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Firm Heterogeneity and the Dynamics of Credit Rationing in Japan[*]

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Abstract

The role of firms' financial heterogeneity in determining the credit channel of monetary policy attracted more attention recently. We investigate the degree of financial constraints among listed Japanese firms from 1994 to 2014. Based on an estimated financial constraints index, we analyze the distribution of this value and investigate its time-series changes. First, the distribution of financial constraints is approximately a gamma distribution with a long right tail, meaning that many firms have weak credit constraints and a small number of firms have severe credit constraints. Second, the spread between the 75th and the 25th percentiles of the financial constraints index increased, especially after 2000, which implies that financial inequality increased recently. Third, this increased inequality may be due to the growing inequality between firms within the same industry. We conduct a simple regression of the financial constraints index on productivity and find that the increased financial heterogeneity appears to be linked to the increase in productivity dispersion.

1 Introduction

The Japanese Financial Service Agency (JFSA) reports that there seems to be a perceptional gap between financial institutions and their customers (see Strategic Directions and Priorities, 2016-2017). Banks believe that bankable customers are scarce, and thus competition among banks is very severe. Firms with low creditworthiness, on the other hand, believe that banks will not issue loans without collateral or guarantees. The JFSA calls this phenomenon "financial exclusion in Japan." Despite awareness of the problem, as far as we know, the literature contains no quantitative analyses of this problem.

This study investigates this phenomenon using various statistical approaches. We consider the firm's investment model, in which firms face financial constraints due to asymmetric information between lenders and borrowers, and we measure the extent to which each firm suffers from these financial constraints. Based on the estimated financial constraints index, we analyze the distribution of this value and investigate its time-series changes. We call the dispersion of the financial constraints index among firms "financial heterogeneity." We further analyze this financial heterogeneity by decomposing it into within- and between-industry effects and connecting it to the firm's productivity index.

From these analyses, we find that the distribution of the financial constraints index has a gamma distribution with a long right tail, and that this skewness became large, especially after 2000. This finding indicates a high number of firms under weak credit constraints and a small number of firms under severe credit constraints, a trend that became more remarkable since 2000. The additional analyses also show that the financial heterogeneity we observe is due mainly to the dispersion between firms within the same industry and that the firm's productivity, such as total factor productivity (TFP), possibly increases this financial heterogeneity.

Our paper contributes to four key strands of the literature. The first strand discusses measurements of financial constraints at the individual firm level. Prior studies propose and test various criteria based on firm characteristics (see, e.g., Lamont et al., 2001; Whited and Wu, 2006; Hadlock and Pierce, 2010) using various financial variables to capture the degree of financial constraints. However, existing studies rarely incorporate collateral, which serves as a buffer to the firm's default risk. As Ogawa et al. (1996) and Ogawa and Suzuki (1998) show, in Japanese corporate finance, land assets play a very important role as collateral for borrowing. Further, the JFSA questionnaire survey also indicates that banks require that firms have sufficient collateral to receive a loan. We account for this background and measure the degree of financial constraints using a firm's land assets.[1]

Second, this paper also contributes to the empirical literature on the link between productivity and financial constraints. Ferrando and Ruggieri (2018) recently

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[1]In addition to these factors, Kiyotaki and Moore (1997) consider that a firm's credit constraints depends on its collateral. This is a common setting in the recent macroeconomic literature.

investigate the relationship between firms' financial structures and TFP in several Euro area countries from 1995 to 2011, and find that a 1% fall in the degree of financial constraints predicts a 0.185% increase in productivity. In contrast with this study, we focus on the elasticity of financial constraints with firm's productivity. Specifically, our empirical hypothesis is that firms with lower productivity will obtain lower profits, which will tighten its future financial constraints. Through several regressions, we find that a 1% fall in TFP leads to an increase of 0.61% in financial constraints index.

Third, our paper contributes to the literature on inequality among firms, which focuses mainly on wage or productivity dispersion among them. For example, on wage dispersion, Dunne et al. (2004) and Faggio et al. (2010) use plant- or firm-level data to analyze changes in the distribution of wages. On productivity dispersion, Bartelsman and Doms (2000) and Syverson (2011) provide literature surveys. The stylized facts from these studies indicate a large dispersion of productivity across establishments or firms in the same industry and that this dispersion has been increasing in recent years. In contrast with these prior works, we focus on the dispersion of financial constraints among firms. We apply the same statistical approach from productivity analysis to analyze our theme.

Finally, we contribute to the literature on the role of heterogeneity among firms in determining the business cycle dynamics of aggregate investment. Ottonello and Winberry (2018) develop a heterogeneous firm New Keynesian model with default risk and find that firms with low leverage are the most responsive to monetary policy and conduct almost all aggregate investments. Amiti and Weinstein (2018) use matched bank-firm lending data in Japan and show that idiosyncratic bank loan supply shocks explain 30-40% of aggregate loan and investment fluctuations. Our study introduces the distribution of financial heterogeneity and we find an increasing dispersion in financial constraints. This finding can become the basis for recent studies that focus on firm heterogeneity.[2]

Our paper proceeds as follows. Section 2 explains our statistical method to measure the degree of financial constraints. Section 3 describes our data and its characteristics. Section 4 investigates the distribution of our financial constraints index and its time-series changes following the method used in productivity analysis. Section 5 describes the empirical strategy to estimate the effect of productivity on financial constraints and reports the results. Section 6 concludes.

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[2]Our study may also relate to that by Gabaix (2011), who proposes that idiosyncratic firm-level shocks can explain an important part of aggregate movements. To study this connection rigorously, we must check whether the distribution of our financial constraints index is fat-tailed, and if so, whether this granular effect can lead to the dysfunction in Japanese monetary policy.

2 Measuring financial constraints

To evaluate the financial heterogeneity among firms, we first prepare a financial constraints index at the individual firm level. Prior studies prepare these using firms' balance sheets and profit and loss accounts. The Kaplan and Zingales (Lamont et al., 2001), Whited and Wu (2006), and Hadlock and Pierce (2010) indices are the most popular measures of financial constraints. Many users of these indices use existing coefficient estimates to create an index of financial constraints for their own samples, with the assumption that the coefficients are stable across samples and over time.

We do not adopt this approach for two reasons. First, as Farre-Mensa and Ljungqvist (2016) state, constructing an index of financial constraints by extrapolating out of sample creates measures that do not capture the real financial constraints. That is, firms classified as "constrained" have no trouble raising debt. Second, the problem of out-of-sample extrapolation becomes more serious if we apply this method to a sample of countries besides the US. This is because each country has different employment and product market legislation and different political and financial institutions, which create differences in the mechanisms of financial constraints. To overcome these limitations, we re-estimate the structural model with our own sample and focus on the specific features of Japanese corporate finance.

We base our benchmark model on Whited (1992) and Whited and Wu (2006). The model is a partial equilibrium model in the sense that the firm takes factor prices and the behavior of financial sectors as given. We summarize financial constraints in this model in two constraints: a limit on the amount of debt issues and a limit on the amount of outside equity financing. The investment Euler equation from this model indicates the extent to which firms suffer from financial constraints. By denoting investment by I, stock of capital by K, the stochastic discount factor by β, the shadow value of external finance by Θ, and the depreciation rate of capital by δ, we obtain the following investment Euler equation:

$$\psi_I + 1 = E_t \left[\beta_{t,t+1}(1 - \Theta_t)\Big(\Pi_K - \psi_K + (1 - \delta)(\psi_I + 1)\Big) \right], \qquad (1)$$

where ψ_I and ψ_K are the marginal adjustment costs associated with capital, and Π_K is the marginal profit of capital.[3] For more information, see Appendix A.

Equation (1) follows the Euler equation in Whited (1992), Love (2003), and Whited and Wu (2006). The left hand side of equation refers to the marginal cost of investing today, while the right hand side refers to the discounted marginal cost of postponing investment until tomorrow, which is the sum of the foregone marginal benefit of capital plus the marginal adjustment costs and purchasing costs from the

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[3]We normalize the relative price of capital goods to unity. For clarity of exposition, we omit any taxes and tax deductions. In the estimation, the firm's discount rate, the price of capital goods, and profits are all appropriately tax-adjusted. For more detail, see Appendix A.

investment tomorrow. We discount the marginal cost of postponing investment by $1 - \Theta$, which is the discount factor associated with the external finance premium. If firms face financial constraints, which in the model is equivalent to the inability to issue new debt or new equity, this value decreases, triggering firms to postpone investment. We identify variable Θ by using the information on the wedge between the marginal cost of investing today and the marginal cost of postponing investment until tomorrow.

In the model, the variable Θ does not have an analytical solution. Thus, we must parameterize Θ as a function of observable firm characteristics. For example, Whited (1992) formulates this variable using the firm's debt ratio and interest coverage ratio. Whited and Wu (2006) specify this variable using the cash flow to asset ratio, positive dividend dummy, long-term debt to total assets, size, sales growth, and industry sales growth.[4] We parameterize Θ as a quadratic function of the following variables:

$$\Theta_t = c_1(LOAN_{t-1}/LAND_{t-1}) + c_2(LOAN_{t-1}/LAND_{t-1})^2, \qquad (2)$$

where $LOAN$ are loans outstanding, which consist of short- and long-term debt outstanding, and $LAND$ is the market value of the firm's land assets.

Our formulation is important in the context of the Japanese corporate finance. Historically, land assets played an important role as collateral for borrowing during the mid-1980s and early 1990s (see Ogawa et al., 1996; Ogawa and Suzuki, 1998). Kiyotaki and Moore (1997) provide a theoretical analysis of the channel through which land prices are transmitted to the real economy. Few studies analyze the role of land assets in Japan's two lost decades, though Mizobata (2014) points out that the decrease in land prices in this period restricted firms' investment rates at the replacement level. Thus, we use the ratio of loans outstanding to land assets to represent the firm's collateralizable net worth in Equation (2).

Using macro data, we confirm the role of land assets in Japan's *post-bubble* economy. The Bank of Japan database reports the amount of loans by type of collateral. During this period, about 40% of total loans are secured by any form of physical asset. Examining the breakdown of collateral reveals that around 70% to 80% of the collateral consists of real estate, and this proportion has been increasing since 2000. In addition, the survey by Teikoku Databank, which investigates 220,000 companies in Japan, shows that as of 2016, about two thirds of these companies borrow money from banks by offering securities. Hence, we can consider that land assets still have an important role as collateral in Japan.

Finally, we introduce the procedure to construct the financial constraints index for individual firms. We estimate the investment Euler equation in Equation (1) by substituting Equation (2) into the variable Θ. Assuming rational expectations, the

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[4]Whited and Wu (2006) apply this rich setting to quarterly firm-level data, and argue that such an approach is necessary due to their goal of constructing a financial constraints index that can explain asset returns, which fluctuate intensely over time.

Cobb-Douglas production function, and the quadratic adjustment cost function, we estimate the Euler equation in the first difference to eliminate possible individual firm effects. We use the generalized methods of moments (GMM) along with time dummies. Our instruments include all of the Euler equation variables dated at $t-2$ and $t-3$. We also include three additional financial variables as instruments: cash flows, cash holdings, and tax payments, all of which we normalize by capital stock.[5] Through these procedures, we can identify the necessary structural parameters to recover the variable Θ. We use these recovered estimates of Θ as the financial constraints index at the individual firm level.

3   Data

We collected our firm-level data from the Development Bank of Japan database of unconsolidated accounts, which reports detailed information on a wide range of firm characteristics at an annual frequency. The database covers all firms listed in the Tokyo, Osaka, Nagoya, and other regional stock exchanges in Japan from 1960 to present. Since the data contains the information on entry and exits, our panel is unbalanced and has no survival bias.

We select the sample as follows. First, we focus on the sample period running from 1994 to 2014 to avoid the effects of the earlier economic bubble in Japan. Since the estimated equation contains the lead variable, the sample period we actually use in estimation runs from 1994 to 2013. Second, we exclude firms from primary, regulated, and financial industries, including agriculture, forestry, and fisheries; mining; electric, gas, water services; transport and postal activities; and financial services. Third, we drop any firm-year observations with negative total assets, a debt ratio is greater than one, or sales growth greater than 100%. We include a firm if it has at least five consecutive years of complete data, which we require to estimate the Euler equation, and if it never has more than two consecutive years of negative operating profits.[6] Finally, we trim outliers in all key variables at the top and bottom 1% level.

Table 1 summarizes the distribution of firms across industries for the sample of 2,303 firms according to the standard industrial classification in Japan. The table indicates that the sample contains 1,388 firms in the manufacturing sector and 915 firms in the non-manufacturing sector for the sample period. The chemicals, machinery, electrical machinery, wholesale trade, and retail trade industries have relatively large samples, with 201, 241, 204, 215, and 192, firms each, respectively.

Table 2 reports the summary statistics of the key variables. Column 1 shows the result for the full sample, while columns 2 to 7 report the statistics for the

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[5]Brown et al. (2012) show that firms use cash reserves as a buffer of liquidity to maintain a smooth investment path. If we ignore this endogenous liquidity management, we will very likely have biased estimates. We therefore use cash holdings as an instrument.

[6]This criterion is important because we are interested in firms that face external finance constraints rather than firms that are in financial distress (see Whited and Wu, 2006).

Table 1: Number of firms by industry

Industry	Firm count	Share of sample (%)
Food	136	5.9
Textiles	66	2.9
Wood and furniture	18	0.8
Pulp and paper	34	1.5
Printing and publishing	16	0.7
Chemicals	201	8.7
Petroleum	11	0.5
Ceramics	65	2.8
Steel	54	2.3
Non-ferrous metals	44	1.9
Fabricated metals	79	3.4
Machinery	241	10.5
Electrical machinery	204	8.9
Transportation equipment	121	5.3
Miscellaneous manufacturing	98	4.3
Construction	180	7.8
Information and communications	102	4.4
Wholesale trade	215	9.3
Retail trade	192	8.3
Real estate	64	2.8
Goods rental and leasing	11	0.5
Scientific research, professional and technical services	22	1.0
Accommodation	5	0.2
Eating and drinking services	44	1.9
Living-related and personal services and amusement	36	1.6
Education, learning support	11	0.5
Medical, health care, and welfare	5	0.2
Services	28	1.2
All	2,303	100.0

Source: Development Bank of Japan database

Notes: We classify industries following the Japanese Industrial Classification. We calculate firm counts for the sample periods (1994-2014). The "Share of sample" column is the fraction of firms in each industry (unit is percent).

sub-samples. We separate the full sample of 2,303 firms into groups that are more or less likely to face financial constraints according to industry, the payout ratio, and the leverage ratio. In the latter two cases, we first calculate the payout ratio or debt ratio for each firm, and then consider firms with high dividends or high debt if their average value is in the top 50th percentile of the sample. Such group becomes useful later because it suggests whether or not our financial constraints index is appropriate.

The summary statistics show several findings. First, comparing the manufacturing and non-manufacturing firms, we find that the latter tend to do more investments, earn less profits, have more internal funds, and have less debt to land assets.[7] Second, from the classification of financial variables, we find that firms paying high dividends or having less leverage are more likely to invest more, earn more profits, and have more internal funds. More interestingly, there is a tendency that firms that pay high dividends have less debt to land assets, while firms with less leverage pay more dividends to shareholders. This tendency is in line with the hypothesis of our theoretical model; that is, if firms are under financial constraints, which limit firms' ability to issue new debt, then firms decrease their dividends to shareholders to use these money for investments.

4   The firm-level financial constraints index

In this section, we first introduce the estimation result of the investment Euler equation we defined in Section 2. In addition to constructing the financial constraints index at the individual firm level, we report the distribution of the financial constraints index and verify the time-series changes of this distribution. We confirm whether firms show financial heterogeneity, and if so, whether this financial inequality increased in Japan's post-bubble economy. Finally, we decompose the dispersion of financial heterogeneity into within-industry and between-industry effects and confirm which factor has the most effect on this financial inequality in Japan. This analysis is useful because these two effects suggest different economic policies.

4.1   Estimation results

Table 3 shows the estimation result of the investment Euler equation. Our estimated structural parameters are the quadratic adjustment cost parameter (a); firms' mark-up (μ); and the parameters (c_1, c_2), which characterize the firm's financial constraints. We report the estimated values of these parameters for the full sample and the sub-samples. Since the test of over-identifying restrictions cannot reject the null hypothesis that the lagged variables we use as instruments are not

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[7]We can easily obtain operating profits by calculating the difference between operating revenues and operating costs.

Table 2: Summary statistics for the full sample and sub-samples

	Baseline	Manu-facturing	Non-manu-facturing	High divi-dend	Low divi-dend	High debt	Low debt
Number of firms	2,303	1,388	915	1,163	1,140	1,116	1,187
Observations	25,273	16,335	8,938	13,277	11,996	11,676	13,597
Firm/observation	10.97	11.77	9.77	11.42	10.52	10.46	11.45
Investments							
Mean	0.090	0.088	0.095	0.099	0.082	0.087	0.093
Median	0.068	0.069	0.064	0.075	0.061	0.065	0.070
Operating revenues							
Mean	5.938	3.133	11.06	4.594	7.425	5.158	6.607
Median	3.071	2.493	5.874	2.863	3.423	2.886	3.261
Operating costs							
Mean	5.633	2.884	10.66	4.228	7.189	4.932	6.236
Median	2.827	2.275	5.598	2.581	3.247	2.687	2.968
Cash flows							
Mean	0.185	0.162	0.226	0.229	0.136	0.129	0.233
Median	0.135	0.130	0.152	0.165	0.111	0.109	0.168
Cash holdings							
Mean	0.618	0.418	0.984	0.664	0.567	0.408	0.799
Median	0.292	0.227	0.485	0.318	0.264	0.203	0.409
Tax payments							
Mean	0.092	0.063	0.144	0.115	0.065	0.050	0.127
Median	0.048	0.037	0.081	0.065	0.032	0.027	0.075
Debt to land ratio							
Mean	1.237	1.261	1.193	0.988	1.513	1.930	0.642
Median	0.663	0.714	0.565	0.419	0.912	1.209	0.252
Payout to asset ratio							
Mean	0.011	0.011	0.012	0.017	0.005	0.008	0.014
Median	0.008	0.009	0.007	0.011	0.005	0.006	0.010

Source: Development Bank of Japan database

Notes. "Investments" are the sum of each firm's annual change in tangible fixed assets plus depreciation. "Operating revenues" include operating sales plus the change in finished goods inventories. "Operating costs" are the cost of sales plus selling, general, and administrative expenses minus depreciation. "Cash flows" are each firm's current net income plus depreciation. "Cash holdings" are cash and deposits with banks. "Tax payments" are income taxes-current minus income taxes-correction or deduction. All variables are divided by the market value of capital stock at the beginning of the period. Finally, we define the "Debt to land ratio" as the sum of short-term loans, long-term loans, and bond issued divided by the market value of land assets.

Table 3: GMM estimates of the investment Euler equation

	Baseline	Manu-facturing	Non-manu-facturing	High divi-dend	Low divi-dend	High debt	Low debt
a (Adjustment cost)	0.873	0.141	1.190	0.334	2.678	0.424	0.232
	(0.487)	(0.313)	(0.798)	(0.244)	(1.490)	(0.556)	(0.380)
μ (Mark-up)	1.055	1.045	1.037	1.116	1.004	1.150	1.071
	(0.029)	(0.025)	(0.027)	(0.023)	(0.032)	(0.028)	(0.018)
c_1 (D/L)	0.198	0.135	0.224	0.291	0.231	0.208	0.204
	(0.095)	(0.125)	(0.092)	(0.076)	(0.076)	(0.046)	(0.082)
c_2 (Square of D/L)	-0.012	-0.011	-0.012	-0.017	-0.013	-0.012	-0.013
	(0.006)	(0.008)	(0.006)	(0.005)	(0.005)	(0.003)	(0.006)
J-statistics	10.29	18.92	7.584	6.087	2.517	6.547	12.92
P-value [DF=12]	0.591	0.091	0.817	0.912	0.998	0.886	0.375
Θ (Credit rationing)							
Mean	0.182	0.116	0.198	0.210	0.264	0.298	0.102
Median	0.125	0.089	0.121	0.118	0.199	0.233	0.050
Firms	25,273	16,335	8,938	13,277	11,996	11,676	13,597
Obs	2,303	1,388	915	1,163	1,140	1,116	1,187

Source: Development Bank of Japan database and author's estimation

Notes. The sample period is from 1994 to 2014. The model is given by Equations (1) and (2). We run the nonlinear GMM estimation for the model in the first difference with twice and thrice lagged instruments along with time dummies. The GMM instruments are all of the Euler equation variables with the cash flows, cash holdings, and tax payments, all of which we divide by capital stock. a is a quadratic adjustment cost parameter, μ is a mark-up, and c_1 and c_2 are the parameters that characterize the severity of a firm's financial constraints. Standard errors are reported in parentheses and corrected for the moving average errors induced by differencing using the Newey and West (1987) procedure. The J-statistics and p-values of the model specification are reported in the middle of the table. DF refers to the degree of freedom of the J-statistics.

correlated with the expectation errors at the 5% significance level, we can conclude that our model assumptions are not mis-specified.

First, we look at the parameter a for the adjustment cost function. In our estimation, we assume that the adjustment cost function has the basic quadratic form in investments. Theoretically, this parameter has a positive sign. We can find that this theoretical requirement is satisfied for all groups in the table, though not so significant. The estimated values range from 0.141 to 2.678, which suggests only a mild economic importance of this parameter. This is because if a firm has a capital stock of 1 billion yen and invests 100 million yen, our estimate of the adjustment cost parameter implies that the adjustment costs are 13 million yen at most.[8]

Next, we investigate the parameter μ, which represents the firm's mark-up. Theoretically, if firms operate in a perfectly competitive market, this value is one. On

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[8]This scale is very similar to Whited's (1992) result; see page 1447.

the other hand, if firms have market power in their business, this value becomes larger than one. We can check these two hypotheses by testing whether the value of μ is different from one. By inference, we can find that except for three regressions (columns 2, 3, and 5), this parameter is different from one at the 5% significance level. Hence, there seems to be a non-negligible market power among Japanese non-financial corporations.[9]

Finally, we look at the most important parameter to construct our own financial constraints index. Table 3 shows that the parameters c_1 and c_2 are significant at the 5% level, except for manufacturing sector. To observe the economic importance of this parameter, we calculate the value of Θ based on Equation (2). We report the mean and the median value of Θ for each category in the lower part of the table. In the full sample, we find an average estimate for Θ of 0.182, indicating that *on average*, the firms discount their future profits at this rate as the external financing premium. Notably, we find a larger estimate for this premium in several sub-samples, such as the low-dividend or high-debt firms. This finding is consistent with the literature and with the summary statistics reported in Section 3. The table also shows that the mean Θ is larger than the median value of Θ in each category. We find this result because Θ has a left-skewed distribution. In the next section, we discuss this result in detail.

## 4.2   Financial heterogeneity among firms

Based on the estimate of Θ in subsection 4.1, we depict the distribution of Θ among firms using the result of the baseline estimation in Table 3. We can also use the result of the estimates for the sub-samples, however, doing so does not change our main results. We omit these results for conciseness. Figure 1 expresses the distribution of Θ in our four categories: the entire period, 1994, 2004, and 2013, respectively.

All figures show that the distribution of the financial constraints index across firms has a left-skewed distribution. This finding indicates that many firms have weak credit constraints and a small number of firms have severe credit constraints. Using the Cox and Jenkins (2003) technique, we search a two-parameter gamma distribution that approximates our distribution of financial constraints. The two parameters are the shape and scale parameter. By maximum likelihood estimation, we can obtain the two parameters that best fit our distribution. For example, we find that a gamma distribution with a shape parameter of 1.104 and a scale parameter of 0.195 best fits our distribution of Θ over the whole period. These values are 1.176 and 0.167 for 1994, 1.106 and 0.184 for 2004, and 1.094 and 0.235 for 2013.

Figure 1 also indicates how the distribution of Θ changed every ten years. For example, comparing the distribution of Θ in 1994 with that in 2004 shows that the fraction of firms under very weak financial constraints increased over those ten

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[9]Gutiérrez and Philippon (2017) show that investment weakened relative to measures of profitability in the US since 2000 and that this weakness is partially due to the concentration of firms.
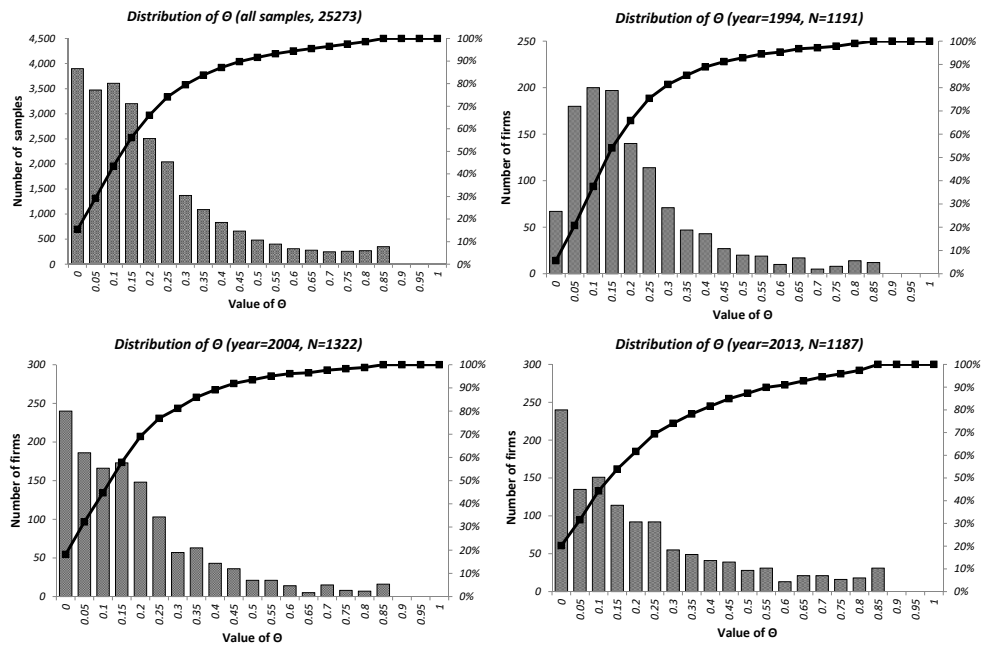
Figure 1: Financial constraints index across firms

Notes. The left-upper panel shows the distribution of Θ among all 2,303 firms throughout the whole period, while the other panels show the distribution of Θ among firms in 1994, 2004, and 2013. The line graph of square markers represents the cumulative distribution of firms in each year.
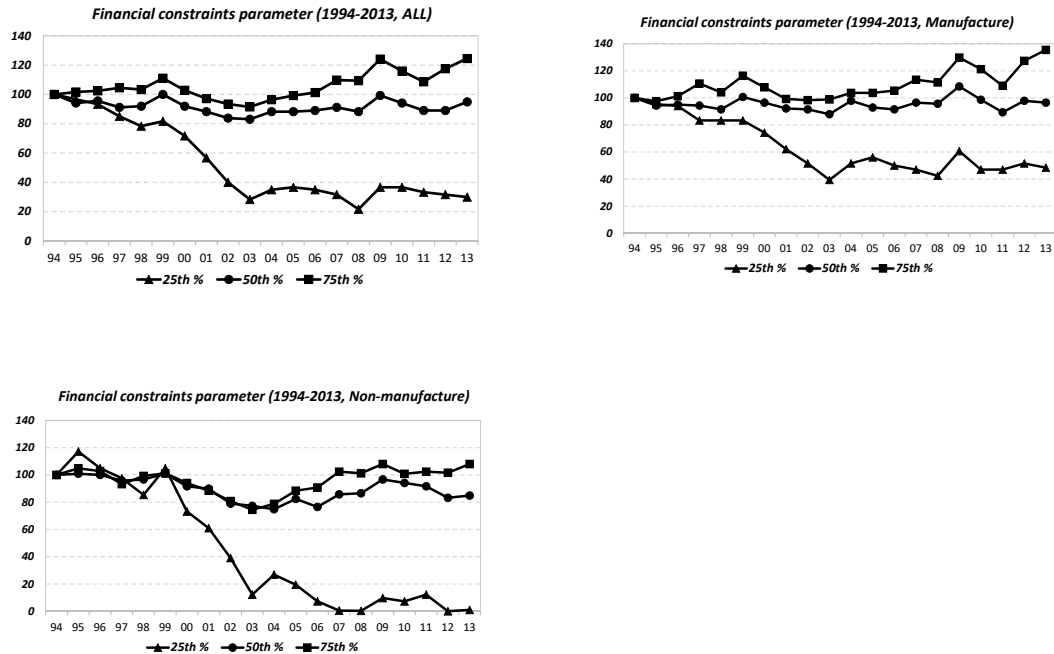
Figure 2: Evolution of financial heterogeneity

Notes. We depict the values of Θ at the 75th, 50th, and 25th percentiles by normalizing the initial values as unity (Index = 100 in 1994). The lines with square, circular, and triangular markers represent the cumulative change of Θ for the 75th, 50th, and 25th percentiles, respectively.

years. We can confirm this by looking at the distribution, which moved to the left. The difference between 2004 and 2013 is not as apparent, but we can find that in 2013, the number of firms with a Θ below 0.05 is as large as in 2004. We analyze these dynamics of credit rationing in Japan in more detail in the next section.

4.3   Evolution of financial heterogeneity

Following to Faggio et al. (2010), we compute the value of Θ at the 75th, 50th, and 25th percentiles and represent the cumulative changes relative to the initial year, 1994, by normalizing the initial value of these percentiles as unity. We depict these results in Figure 2. First, looking at the left-upper panel, the spread between the 75th and the 25th percentiles of the financial constraint index increased, especially after 2000. More specifically, the value of the 75th percentile increased by 20%, while the value of the 25th percentile decreased by 70%. Hence, we find that this financial inequality among Japanese firms is mainly due to the increase in the number of firms under weak financial constraints.

Next, we look at the remaining two panels, which depict the evolution of financial heterogeneity in each industry by dividing the full sample into manufacturing and non-manufacturing sectors. These panels show that the dynamics of the financial

constraints index in the non-manufacturing sector is the main driver of our finding above.[10] In the non-manufacturing sector, the value of the 75th and 50th percentile remain mostly the same, while the value of 25th percentile decreased considerably since 2000. Looking at this value after 2000, we find that about 25% firms are not financially constrained at all because firms have no bank borrowing. This is especially true in the information and communications, wholesale trade, and retail trade industries, which have relatively large samples of such firms.[11]

4.4 Decomposition of financial inequality

In this section, we further analyze the content of financial heterogeneity in Japan. We decompose the overall inequality in the financial constraints index into within-industry and between-industry components. Our decomposition method follows Ohtake and Saito (1998) and Dunne et al. (2004). Faggio et al. (2007, Appendix A) provide a detailed description of the decomposition.

Using this method, we can decompose the dispersion of financial constraints index into two components as follows:

$$
V(\Theta_{it}) = \sum_{ind=1}^{28} s_{ind,t}\sigma_{ind,t}^2 + \left\{ \sum_{ind=1}^{28} s_{ind,t}\overline{\Theta_{ind,t}}^2 - \left(\sum_{ind=1}^{28} s_{ind,t}\overline{\Theta_{ind,t}} \right)^2 \right\}, \quad (3)
$$

where $V(\Theta)$ denotes the variance of Θ, $s_{ind,t}$ denotes the share of each industry in year t, $\sigma_{ind,t}^2$ denotes the variance of Θ for each industry in year t, and $\overline{\Theta_{ind,t}}$ denotes the average value of Θ for each industry in year t. From Table 1, we analyze 28 industries.

Based on the equation above, we decompose the variance of Θ into within-industry and between-industry components, which has important implications for economic policy. If the within-industry effect is important, then the government will have to tackle the problem of financial support for individual firms with severe financial constraints. Conversely, if between-industry effect is important, then the government should address industry structural policy such as the transfer of funds among industries.

Figure 3 depicts the result. The solid line shows the variance of Θ among firms between 1994 and 2013. The long dashed line shows the within-industry component and the chain line shows the between-industry component. Looking first at inequality overall, we see that almost all of the variance of Θ is attributable to the variation within the same industry; that is, the within-industry effect. The fraction of within-industry effect is more than 90%. We can also find that the trend increases in the

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[10]Interestingly, Oulton (1998) and Faggio et al. (2010) show that the increase in the firm-level productivity dispersion occurs mainly in the service industries.

[11]Zero leverage firms are not a specific phenomenon in Japan. For example, Strebulaev and Yang (2013) show that from 1962 to 2009, an average 10.2% of large public non-financial US firms have zero debt and almost 22% have a less than 5% book leverage ratio.
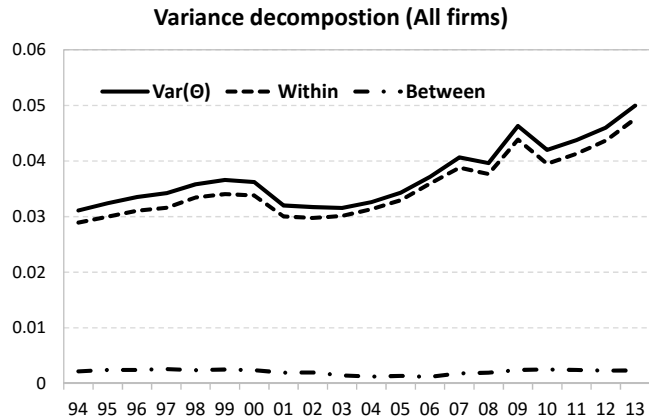
Figure 3: Decomposition of financial inequality

Notes. The solid line shows the variance of Θ among firms between 1994 and 2013. The long dashed line shows the within-industry component and the chained line shows the between-industry component over the same period.

within-industry effect are very similar to the trend increase in the overall variation of Θ. Specifically, the variance of Θ for both series increased after 2001, reached a peak in 2009, and is still increasing after 2010. In short, the dominant reason for the increase in financial inequality seems to be the growth of inequality between firms within the same industry.

Our findings have much in common with the literature on productivity analysis. For example, Oulton (1998) uses a sample of 140,000 UK companies for 1989 to 1993 and finds that even at the 4-digit industry level, industry structure can account for only about 13% of the productivity variance among independent firms. Similarly, Dunne et al. (2004) show that wage and productivity dispersion across US manufacturing plants mainly arises from the difference between plants within the same industry. For 1992, the percentage of the within-industry effect is about 75%. Faggio et al. (2010) reinforce Dunne et al.'s (2004) result using data on non-manufacturing firms and conclude that the dominant reason for the increase in productivity inequality appears to be the growth of inequality between firms within the same industry. The similarities between our results and those from productivity analysis suggest that the severity of financing constraints for firms is related to the firms' productivity.

5 Financial constraints and productivity

In this section, we examine our results further by exploring the effect of a firm's productivity on its financial constraints. Ottonello and Winberry (2018) explain

the mechanism of how a firm's productivity affects its financing constraints from a theoretical perspective. Consider a firm with a low level of productivity. In this case, operating profit from its production process also becomes small, decreasing the amount of cash on hand. This type of firm must issue new debt with the burden of interest payments and pay zero dividends to shareholders. Otherwise, the firm will reduce efficient investments or at worst go into default.

This case is the reverse of that in Ferrando and Ruggieri (2018), who test whether constraints in accessing external finance translate into lower firm productivity. Theoretically, they consider that financial frictions hamper a firm's productivity by restraining investment in higher quality projects, intangible assets, research and development, or the newest technology. Our theme has much in common with theirs, and in practice, it seems that both routes apply. However, we focus here on how a firm's productivity affects its financial constraints.

To test our hypothesis, we use our own financial constraints index as well as labor productivity and TFP, which are common productivity indices in the literature. We use the logarithm of value-added per worker as labor productivity by defining value-added as operating profits plus labor costs plus depreciation.[12] For TFP, we use the basic method and calculate the difference between weighted inputs and outputs. We first compute the ratio of total wages over value added, and then calculate the average for each firm over its sample period. Using this firm-specific weight, we measure TFP as

$$TFP_{it} = \ln Y_{it} - \alpha_i \ln L_{it} - (1 - \alpha_i) \ln K_{it}, \qquad (4)$$

where Y_{it} denotes value added, α_i denotes the share of labor costs in value added, L_{it} denotes the number of workers, and K_{it} denotes capital stock. Index i denotes the firm and t denotes the year.

Table 4 shows the estimation results. We conduct three regressions for each type of productivity: simple OLS, panel fixed effect estimation, and system GMM estimation. All estimations measure the effect of a firm's productivity on its financial constraints. As we discussed above, there is a simultaneity problem between productivity and the financial constraints index, which introduces a bias for the coefficient of the estimation in the simple OLS and panel fixed effect estimations. On the other hand, Blundell and Bond's (1998) system GMM estimation estimates the parameter consistently by solving the problems of weak instruments and simultaneity. This method is often used in a dynamic panel setting, but is also useful in a non-dynamic panel setting (see Aguirregabiria, 2009).

As with labor productivity, there is no sign of a significant effect of productivity on financial constraints. On the other hand, as with TFP, all three regressions show that productivity significantly affects a firm's financial constraints. Quantitatively, a 1% fall in productivity leads to an maximum increase in financial constraints index

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[12]To explore the robustness of our estimations, we alternatively use sales per worker as labor productivity. This change does not alter the estimation results in Table 4 considerably.

Table 4: Effect of TFP on financial constraints

Dependent variable: Log of financial constraints (Θ)	OLS	Within	System GMM	OLS	Within	System GMM
Labor productivity	-0.015	-0.061	-0.050			
	(0.024)	(0.057)	(0.089)			
TFP				-0.011	-0.156	-0.610
				(0.007)	(0.067)	(0.142)
cons.	-1.963	-1.509	-1.547	-2.040	-1.138	-1.591
	(0.238)	(0.549)	(0.815)	(0.092)	(0.421)	(0.838)
Obs	17,574	17,574	17,574	17,400	17,400	17,400
Firms	1,806	1,806	1,806	1,805	1,805	1,805
m2			-0.38			-1.02
p-value			0.701			0.309
Hansen J-statistics			93.23			36.51
p-value			0.000			0.353

Notes. Instruments used in system GMM are each productivity variable lagged by $t-3$ and $t-4$ in the differenced equation and differenced lagged at $t-2$ in the level equation. All columns include a full set of time dummies. The "m2" statistics refer to the test for second-order autocorrelation in the first-differenced residuals, while the "Hansen J-statistics" are the tests for over-identifying restrictions. We use both statistics only in the system GMM. Standard errors robust to heteroscedasticity and within-firm serial correlation are reported in parenthesis.

of 0.61%. The reason that the two productivity indices lead to different results may be because a firm's capital intensity has a large influence on its labor productivity. The other reason is that the denominator of the definition of labor productivity; that is, the number of employees, has a non-negligible measurement-error because this variable does not account for the change in part-time workers and any working hours. Despite this problem, we can conclude that firm-level productivity is likely to determine the degree of financial constraints for each firm.[13]

6 Conclusion

This study investigates the degree of financial constraints among listed Japanese firms from 1994 to 2014. We derive the distribution of the financial constraints index and apply an econometric method from productivity analysis to analyze financial heterogeneity. The analysis yields several results. (i) The distribution of the financial constraints index has a gamma distribution with a long right tail. (ii) The spread between the 75th and the 25th percentiles grew since 2000. (iii) This increased dispersion in financial constraints is mainly due to the growth in inequality

---

[13]Morikawa (2007) shows that productivity dispersion in the Japanese service industry increased from 2001 to 2004 using firm-level panel data from the Basic Survey of Japanese Business Structure and Activities.

between firms within the same industry. (iv) The increased inequality in financial constraints seems to be linked with the increase in productivity dispersion.

Our results have some important policy implications. First, since the dispersion of the financial constraints index is due to inequality between firms within the same industry, governments should consider the issue of financial support for individual firms with severe financial constraints. Japan conducted such a policy from October 1998 to March 2001 through the Special Credit Guarantee Program for Financial Stability, with the aim of alleviating the severe credit crunch the small business sectors faced by completely covering default costs. Second, the source of dispersion in financial heterogeneity is possibly due to the increase in productivity dispersion, so governments should improve the productivity of low TFP firms, which decreases the dispersion in both productivity and financial constraints. As Oulton (1998) shows, we point out that competition policies such as relaxing the barriers to entry and competition with foreign firms can help increase the productivity of poor performers and decrease productivity dispersion. Since the credit guarantee program can lead to moral hazard among private financial institutions (see Uesugi et al., 2010), it will be useful to adopt both policies simultaneously.

Our results have an important caveat. Our sample of firms does not represent the whole population of firms in Japan. Specifically, our sample includes only listed firms, though there are many more non-listed firms in Japan. Quantitatively, the capital expenditures of our sample represented about 11.2 trillion yen in 2014, which is about 16% of Japanese total investments for that year (68.4 trillion yen from the System of National Accounts). Since non-listed firms are more likely to face severe credit rationing, our results possibly underestimate the degree of financial constraints in Japan. Data limitations are an important reason why we do not use data on non-listed firms, but validating our measure with such data represents a potentially fruitful avenue of future research.

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Appendix A: The model

In this appendix, we explain the benchmark model, which is based on the model developed in Whited (1992) and Whited and Wu (2006). This model is the basis for our estimation. A representative firm maximizes its market value, which is defined by the present value of future dividends:

$$V_{it} = E_{it} \sum_{j=0}^{\infty} \beta_{t,t+j} d_{i,t+j}, \tag{A.1}$$

where V_{it} is firm i's market value at time t, E_{it} is firm i's expectation operator conditional on the information available at time t, $\beta_{t,t+j}$ is the stochastic discount factor at time $t+j$, and $d_{i,t+j}$ is firm i's dividend at time $t+j$.

We obtain the following relation from the definition of dividends:

$$d_{it} \equiv (1-\tau_t)\left[\pi(K_{it}, A_{it}) - \psi(I_{it}, K_{it}) - i_t B_{it}\right] - (1-z_t)I_{it} + B_{i,t+1} - (1-\pi_t^e)B_{it}, \tag{A.2}$$

where τ_t is the corporate income tax rate, K_{it} is firm i's quantity of capital stock, A_{it} is firm i's productivity, I_{it} is firm i's gross investment, i_t is the nominal interest rate, B_{it} is firm i's debt outstanding, z_t is the present value of tax savings from investment allowances on a unit of investment, and π_t^e is the expected inflation rate. Here, we evaluate each term as a real value by normalizing the capital goods price to one. The function π is the firm's profit function and the function ψ is the adjustment cost function.

This model has the following constraints:

$$K_{i,t+1} = I_{it} + (1-\delta)K_{it}, \tag{A.3}$$

$$d_{it} \geq d_{it}^*, \tag{A.4}$$

$$B_{i,t+1}^* \geq B_{i,t+1}. \tag{A.5}$$

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Equation (A.3) represents the law of motion for capital and δ expresses the depreciation rate. Equation (A.4) represents the limitation of outside equity financing. A negative value for d_{it}^* implies that the firm is able to issue new equity. Finally, Equation (A.5) represents the borrowing constraint and the variable $B_{i,t+1}^*$ is the debt ceiling at time t. We derive Equation (A.5) from the imperfect credit market. If the credit market is perfect, firms can borrow as much as they like. On the other hand, an imperfect credit market has information asymmetries between firms and lenders, giving rise to this constraint.

This describes the full model. The representative firm maximizes Equation (A.1) following constraints (A.2) to (A.5). Let λ_{it} be the series of Lagrange multipliers associated with Equation (A.4) and let γ_{it} be the series of Lagrange multipliers associated with Equation (A.5). Then, we obtain the following first-order conditions for capital and debt outstanding:

$$
E_{it}\beta_{t,t+1}\left[\left(\frac{1-\tau_{t+1}}{1-\tau_t}\right)\left(\frac{1+\lambda_{i,t+1}}{1+\lambda_{it}}\right)\left(\pi_K(K_{i,t+1},A_{i,t+1})-\psi_K(I_{i,t+1},K_{i,t+1})\right.\right.
$$
$$
\left.\left.+(1-\delta)\left(\psi_I(I_{i,t+1},K_{i,t+1})+\frac{1-z_{t+1}}{1-\tau_{t+1}}\right)\right)\right]=\psi_I(I_{it},K_{it})+\frac{1-z_t}{1-\tau_t},
$$
$$
\tag{A.6}
$$

$$
(1+\lambda_{it})-E_{it}\left[\beta_{t,t+1}(1+(1-\tau_{t+1})i_{t+1}-\pi_{t+1}^e)(1+\lambda_{i,t+1})\right]-\gamma_{it}=0. \tag{A.7}
$$

Appendix B: Estimation method

In this appendix, we explain the estimation procedure for our investment Euler equation in detail. To estimate the Euler equation for capital (Equation (A.6)), we first rewrite this equation with the expected error term:

$$
\beta_{t,t+1}\left(1-\Theta_{it}\right)\left(\frac{1-\tau_{t+1}}{1-\tau_t}\right)\left(\pi_K(K_{i,t+1},A_{i,t+1})-\psi_K(I_{i,t+1},K_{i,t+1})\right.
$$
$$
\left.+(1-\delta)\left(\psi_I(I_{t+1},K_{i,t+1})+\frac{1-z_{t+1}}{1-\tau_{t+1}}\right)\right)=\psi_I(I_{it},K_{it})+\frac{1-z_t}{1-\tau_t}+e_{i,t+1},
$$
$$
\tag{B.1}
$$

where $\Theta_{it}\equiv 1-(1+\lambda_{i,t+1})/(1+\lambda_{it})$. The variable $e_{i,t+1}$ is firm i's expected error and is orthogonal to any variable in the information set of firm i at time t.

Before estimating the Euler equation, we must specify the relevant functions. First, we specify the marginal revenue product of capital (π_K). If the goods market operates under perfect competition and the production function meets the constant returns to scale property, then the profit function becomes linear with capital. In

this case, the marginal revenue product of capital is equal to the average revenue product of capital, and thus

$$\pi_K(K_{it}, A_{it}) = \frac{Y_{it} - C_{it}}{K_{it}}, \tag{B.2}$$

where Y_{it} represents firm i's operating revenue and C_{it} represents firm i's variable costs. We evaluate both terms as real values. On the other hand, if the goods market is imperfect, then the marginal revenue of capital becomes

$$\pi_K(K_{it}, A_{it}) = \frac{Y_{it} - \mu C_{it}}{K_{it}}, \tag{B.3}$$

where μ is the markup.

Next, we consider the specification for the adjustment cost function. We specify this function as

$$\psi(I_{it}, K_{it}) = \frac{\alpha}{2} \left(\frac{I_{it}}{K_{it}} - \delta \right)^2 K_{it}, \tag{B.4}$$

where α is the parameter associated with the adjustment costs and this value is positive. Adjustment costs occur due to the net investment change, and the second derivative of this function on gross investment is positive.

Finally, we consider the term Θ, which we construct from the Lagrange multipliers. From Equation (A.7), we find that Θ is closely related to the borrowing constraint. Further, we determine the severity of the borrowing constraint by the quantity that firms can borrow ($B_{i,t+1}^*$). As we show in the main body of the text, since land assets play an important role as collateral in Japan, we use the ratio of loans outstanding to land assets to represent the collateralizable net worth of the firm and formulate Θ as follows:

$$\Theta_{it} = c_1(LOAN_{i,t-1}/LAND_{i,t-1}) + c_2(LOAN_{i,t-1}/LAND_{i,t-1})^2, \tag{B.5}$$

where $LOAN_{i,t-1}$ is the debt outstanding at the beginning of time t and $LAND_{i,t-1}$ is the land stock at the beginning of time t.

Then, we can summarize our structural model to estimate as

$$\beta_{t,t+1} (1 - \Theta_{it}) \left(\frac{1 - \tau_{t+1}}{1 - \tau_t} \right) \left\{ \left[\frac{Y_{i,t+1} - \mu C_{i,t+1}}{K_{i,t+1}} \right] + \frac{\alpha}{2} \left[\left(\frac{I_{i,t+1}}{K_{i,t+1}} \right)^2 - \delta^2 \right] \right. \tag{B.6}$$

$$\left. + (1 - \delta) \left[\alpha \left(\frac{I_{i,t+1}}{K_{i,t+1}} - \delta \right) + \frac{1 - z_{t+1}}{1 - \tau_{t+1}} \right] \right\} - \alpha \left(\frac{I_{it}}{K_{it}} - \delta \right) - \frac{1 - z_t}{1 - \tau_t} = e_{i,t+1},$$

$$\Theta_{it} = c_1(LOAN_{i,t-1}/LAND_{i,t-1}) + c_2(LOAN_{i,t-1}/LAND_{i,t-1})^2.$$

As we show at the beginning of this appendix, firm i's expected error at time t is orthogonal to any variable in the information set of firm i at time t. We estimate (B.6) in the first difference to eliminate possible fixed firm effects. By defining the

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subset of the information set of firm i at time $t-1$ as $Z_{i,t-1}$, we derive the following conditions:

$$E(Z_{i,t-1} \otimes (e_{i,t+1} - e_{it})) = 0. \qquad (B.7)$$

We use GMM to estimate (B.7), which requires us to use instruments from the firm's information set at time $t-1$.

Appendix C: Data construction

1. Sample selection

Our data source is the Development Bank of Japan database. We use this database from the 2016 CD-ROM version. This database incorporates the financial statements of all listed firms in Tokyo, Osaka, Nagoya, and other regional stock exchanges in Japan from 1960 to 2016. The data also contains the information on all entrants and exiters. We dropped the observations that satisfy any of the following conditions:

1. Firms in the agriculture, forestry, and fisheries; mining; electric, gas, water services; transport and postal activities; and financial services industries.

2. Observations with negative total assets, a debt ratio of greater than one, or sales growth of greater than 100%.

3. Firms without at least five consecutive years of complete data.

4. Firms with more than two consecutive years of negative operating profits.

5. Observations whose values are at the top and bottom 1% level.

2. Description of the variables

Capital stock (K_{it})

We construct the series of physical depreciable capital stock using the perpetual inventory method (Hayashi and Inoue, 1991). The benchmark capital stock is that of fiscal year 1980. For companies that opened after 1980, the base year is the year following the starting year. We assume that the book value of capital stock in this period is equal to the capital stock on a replacement cost basis. The physical depreciation rate is 8% per year. Given the benchmark value of capital stock, we can obtain the real capital stock series from the following equation:

$$K_{it+1} = (1 - \delta)K_{it} + I_{it},$$

where I_{it} is firm i's real investment.

Investment (I_{it})

First, we calculate the nominal investment using

$$
\begin{aligned}
\text{Nominal investment} \quad = \quad & \text{Depreciable property in the current period} \\
& - \text{Depreciable property in the previous period} \\
& + \text{Depreciation}
\end{aligned}
$$

We deflate this value using the corporate goods price index (base year, 2010), which is an index of the stage of demand for and use of capital goods. We downloaded this data from the Bank of Japan database.

Debt outstanding (B_{it})

We use the sum of firm i's long-term loans payable, short-term loans payable, and corporate bonds at the beginning of period t as B_{it}. We evaluate this variable at nominal values.

Land stock (L_{it})

We follow the perpetual inventory method to calculate the market value of the land stock series. Fiscal year 1980 is the benchmark period. For companies that opened after 1980, the base year is the year following the starting year. We compute the benchmark stock of land at the market price by multiplying the price to book ratio calculated from the System of National Accounts and Yearly Report of Financial Statements of Incorporated Business (the price to book ratio is 5.5 in 1980). We calculate the net investment in land as follows:

$$
\text{NILAND}_{it} = \begin{cases} \text{ILAND}_{it}, & \text{if} \quad \text{ILAND}_{it} > 0 \\ \text{ILAND}_{it} \frac{P_t^L}{P_{t-1}^L}, & \text{if} \quad \text{ILAND}_{it} < 0 \end{cases} ,
$$

where we calculate land investment (ILAND) as

$$
\text{ILAND} = \text{Land in current period} - \text{Land in previous period}
$$

We make the LIFO-type assumption that the land sold in period t was purchased in the most recent period, $t - 1$. Finally, we calculate the land stock at the market price as

$$
L_{it} = L_{i,t-1} \frac{P_t^L}{P_{t-1}^L} + \text{NILAND}_{it}.
$$

The land price index (P_t^L) is that of the national urban land for all uses in the Land Price Index in Cities published by the Japan Real Estate Institute. This variable is nominal.

Output (Y_{it}) and cost (C_{it})

Our output includes sales plus the changes in finished goods inventories. Our cost variable consists of costs of goods sold plus general, selling, and administrative expenses minus capital depreciation. We deflate these values using the corporate goods price index.

Corporate income tax rate (τ_t)

We use the combined corporate income tax rate from the OECD Tax Database. Since we cannot use this series from 1980 to 1999, we construct this series using the following formula:

$$\tau_t = \frac{\text{Central government tax rate} \times (1 + \text{Inhabitants tax rate}) + \text{Enterprise tax rate}}{1 + \text{Enterprise tax rate}}$$

We base this formula on the definition of statutory corporate income tax rate, considering the special treatment of the enterprise tax rate.

Tax savings from depreciation allowances (z_t)

Under the static expectations for the future tax rates and discount rates, we can obtain the following expression for z_t:

$$z_t = \frac{\tau_t \delta}{1 - \beta_{t,t+1}(1 - \delta)},$$

where the variable β is the discount factor. This is the same as in Ogawa et al. (1996).

Discount factor ($\beta_{t,t+1}$)

First, we construct the nominal interest rate for each firm as follows:

$$i = \frac{\text{Interest expenses}}{\text{Long-term loans payable} + \text{Short term loans payable} + \text{Corporate bonds}}$$

Second, we calculate real interest rate using the corporate goods price index and adjust these values by the tax savings from the firm's debt. Finally, we use the median values as the common discount factor for all firms for each year.

Cash flow

We construct this variable using each firm's current net income plus depreciation.

Cash holdings

Cash holdings refers to the cash and deposits with banks.
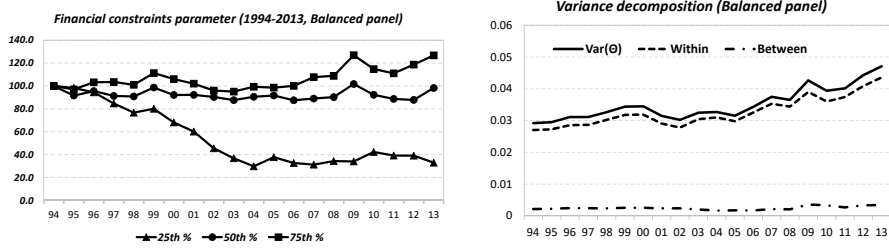
Figure 4: Evolution of financial heterogeneity in a balanced panel
Notes. The symbols here have the same meaning as in the previous figure.

Tax payments

We calculate tax payments as income taxes-current minus income taxes-correction or deduction.

Appendix D: Firm entry and exit

The entry and exit of firms can affect the increase in financial heterogeneity that we observe in the main text. For example, entrants must meet strict listing criteria when they list their stocks on a stock exchange. Hence, they will have lower leverage ratios in their starting periods in general. If entry barriers decreased due to liberalization in recent years, then a wider variety of entrants will enter the market, which possibly leads to an increase in the fraction of firms under weak credit constraints that we observe in Section 4. On the other hand, exiters can also affect the dispersion of financial constraints. Since one of the main reason for a firm delists is a default, then an increase of exiters can decrease the fraction of firms under severe credit constraints, which leads us to underestimate the dispersion in financial constraints.

To check this effect, we exclude all entrants and exiters and look at the evolution of financial heterogeneity for a balanced panel of continuing firms. That is, we focus on the firms that existed for the entire period of 1994 to 2014. We find 1,137 continuing firms, which is almost the half of the entire sample of firms. Using this sample, we conduct the same analyses in Section 4. Figure 4 depicts the results. The left panel in the figure shows an increase in financial heterogeneity in a balanced panel without the effects of entries and exits. The right panel in the figure shows that the dominant reason for this rise in financial heterogeneity depends on the growth in inequality between firms within the same industry. We can conclude that entrants and exiters do not cause the financial heterogeneity we find in the main text.