly, we reiterate the points noted regarding the empirical analysis in this paper. First, we extracted financially-supported firms according to methods used in several previous studies; however, the empirical analysis is only based on limited data. The results should be taken with some latitude, as the level of the share of financially-supported firms differs depending on the method. Next, we presented the results of empirical analysis on the relationship between the low interest rate environment and financially-supported and low productivity firms. It is necessary to note that those results do not necessarily show a causal relationship. There is also a possibility that the potential growth rate declined in Japan due to macroeconomic factors that affect productivity, such as the deceleration of capital accumulation and usage of capital, resulting in the Japanese economy consequently falling into a low interest rate environment. Meanwhile, many previous studies point out that low productivity firms have survived owing to various policy supports. As there are few cases of empirical analysis in Japan on the low interest rate environment and financiallysupported firms, this paper makes a major contribution. Nonetheless, it is simplistic to think that the number of low productivity firms will decrease if the Japanese economy is able to move out of a low interest rate environment. Taking into account the structural problems surrounding the Japanese economy, it is necessary to discuss issues for sustainable growth and ways to solve them comprehensively. Going forward, future research is required, including into theories that can appropriately explain the economic structure in Japan.

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Large firms				
	Leverage ratio, %	Ratio of cash and deposit, %	ROA, %	ICR
Median				
Fin-supported firms (n= 300)	45.35	8.19	-1.03	-0.88
Other firms $(n=30,206)$	20.74	10.90	2.38	9.65
t-test for differences, including fixed effects for	individual firms, indus	stry and time		
Differences from Other firms	6.05 (1.01) [4.06, 8.04]	0.13 (0.45) [-0.75, 1.01]	-2.68 (0.21) [-3.10, -2.26]	-25.61 (19.48) [-63.79, 12.57]
Median				
Low productivity firms $(n=5,970)$	24.78	11.39	0.41	2.94
Non low productivity firms ($n=24,536$)	19.99	10.71	2.79	11.82
t-test for differences, including fixed effects for	individual firms, indus	stry and time		
Differences from non low productivity firms	2.43	-0.34	-3.37	-36.44
	(0.33)	(0.14)	(0.25)	(7.11)
	[1.79, 3.07]	[-0.61, -0.08]	[-3.87, -2.87]	[-50.38, -22.51]
SMEs				

Table 1: Characteristics of financially-supported firms and low productivity firms

	Leverage ratio, %	Ratio of cash and deposit, %	ROA, %	ICR
Median				
Fin-supported firms (n= 114,180)	98.04	9.36	-7.32	-6.65
Other firms $(n=3,032,535)$	60.70	15.20	1.73	2.43
t-test for differences, including fixed effects for	individual firms, indus	stry and time		
Differences from Other firms	12.55	-1.29	-7.28	-28.77
	(1.41)	(0.20)	(0.86)	(3.52)
	[9.79, 15.31]	[-1.69, -0.89]	[-8.96, -5.59]	[-35.67, -21.87]
Median				
Low productivity firms (n= 575,969)	80.27	10.61	-2.41	0.17
Non low productivity firms (n= 2,570,746)	58.33	15.91	2.03	2.76
t-test for differences, including fixed effects for	individual firms, indus	stry and time		
Differences from non low productivity firms	7.09	-1.13	-8.04	-16.97
	(0.73)	(0.17)	(0.88)	(1.85)
	[5.66, 8.52]	[-1.46, -0.80]	[-9.76, -6.32]	[-20.59, -13.34]

Note: Financially-supported firms (fin-supported firms) are extracted using the method by Yamada *et al.* (2025). The sample period is fiscal 1990-2022 for large firms and fiscal 2005-2022 for SMEs. Figures in parentheses show cluster robust standard errors. Figures in square brackets show 95 percent confidence intervals.

	Yamada <i>et al.</i>	Banerjee and	Albuquerque and
	(2025)	Hofmann (2018)	Iyer (2023)
All samples			
β_1	1.38	1.37	1.18
	(0.36)	(0.30)	(0.24)
	[0.67, 2.09]	[0.78, 1.96]	[0./1, 1.66]
β_2	-0.05	0.01	-0.02
	(0.03)	(0.02)	(0.02)
	[-0.10, 0.00]	[-0.03, 0.05]	[-0.06, 0.03]
Observations	30,506	30,506	30,506
Sub-samples, 1990s			
β_1	0.65	0.69	0.81
	(0.17)	(0.22)	(0.14)
	[0.31, 0.98]	[0.25, 1.12]	[0.54, 1.09]
β_2	0.01	0.02	-0.03
	(0.02)	(0.02)	(0.01)
	[-0.03, 0.05]	[-0.02, 0.06]	[-0.05, -0.00]
Observations	6,855	6,855	6,855
Sub-samples, after 2	000		
β_1	1.74	1.41	1.33
	(0.36)	(0.39)	(0.29)
	[1.03, 2.45]	[0.64, 2.18]	[0.75, 1.91]
β_2	-0.05	0.07	-0.02
	(0.07)	(0.05)	(0.04)
	[-0.18, 0.08]	[-0.02, 0.16]	[-0.10, 0.06]
Observations	23,651	23,651	23,651

Table 2: Estimation for productivity of financially-supported firms, large firms

Note: Figures in parentheses show cluster robust standard errors. Figures in square brackets show 95 percent confidence intervals.

	Yamada <i>et al.</i>	Banerjee and	Albuquerque and
	(2025)	Hofmann (2018)	Iyer (2023)
β_1	0.70	0.91	0.93
	(0.24)	(0.17)	(0.15)
	[0.23, 1.16]	[0.57, 1.25]	[0.65, 1.22]
β_2	-0.05	-0.04	-0.05
	(0.06)	(0.02)	(0.02)
	[-0.16, 0.07]	[-0.07, -0.00]	[-0.10, -0.01]
Observations	3,146,715	3,146,715	3,146,715

Table 3: Estimation for productivity of financially-supported firms, SMEs

Note: Figures in parentheses show cluster robust standard errors. Figures in square brackets show 95 percent confidence intervals.

	Yamada et al.	Banerjee and	Albuquerque and
	(2025)	Hofmann (2018)	Iyer (2023)
All samples			
ϕ	0.35	0.79	0.36
	(0.31)	(0.41)	(0.24)
	[-0.26, 0.96]	[-0.01, 1.59]	[-0.11, 0.83]
γ_{ROA}	-0.21	-0.85	-0.41
TROM	(0.16)	(0.37)	(0.18)
	[-0.53, 0.11]	[-1.57, -0.13]	[-0.76, -0.06]
γ_{low}	0.05	0.10	0.10
1100	(0.04)	(0.05)	(0.04)
	[-0.03, 0.13]	[0.00, 0.20]	[0.01, 0.18]
Vage	0.49	1.57	0.13
Tuge	(0.48)	(0.87)	(0.21)
	[-0.46, 1.43]	[-0.13, 3.27]	[-0.28, 0.55]
γ_{ada}	-0.08	-0.16	-0.44
rgap	(0.12)	(0.20)	(0.20)
	[-0.32, 0.17]	[-0.55, 0.23]	[-0.83, -0.05]
Observations	30 108	30 502	29.600
Observations	50,108	50,502	29,000
Sub-samples, 1990s			
ϕ	0.73	1.26	0.75
	(1.03)	(1.30)	(1.10)
	[-1.29, 2.76]	[-1.29, 3.81]	[-1.40, 2.91]
γ_{ROA}	-0.74	-2.12	-0.85
TROM	(0.96)	(1.57)	(0.87)
	[-2.63, 1.14]	[-5.21, 0.96]	[-2.56, 0.85]
γ_{low}	0.15	0.26	0.21
Tiev	(0.19)	(0.19)	(0.23)
	[-0.23, 0.53]	[-0.12, 0.64]	[-0.24, 0.65]
Vaga	3.15	5.36	-0.21
Tuge	(5.14)	(4.99)	(0.66)
	[-6.92, 13.22]	[-4.42, 15.13]	[-1.50, 1.08]
γ.	-0.43	-0.70	-1.07
Ygdp	(0.65)	(0.84)	(1.32)
	[-1.69, 0.84]	[-2.34, 0.95]	[-3.66, 1.52]
Observations	6 7 2 7	6 855	6 717
Obser vations	0,727	0,055	0,717
Sub-samples, after 200	00	0.04	0.00
ϕ	0.62	0.91	0.39
	(0.97)	(1.33)	(0.38)
	[-1.29, 2.52]	[-1.70, 3.51]	[-0.35, 1.13]
γ_{ROA}	-0.11	-0.52	-0.30
	(0.14)	(0.49)	(0.15)
	[-0.38, 0.16]	[-1.49, 0.44]	[-0.60, 0.00]
Ylev	0.01	0.04	0.07
	(0.02)	(0.05)	(0.03)
	[-0.03, 0.05]	[-0.05, 0.13]	[0.00, 0.13]
Yage	0.15	0.93	0.15
	(0.22)	(1.00)	(0.13)
	[-0.28, 0.58]	[-1.04, 2.90]	[-0.11, 0.41]
γ_{adn}	0.06	0.05	-0.29
' gup	(0.07)	(0.11)	(0.13)
	[-0.09, 0.20]	[-0.17, 0.27]	[-0.54, -0.04]
Observations	21 150	12 201	202
OUSCIVATIONS	21,130	23,304	22,303

Table 4: Relationship between financially-supported firms and interest rate, large firms

	Yamada <i>et al.</i> (2025)	Banerjee and Hofmann (2018)	Albuquerque and Iyer (2023)
ϕ	3.24	5.27	2.55
	(2.22)	(3.55)	(1.12)
	[-1.11, 7.58]	[-1.69, 12.23]	[0.35, 4.75]
YROA	-0.22	-0.59	-0.27
TROM	(0.09)	(0.20)	(0.06)
	[-0.41, -0.04]	[-0.97, -0.20]	[-0.39, -0.15]
YLON	2.03	4.84	3.38
	(0.85)	(1.58)	(0.81)
	[0.37, 3.68]	[1.74, 7.93]	[1.79, 4.98]
Yaae	2.13	5.53	0.54
	(0.91)	(1.85)	(0.21)
	[0.35, 3.91]	[1.91, 9.15]	[0.12, 0.95]
Yadp	0.16	0.38	-0.15
0 ° F	(0.18)	(0.36)	(0.10)
	[-0.20, 0.52]	[-0.32, 1.08]	[-0.34, 0.05]
Observations	3,146,715	3,146,715	3,146,715

Table 5: Relationship between financially-supported firms and interest rate, SMEs

	Firms remaining a	t low productivity
	for 3 years	for 5 years
All samples		
ϕ	-0.95	-0.57
	(0.40)	(0.27)
	[-1.72, -0.17]	[-1.11, -0.04]
γ_{ROA}	-2.35	-1.27
	(0.56)	(0.36)
	[-3.45, -1.25]	[-1.98, -0.56]
Ylev	0.06	0.05
	(0.03)	(0.03)
	[-0.00, 0.12]	[-0.00, 0.10]
Yage	-7.68	-5.65
	(1.14)	(0.93)
	[-9.91, -5.45]	[-7.46, -3.83]
γ_{gdp}	0.86	0.50
- •	(0.44)	(0.26)
	[-0.01, 1.73]	[-0.01, 1.01]
Observations	30,502	30,502
0.1 1 1000		
Sub-samples, 1990s	0.14	0.12
ϕ	-0.14	-0.12
	(0.38)	(0.24)
	[-0.88, 0.60]	[-0.58, 0.55]
γ_{ROA}	-2.97	-1.69
	(1.09)	(0.70)
	[-5.12, -0.83]	[-3.06, -0.33]
Ylev	0.06	0.05
	(0.07)	(0.06)
	[-0.07, 0.20]	[-0.06, 0.16]
Yage	-9.40	-7.11
	(2.32)	(1.93)
	[-14.54, -4.40]	[-10.93, -3.28]
γ_{gdp}	0.81	(0.28)
	(0.47)	(0.28)
	[-0.11, 1./3]	[-0.08, 1.01]
Observations	6,838	6,838
Sub-samples. after 200)0	
	-6.36	-3.80
ψ	(1.79)	(1.18)
	[-9.88, -2.84]	[-6.10, -1.49]
1/	-2.28	-1.21
<i>KROA</i>	(0.97)	(0.61)
	[-4.18, -0.38]	[-2.40, -0.02]
1 /1	0.07	0.06
rlev	(0.05)	(0.04)
	[-0.02, 0.15]	[-0.03, 0.14]
Vaca	-7.71	-5.55
rage	(2.89)	(2.39)
	[-13.37, -2.04]	[-10.24, -0.86]
γ_{adm}	0.63	0.37
ryap	(0.48)	(0.28)
	[-0.31, 1.56]	[-0.17, 0.91]
Observations		73 617
Observations	23,047	23,047

Table 6: Relationship between low productivity firms and interest rate, large firms

	Firms remaining at low productivity		
	for 3 years	for 5 years	
ϕ	-2.57	-1.46	
	(0.40)	(0.29)	
	[-3.37, -1.78]	[-2.03, -0.90]	
γ_{ROA}	-0.27	-0.15	
	(0.09)	(0.06)	
	[-0.44, -0.10]	[-0.26, -0.03]	
γ_{len}	5.91	3.79	
	(1.35)	(1.11)	
	[3.26, 8.57]	[1.62, 5.96]	
Yaae	0.03	0.29	
	(0.34)	(0.33)	
	[-0.63, 0.69]	[-0.36, 0.94]	
γ_{adp}	0.06	0.01	
3	(0.08)	(0.07)	
	[-0.10, 0.22]	[-0.12, 0.14]	
Observations	3,146,715	3,146,715	

Table 7: Relationship between low productivity firms and interest rate, SMEs



Figure 1: Share of financially-supported firms

Figure 2: Share of firms remaining at low productivity (a) Large firms (b) SMEs





Figure 3: Distribution of individual firms' productivity (a) Large firms (b) SMEs



Figure 4: Distribution of individual firms' productivity, financially-supported firms among large firms

Note: Financially-supported firms (fin-supported firms) are extracted using the method by Yamada *et al.* (2025). The same method is used for figures below.

Figure 5: Distribution of individual firms' productivity, financially-supported firms among SMEs

(a) 2000s

(b) 2010s





Figure 6: Share of financially-supported firms by size, large firms (a) By asset (b) By Sales

Figure 7: Persistency of financially-supported firms (a) Large firms (b) SMEs



Figure 8: Relationship between interest rate payment and financially-supported firms



Figure 9: Relationship between interest rate payment and low productivity firms



share of firms remaining with low productivity for 5 years, % $\frac{25}{1}$